STUDIES ON SOME METABOLIC PROFILES IN BLOOD OF BLACK BENGAL GOAT (*Capra hircus*) REARED UNDER GRAZING MANAGEMENT SYSTEM

A THESIS
SUBMITTED TO THE
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
VETERINARY PHYSIOLOGY AND CLINICAL BIOCHEMISTRY

By
Sm. SUJATA NAYAK (JANA)

DEPARTMENT OF VETERINARY PHYSIOLOGY
& CLINICAL BIOCHEMISTRY
FACULTY OF VETERINARY AND ANIMAL SCIENCES
BIDHAN CHANDRA KRISHI VISWAVIDYALAYA
MOHANPUR, WEST BENGAL
1988

Bidhan Chandra Krishi Viswavidyalaya

Dr. B.Bhattacharyya,B.Sc,M.V.Sc.,Ph.D.
Reader
Deptt. of Physiology and Biochemistry

C E R T I F I C A T E

This is to certify that the thesis entitled "Studies on some metabolic profiles in blood of Black Bengal goat (Capra hircus) reared under grazing management system submitted by Sm. Sujata Nayak (Jana) in fulfilment for the award of the Degree of Doctor of Philosophy in Veterinary Physiology and Clinical Biochemistry is a record of bonafide research carried out by her under my guidance and supervision. No part of this thesis has been submitted to any other University or Institute for the award of any degtee or diploma. The assistance and help received during the course of investigation and sources of literature have been fully acknowledged.

(B. Bhattacharyya)

Dated,Mohanpur
The 29th Feb 1988

A C K N O W L E D G M E N T

At the outset, I must bow down my head towards the subline supremity and also towards my parents, whose good wishes have inspired me to take up the research work.

It is a great pleasure for me to pay my regards and record my indebtedness to my supervisor, Dr. B.Bhattacharyya, B.Sc.,M.V.Sc Ph.D.,Reader, Deptt. of Physiology and Biochemistry, Faculty of Veterinary and Animal Sciences, Bidhan Chandra Krishi Viswavidyalaya whose guidance and constant supervision enabled me to complete this research. I express my heatfelt gratitude to him.

It is a proud privilege to record my humble regards and sincerest gratitude to my revered teacher Prof. D.N.Moitra, B.Sc., M.V.Sc., Ph.D., Deptt. of Animal Production and Management. His constant encouragement and active help has inspired me to overcome a number of difficulties which actively helped me to complete this work.

I am greatly indebted to my revered teacher, Prof.B.N.Roy, B.Sc., M.V.Sc., Ph.D., Deptt. of Physio. & Biochemistry and Prof. S.P.Ghosh, B.Sc., M.V.Sc., Ph.D. Deptt. of Biochemistry and Physiology. My grateful thanks are due to them for encouragement.

I am so very grateful to Dr. S.Bhowmik (Roy), Lecturer, Deptt. of Physio. and Biochemistry, who took all interest to help me in may ways regarding this thesis work.

I acknowledge the help I received from Dr.M.K.Dasgupta, M.V.Sc., Ph.D., Reader, and Dr.S.Sanyal, M.V.Sc, Lecturer,Deptt. of Physiol. and Biochem. for their sincere and active co-operation.

I also take this opportunity of placing on records my regards and heartful thanks to Dr.R.Duttagupta,M.V.Sc.,Ph.D., Reader, Animal Genetics and Breeding for his helpful suggestion and statistical analysis of the data.

I am very grateful to Head of the Deptt. of Animal Production and Management for providing all possible farm facilities including experimental animals and all necessary experimental requirements during the entire experimental periods. I also express my thanks to the Head of the Deptt. of Animal Nutrition for laboratory facilities.

I shall be falling in my duty if I do not express my sincere gratitude and heartful thanks to Dr.A.Chakraborty,M.V.Sc., Ph.D., Head, Deptt. of Pharmacology and Toxicology, Dr.S. Bandopadhya, M.V.Sc., Ph.D., Head, Deptt. of Gynaecology and Obstitrics, Dr.S.K.Mitra, M.V.PH., Dr. A.K.Pramanik, M.V.PH, Deptt. of Medicine and Public Health, Dr. T.Ghosh, M.V.Sc., Ph.D., Dr.P.Biswas, M.V.Sc., Ph.D., Deptt. of Animal Nutrition, Dr.M.N. Chaudhury, M.Sc. and M.N.Roy, M.V.Sc., Deptt. of Anatomy and Histology for their co-operation and active help.

I am also thankful to all staff of the Deptt. of Physiology and Biochemistry for their heartful co-operation and to the supporting staff of the goat farm under the Deptt. of Animal Production and Management.

I am indebted to Dean, Faculty of Veterinary and Animal Sciences and Dean, Postgraduate Studies for providing me necessary facilities to work in this University.

I am thankful to the Librarian and staff of the Library, Bidhan Chandra Krishi Viswavidyalaya,Nadia for their intensive help.

Thanks are also due to S.Biswas for the neatly typing this manuscript.

I am also to acknowledge my indebtedness to many others particularly Dr. T.K.Nayak, M.B.B.S., Mr. T.Nayak, M.Sc., Miss K. Nayak, M.A. and Dr.A.K.Bera, M.Sc.,Ph.D. for their constant encouragement and active co-operation.

The financial help received from the Vice-Chancellor to work as University Research Scholar is greatly acknowledged.

Sujata Nayak (Jana)

TABLE OF CONTENTS

List of tables

List of figures

C H A P T E R - I

INTRODUCTION

INTRODUCTION

India is predominantly an agricultural country. The present day population explosion in our country had demanded all-out development in the field of agriculture and livestock to meet the challenge of food shortage in our country. We have made considerable progress in the field of agriculture and boosted up production of agricultural commodities with the use of latest scientific knowledge. The development in the field of livestock production is not that much encouraging due to some inherent constrains. But scientists engaged in the livestock development programme are putting their best to increase the production potential of our livestock population by careful manupulation of genetic materials. But full expression of genetic potentiality demands adequate supply of nutrition to the livestock population. The supply of balanced nutrition to the livestock population has become practically impossible due to competetion by the ever-increasing human population for the common food ingredients. For this reason we are trying our level best to formulate unconventional feed as feed-ingredients to boost up the production of our livestock. Our interest so far has been centred round the increasing production of our cattle population to bring about white revolution vis-a-vis green revolution in the field of agriculture.

In this regard our scientific endeavour failed to extend full justice to livestock species like pig,sheep and goat,etc. According to Indian Livestock Census (1977) report, the total sheep and goat population in India is around 41.75 million. These animals are mostly reared by small and marginal farmers of our country who are not equally very viable to raise livestock species like cattle, buffalo, etc. Yet these small ruminants assure some economic help to them. In addition to that these small ruminants particularly sheep and goat contribute a great deal to our National economy in the form of meat, milk, hairs, etc. Very recently scientists have diverted their attention for proper development of these small livestock species. As a result of scientific interest recommendation are coming up covering the field of animal genetics, nutrition, managemental aspect for proper development of these livestock species. In many cases, recommendation on the basis of laboratory experiments like intensive and semi-intensive management system though assures desirable output is not always acceptable by small and marginal farmers of our country, due to their low-economic status. For instance supply of concentrate is beyond their means and even cultivation of improved variety of fodders is not possible for them due to paucity of land. As a result of that goats are mostly reared under what is known as extensive husbandry system e.g. they are taken to graze freely on natural vegetation nearby or drive them place to place in search of vegetation.

Moonro and Allison (1964) stated that much of the land masses of the world have terrain or a climate that makes cultivation of land difficult or impossible but these areas support an indegenous population of ruminants on account of ruminants ability to live upon a miscellaneous population of plant food. The ecology of such area is worth studying with object of propagating and harvesting these animals as a contribution to world supply of animal protein. Mackenzie (1980) reported that free range grazing and browsing is ideal system provided frequent change to clean ground is possible and with this type of management, kids need no concentrate and indeed it is much better without. Johari and Talapatra (1971) studied the growth performance of Jamunapari goat under browsing and stall feeding conditions, the gain in body weight by the farmer was found to be more. Singh and Rakeb (1979) studied the effect of feeding natural grass and barseem on growth rate and nutrient utilization in barbari kids. A positive calcium and phosphorus balance was reported in natural grass feeding group.

The available literature indicates that nutritional experiments at different level of concentrate and or rouphage only deals with digestibility of feed constituents, metabolic trials and body weight gain of the experimental animals. Information are also available dealing with pattern of rumen metabolites under different feeding regime. Such type of study hardly reflects nutritional status of the animals in general under natural habitation in agriculturally developed area. The development of deficiency

under conditions of dietary inadequacy depend upon a number of factors. These are the status of initial reserve, period of deprivation and also the nature of nutrients in feeds. With the exhaution of nutritional reserves, the tissues get deplited and suffer from biochemical lesion consequent of interference of enzymetic pathways. The nature and extent of biochemical lesion which may not still find clinical expression are discernable by qualitative and/or quantitative changes in the turn over, distribution and excretion of metabolic end product. As already pointed out, sufficient information are not available dealing with nutritional status of the animal reared under extensive management system e.g. under natural habitation under different geo-climatic regions. The study of some metabolic profiles under different physiological stages for instance growth, reproduction and production in animals under exclusive grazing management system is considered very essential for assessing nutritional status of these animals and suggesting improvement and/or remedial measures, if necessary.

C H A P T E R - I I

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The goats are well known for their special feeding habit which enable them to meet the basic nutrient requirements for body functions better than any other domestic ruminants.However for optimum and satisfactory level of growth reproduction and production supplementation with additional nutrients may be necessary. The goat is also considered to be superior to other ruminant animals by its conversion efficiency/unit body weight. The special feeding habit of goat and conversion efficiency are considered very significant in our tropical areas due to scarcity of available nutrients.

Unfortunately, nutritional aspect of goat, particularly the grazing goat has not been properly worked out. Available literature on various aspect of nutrition of grazing goat and other ruminant animals are reviewed here.

Hossain (1950) conducted digestibility trial with pipel (Ficus religiosa) leaves with 20 g rape seed and 5 g salt on goat. The digestibility coefficient of dry matter (D.M.) crude protein (C.P.) ether extract (EE), crude fibre (C.F.) and nitrogen free extract (NFE) were 44%, 53%, 29%, 23% and 56% respectively. The average daily intake was 1726 g/100 kg live weight.

Fels et al. (1959) reported herbage intake of grazing sheep weighing 110 lbs varied from 900-1300 g of organic matter/day on clover pasture. The estimate was made on foecal nitrogen index. Intake was low on dry clover which was possibly of low digestibility.

Mazumder (1960) studied the minimum protein requirement for maintenance of goat. The metabolism trial conducted with 0.18% nitrogen to supply 2.81 lb dry matter/100 lb live wt. and also 0.029% nitrogen to supply 2.13 lb dry matter. Dairy requirement of digestible crude protein (DCP) for maintenance of goat was calculated to be 0.65 lb/1000 lb live weight.

Ellot and Topps (1963) observed that low dry matter intake from forages by sheep particularly in tropics may be due to high water content of the ingested forages.

Prosad (1964) reported that dry matter consumed by goat was 2.28 kg/100 live weight. The digestibility co-efficient of dry matter, crude protein, ether extract crude fibre and nitrogen free extract were 64.2%, 48.8%, 60.7%, 40.60% and 75.3% respectively of babul pods fed to bucks.

Devendra (1967) compared the nutrient intake and digestibility of two varieties of guinea grass (Penicum sp.) by goat and sheep. The digestibility of dry matter and crude fibre was 73.0 and 69.9 in goat whereas 70.4 and 62.1 in sheep respectively.

Pachauri et al. (1970) studied the nutritive value of Dhub hay (Cynodon dectylon) for adult sheep. It was found that Dhub hay was fairly palatable and its DCP was 2.65%, TDN 45.04%. The balance of nitrogen was marginally negative but calcium and phosphorus was positive.

Joshi and Ludri (1970) studied the plane of nutrition in grazing sheep during different months. The pasture (Dhub grass mainly) consumption by grazing in terms of dry matters intake during different months of year varied from 2 to 4.8 kg/100 kg body weight. The average was about 3 kg dry matter/100 kg body weight. From the result it was concluded that if animals were properly grazed for atleast 8 hrs. their bulk of requirement could be met from grazing alone practically all the year round even during the worst period.

Saxena and Maheswari (1971) observed the intake of jamnapuri goat maintained on browsing at Chakkranagar and Mathura during different seasons of the year. The dry matter consumption kg/100 kg live weight at Chakkranagar ranged between 2.42 to 3.58 kg whereas Mathura it varied from 1.47 to 2.6 kg. The digestibility coefficient was comparable at two places and was not affected by seasons.

Johari and Talapatra (1971) in an comparable study of browsing and stall feeding in Jamnapari goat, observed that feed consumption and digestibility co-efficient were varying between the age from 3 to 12 months and weight from 7.0 to 12.0 kg. The rate of growth under browsing showed 0.547 kg per fortnight as

against 0.333 kg under stall feeding. The average protein content of the range herbage on which the kids browsed was 17.15% while the crude protein content of various green feeds in the stall during the four months of September to December varied from 9 to 18.5%. They suggested that browsing practice is a cheeper method of rearing kids.

Bhandari and Gupta (1972) reported that dry matter intake from green Ardu (Ailanthens excelsa Roxb) leaves by Malpura rams was 4.26 kg/100 kg live weight.

Djafar and Chinfook (1972) studied the digestibility of four variety of grasses like napier, hybrid indis, Pennisetum parpurium and Tremada willese. It was observed that goat consumed 331, 314, 326 and 211 g dry matter daily. The digestibility of D.M. was 66.98, 76.57, 71.20 and 99.77. The grasses had gross energy value 4929, 3904, 4238 and 4162 KCal/g and digestible energy was 94, 75, 66 and 44 respectively.

Chanost (1972) studied the variation of intake and digestibility of dry matter of pongola grass (Digitaria decumbens) cut after 30-50 days in Alpine male goats. The trial continued for 18 months. The mean digestibility of organic matter was 68.5% and 60.5% after 30 and 50 days and showed a slightly seasonal variation. The intake of dry matter varied from 1.00 to 2.60 kg/100 kg live weight but was not significantly affected by age. The intake of dry matter was not related to dry matter content or digestibility and was slightly related to proportion of leaves. The

magnitude of variation of dry matter intake due to season was 1.00 kg/100 kg live weight.

Sutoh et al. (1972) in a study of digestibility trial of green oats silage cut at root, headling and flowering and milk ripe stage observed the digestibility of organic matter at respective stage 56.9, 61.3, 75.2 and 59.8% in goat. It was concluded that digestibility of silage was influenced more on stage of growth of the grass than by silage quality.

Gallagher and Shalton (1972) conducted digestive trials in metabolic cages on mature male Angora kids and mature Rambonillet ewes with a ration containing 20% cotton seed husk, 25% ground lucern hay, 40% dry rolled sorgham grain and 4% feather meal with trace elements. The organic matter digestibility of different groups were 56.7%, 55.4%, 66.2% and 60.2% respectively. The digestible energy intake were 2743, 1819, 3907 and 3514 KCal per day respectively.

Hamada et al. (1973) conducted digestibility trial with lucern hay cubes and Italian rye grass hay with castrated goats. The average digestibility co-efficient for crude protein, ether extract, nitrogen free extract and crude fibre were 74, 51, 72 and 42 for lucern cubes and 48, 44, 56 and 64 in rye grass hay.

Banerjee and Mondal (1974) reported nutritive value of Dinonath grass (Pennisetum pedicellatum) for adult sheep. The D.M. consumption was 2.17 kg/100 kg body weight. The digestibility of various organic nutrients were D.M. 55.7, C.P. 46.5,EE 47.5,

C.F. 45.1 and NFE 75%. The DCP and TDN values were 3.03 and 52.77 respectively.

Nooruddin et al. (1975) reported digestibility and nutritive value of marvel (Dicanthium annulatum) grass at flowering stage. The chemical composition of the said grass at flowering stage was reported as C.P. 6.33, EE 2.07, C.F. 27.22, NFE 53.10, Calcium 0.54 and Phosphorus 0.30%. The average digestibility of different nutrients is D.M. 48.53, C.P. 47.44, EE 44.56, C.F. 10.25 NFE 46.22%. They reported that the goats recorded a positive balance for calcium phosphorus and nitrogen.

Maheswari and Talapatra (1975a) evaluated nutritive value of cowpea, both green and hay as fodder for stall feeding of Jamnapuri goat. The average intake of green fodder was 3.03 kg/100 kg whereas 4.04 kg/100 kg in case of hay. It was concluded that the hay was more palatable than the green. Milk production was adequate during hay feeding.

Maheswari and Talapatra (1975b) reported berseem as fodder for milch goats. The average dry matter intake of lactating Jamnapuri goat was 4.67 kg/100 kg live weight. The average digestibility coefficient of barseem green fodder for crude protein, ether extract crude fibre and nitrogen free extract was respectively 79.9%, 40.4%, 70.9% and 41.3%. The goat had positive calcium and phosphorus balance during trial.

El Mog (1976) reported that with decreasing quality of roughages the digestibility of fibre components increases in desert goats.

Joynal and Johri (1977) studied the nutritive value of sunhemp hay (Crotalaria juncia) on buck. They reported that the dry matter consumption was 3.03 kg/100 kg body weight. The digestibility co-efficient of different components was as follows, D.M. 56.25 ± 1.03, C.P. 69.78 ± 1.01, E.E. 38.23 ± 2.44, C.F. 53.59 ± 1.64. The bucks recorded positive balance for nitrogen.

Winter et al. (1977) reported Beef Cattle production from 2 grasses/legumes over 3 years. The grasses were either Brachiarea decumbens or Penicum maximum (Common gunea grass). The grasses had little effect on animal production although penicum pasture was overgrazed and required destocking during experiment. The live weight gain was similar (0.54 kg/day) but was significantly less at higher stocking rate.

At highest stocking rate the gain was greater during wet season and lesser during dry season than those at the lesser stocking rate. The phosphorus supplementation did not affect live weight gain but increased blood inorganic phosphorus level.

Bhatia et al. (1978) reported plane of nutrition of Malpura rams grazing on pasture in semi arid areas of Rajasthan. The pasture grass was primarily of Cenchrus grass and Zizyphus bushes.

James (1978) fed leaves and soft twigs of Lancaene ancaeaaheta to Saamen x Malaberi cross goats and reported that the dry matter digestibility and digestibility of crude protein were 67.6% and 70.6% respectively.

Patnayak et al. (1979) reported nutritional value of cow pea, moth (dewgreen) and clusterbeen fodder as hay fed to sheep.

Jindal et al. (1979) studied the effect of high energy supplementation on nutrient utilization and energy balance during growth in goat. The goats were fed 3 levels of energy. Morrission's standard and also 20 and 40% above this standard. The average daily gain in weight was 92.21, 108.85 and 67.74 g in respective group. The crude protein and ether extract digestibility were increased significantly with increase in energy level in the diet. It was concluded that beyond appropriate level, feeding with high energy level diet is uneconomic.

Nabi (1980) reported nutritional studies of sheep under range condition. It was reported that the sheep grazing on Alpine pasture had average dry matter intake of 3.16 kg/100 kg live weight/day during September and 2.98 kg/100 kg during October.

Ghosh (1981) studied water turnover, water requirement and nutrient utilization of Black Bengal goat in different season both under stall feeding and grazing condition. The dry matter intake (kg/100 kg live weight) was not significantly different between stall fed and grazing groups. It was further observed

that season and sex had no significant influence on dry matter intake. The range of dry matter intake was 2.0 to 3.5 kg/100 kg body wt. in different seasons.

Joshi (1985) reported that Makarakari grass can be used as feed for sheep. The intake of ME (469 kg/kg $W^{0.75}$) from grass was more than adequate for maintenance. The protein value of the grass was also satisfactory (50 g D.C.P./kg DM). The supply of calcium and phosphorus was also satisfactory.

Plan of nutrition and chemical composition of pasture

Nath and Malik (1970) studied the chemical composition and nutritive value of Tribalus terrestris L. both green and at post flowering stage, when 50-60% fruit was formed by feeding it to four ram lambs. The plant contained 12.06% C.P., 2.61% E.E., 27.78% C.F. and 40.83% NPE, 68.61% calcium, 0.240% phosphorus. The intake was 3.39 kg/100 kg b.w. of dry materials. The plant was very rich in calcium, C:P ratio was very wide. Dried plant was refused by the rams.

Panday et al. (1971) evaluated nutritive value of akra for adult sheep. Metabolic trial was conducted on six adult sheep fed on G.N. cake and wheat bhusa (control) and wheat bhusa and akra (Exp). Digestible C.P. and T.D.N. in akra was 24.64 and 68.99% respectively. Intake of wheat bhusa was 30% more during akra feeding than during G.N. cake feeding. Loss of urinary nitrogen was comparatively lower so that animal

retained more nitrogen during experimental period. Results indicated superiority of akra protein possibly due to better protein and carbohydrate ratio.

Chakraborty and Bhatia (1971) made a grazing studies in arid and semi arid zones of Rajasthan and assessed performance of wether in sown and natural pasture at Pali with supplemental feeding. The shown pasture consisted of Cenchras setigarus vahl and Dicanthium annulatum. Natural pasture was dominated by Aristida sp. and Ellusive compressa. Withers grazing on shown pasture indicated 188 and 196% extra gain in their body weight over natural pasture on unit area basis. On supplementary feeding animals exhibited extra gain in their body weight 6.17 and 5.22 kg in shown pasture and 5.08 and 4.65 kg in natural pasture in 1966 - 67. Supplementary feeding also increased wool production by 23.6 and 12.6% in sown natural pasture respectively.

Pant and Roy (1971) studied the effect of two levels of barseem (Trifolium alexandrium) in the diet on rumen biochemical and microbial activity in buffaloes (4.5 vs 18 kg). No significant difference was observed in ruminal pH, TVFA concentration as a result of varying level of green in the diet.

Sood and Chopra (1973) reported effect of oxalate content of grasses which when present in high concentration may influence severe alkalosis due to break down of soluble potassium oxalate by rumen bacteria thereby inparing calcium assimilation. In addition, calcium may be rendered unavailable due to

high degree of alkalosis as a result of oxalate break down.

Singh et al. (1974) reported nutritive value of M.P. cheri at different stages of maturity in barberi bucks and Hariana bullocks. The preflowering cheri hervested to milk stage of growth a slightly higher consumption (2 kg/100 0 b.w.) D.M. was observed than cattle (1.78 kg/100 kg body weight) D.M. The digestable coefficient except ether extract was higher in goat than cattle. With goat and 3.30% D.C.P. content respectively were obtained at preflowering and flowering stage of growth while with cattle 2.20% was obtained at milk stage. The T.D.N. contents were 69.2 and 63.9% at preflowering and 50% flowering stage respectively in goat.

Agarwala and Pachauri (1974) studied the effect of supplementation of concentrate mixture or lucern hay on efficiency of feed utilization and performance of sheep fed basal ration Dhub (Cynodon dactylon) hay. A study was conducted on supplementation of concentrate or lucern (Medicago sativa) hay on the basal feeding Dhub for sheep feeding. Improvement was observed in general performance of chokla sheep as evidenced by gain and weight at 4-5 months and higher PCV (26.1 kg v.s. 30.2) ($P < 0.05$). A significant lower ingestion of D.C.P. (1.102 vs 2.173 g/100kg b.w.) ($P < 0.01$) and total digestibility of nutrients (13.42 vs 17.14 g/kg b.w.) on supplementing lucern hay when compared with concentrate suggest efficiency of utilization of Dhub.

Bertrand and Demavin (1975) studied certain characteristics of cool season annual forages and their relationship to performance by growing beef calves. The data indicated that under condition of unrestricted intake of high quality forages by calves of types used in this investigation on animal potential rather than forage quality was the limiting factor influencing average daily gain. From 84 days to the end of trial highly significant positive correlation (r=0.68 and r=0.61) existed between average daily gain and organic matter digestion and crude protein respectively. However highly significant correlation (r=0.80) between organic matter digestion and C.P. indicated that organic matter digestion was associated with 64% of the variability of CP or vice versa. The partial regresson coefficient show organic matter digestion was highly significant and indicated that it was most valuable measure for predicting animals performance after 84 days on experiment.

Sharkarnarrayan (Late) et al.(1975) reported utilization of spear grass pasture, monthly variation in yield, chemical composition and performance of arthers. The data shows that the growth period of spear grass (Heteropogon controlus) was only four months (July to October) like that of monsoon grass. There was rapid decrease in dry forage yield from July to August although highest yield was recorded in October. Crude protein(CP) content decreased from 6.0 to 5.0% from July to September. However because of increase in dry matter yield in September the

total C.P. remained about same. Likewise calcium and phosphorus also decreased from 0.38 to 0.31% and 0.32 to 0.25% respectively. It is suggested that hervesting time of spear grass for conservation is September for maximum nutrients/unit area. Decrease in crude protein, calcium and phosphorus as maturity advances was reported by different Indian workers. Sheep showed a steady gain in body weight from July to October. However from October onwards there was a tendency for maintaining body weight. Since there was close relationship between quality of herbage and amount eaten by animals the reason for lack in body weight gain seem to be related to protein calcium and phosphorus and low intake.

Singh et al. (1975) analysed cell wall content of sixteen important grasses available at Haryana Agri. University. In vitro digestibility of dry matter was also determined. In these grasses C.P. varied from 3.75 to 10.50% NDF 61.80 to 71.95, Cell content 28.5 to 38.2% ADF 28.90 to 40.40% Hemicellulose, 27.20 to 37.17%, cellulose from 18.55 to 30.40%, lignin from 2.75 to 9.75 and silica from 1.60 to 6.80%. In vitro digestibility of these grasses and their cell wall when incubated for 48 hours ranged from 52.70 to 67.60 and 33.84 to 49.5% respectively.

Gupta and Prodhan (1975) made a comparative study on legumes and non-legume forages. A large number of samples from six legumes and seven non-legumes sp. barseem (Trifolium alexandrium), cow (Vigna sinensis), Clusterbeen (Cyamopsis

faenumgraceum), white clover (Melidoras albu), Pearl millet (Pennisetum tyfrides) sorgam (Sorgam valgaris) P. grass (Pennisetum pedicellatum) sudan grass (Sorghum sadanense) and teosinte (Euchlaena maxicana) harvested at three stages of plant growth, preflowering, flowering and post flowering stages were analysed for their chemical constituents and in vitro nutrient digestibility.

An interesting observation was made that decline IVDMD was more rapid in grasses than legumes after flowering stage. Cell wall digestion was higher in non-legumes which may be due to less lignification of cell wall grasses.

Pal et al. (1975) studied on yield, composition and nutritive value of pennisetum pedicellatum forage. The yield after different levels of fertilizer application in the submountaneous region showed that gross yield of forage increased with increased dose of fertilizer used. At the highest level of application of farm yard manure equivalent to 49 kg N/ha and chemical fertilizer equivalent to 45 kg N/ha the average gross yield (in q/ha) in one single cutting at 8% flowering stage were fresh forage 772, DM, 92, C.P. 7.6. The grass at flowering stage contains on D.M. basis 6.67% C.P., 36.53 CF was consumed by the adult sheep @ 2.9 kg/100 kg b.w. The D.C.P. and T.D.N. value of the forage at this state on D.M. basis were 4.2 and 52.6% respectively. As annual crop the grass could provide greens till date in winter but not adequate to range

condition.

Lorrey et al. (1976) studied the effect of previous treatment and energy levels on finishing yearlings steers on winter pasture. The grazing was began when forage was 20 cm in height and contained till forage matured in late spring. The length of grazing season was 75 to 205 days. Average gain was lower (P /0.05) for pasture cattle (0.90 kg) when compared to cattle from clover pasture (1.16 kg) with grain fed cattle (1.06 kg) not different (P / 0.05) from either of the other two treatments. Grain consumption averaged 3.75 kg/day/steers.

Smithson et al. (1976) studied the influence of initial weight on steers from rye grass. This study evaluated initial weight on the performance of steers grazing rye grass pasture. Initial steers weights were 136 kg(light), 204 kg (medium)and 272 kg (heavy). The animals were grazed on rye grass pasture from November to June each year during three years study.There was no difference in average weight gain due to initial stocking weight during either of the three years. However all the three years steer gained more (P /0.05)/ hr. than either medium or heavy steers.

Coleman et al. (1976) reported effect of supplemental energy fed to grazing steers on performance during pasture and subsequent dry lot period. The study was conducted using 403 cross bred beef steers to determine the effect of feeding supplemental energy to grazing steers on growth and feed efficiency

during the pasture and subsequent dry lot periods. Energy supplement consisting of approx. 15% C.P. and 2.9 MCal/kg ME was fed at various rates (0 to 4.5 kg/animal/day). St. angustine grass (Rose lawn variety) were stocked at rate of 2.5 steers/acre. Steers averaged 223 kg initially and were moved from pasture to dry lot when each group averaged a preselected weight of approximately 380 kg. The steers were then fed finishing ration ad lib and 1 to 2 kg pangola digit grass/head daily until they weighed approximately 464 kg. Gain on pasture ranged from 0.38 kg/animal/day for steers receiving no supplement to 0.67 kg/animal/day mental feed. Regression analysis showed that gain on pasture was closely related to amount of supplementation as shown by the equation $Y = 0.373 + 0.106 x - 0.0094 x 2$ where $\bar{Y}$ = predicted rate of gain on pasture and X = amount of supplement in each kg/animal/day. Dry lot gain averaged 0.99 kg/animal/day for all groups and were non-significantly depressed by amount of supplement fed on pasture. The result suggested that fed on pasture did not effect carcas quality grade but increased dressing per cent, fat average and decreased estimated percentage yield.

Gohad (1976) conducted digestibility and metabolism trial to study the performance of goat and sheep fed tropical natural grass (Hyporrbenia sp.) hay. The animals were fed ad libidum and allowed free access to water. Goats consumed more ($P < 0.05$) dry matter i.e. $D.M./K^{0.75}$ than sheep. Water intake

was lower than sheep with the exception of crude fibre digestibility. Sheep and goat exhibited similar pattern in their digestibility of C.P. The C.P. digestibility was 60.25 for goat and 56.50 for sheep ($P < 0.05$). Both goat and sheep were in negative nitrogen balance. Nitrogen loss was similar for both goat and sheep. Hay was not equal to provide energy and protein for maintenance of goats nutritional requirements. The advantage of higher dry matter intake, lower water consumption and higher digestible ability of crude fibre give goats a special ecological niche in tropics.

Wilson et al. (1976) stipca cuba a forage was utilized to determine the suitability of this for growing cattle. The animals all adults were allowed to graze full months. During this time measurements were made of body weight, blood minerals, RBC, forage composition, digestibility and soil constituents. A mineral supplement was made at last 90 days of trial. Soil was deficient in phosphorus, sulpher and magnesium. The forage was deficient in Ca, P, magnasium and copper. Only serum calcium was below the normal value. Red blood cells and haemoglobin steadily increased throughout the trial. Mineral deficiency was severe, skeletal degeneration, lethergy, rough hair coat, periodic lameness and staggering occurred prior to treatment with mineral supplementation. It is concluded that satisfactory growth can be obtained if deficient nutrients are identified and provided in appropriate supplement.

Docker et al. (1976) reported effect of drying on forage quality of alfalfa and Reed cannary grass fed to lambs. The gains of lambs fed alfalfa hay, fresh alfalfa, reed canary grass hay and fresh canary grass were 97, 63, 48 and -7 g/day respectively. These gains means were significant ($P < 0.05$). Gains were related to intake of DM but lambs fed fresh forages did not gain as much/unit of forage dry matter consumed as these fed as hay. The fresh reed canary grass contained 69% more alkaloid than reed canary grass hay. Digestibility of DM was not affected by kind of forage but alfalfa protein was more digestible ($P < 0.05$) than were protein and crude fibre of reed canary grass.

Botkin and Lang (1978) observed the influence of severe dietary restriction during dry period on subsequent ewe productivity. The result of severe dietary restriction to growing ewes during dry period revealed that subsequent ewe productivity was reduced even though diet was adequate for remainder of time. Lambing percentage was 22% lowered after 1st year and 52% lowered after second year. The birth weight and weaning weight of lambs as well as fleece weight of wees were not significantly influenced by treatment.

Talapada and Purohit (1978) made a comparative study of hybrid Napier NB 21 fodder as green silage and hay. The trial was conducted in adult Kankrej Bullock. The average DM intake was 2.22 ± 0.05, 1.71 ± 0.03 and 1.71 ± 0.09 kg/100 kg live wt. for green, silage and hay. The digestibility CP was highest in

green and silage than hay form. EE digestibility was high in silage form and low in hay form. The digestibility of NFE and organic matter was lowest in hay. The digestibility study indicated that NB 21 was superior as green or silage than hay. The balance study suggested that NB 21 needs to be supplemented with phosphorus and calcium rich supplementation.

Reid et al.(1978) reported performance of lambs on perennial rye grass, smooth broom grass, orchard grass and tall fescue pasture. The live weight gains of lambs on tall fescue pasture were not different from the perenneal grass but was lower than those of smooth broom grass and orchard grass. The rate of gain in body weights of lamb grazing different grasses related fairly consistently to estimate of digestible D.M.

Bowling et al. (1978) used one hundred steer calves in the managemental system for producing beef. Growth stimulants were not used. Steers were slaughtered at calves, yearlings, long yearlings and two years old after a period of grass alone, grain on grass, or in dry lot. Steers fed grain reached slaughter weight and grade 100-230 days earlier, dressed higher and yielded lower percentage of primal cuts than steers finished on forage management. Steers fed on grass and then fed concentrate for 98 days before slaughter produced much more proteins than steers grain fed for 125-235 days after weaning or fed grain on grass either long yearling or two years old. The beef management practices to conserve grains and yet to produce high quality

beef would incorporate maximum growth and frame development on forages followed by short term (100-120 days) dry lot feeding management practice of this nature which would allow maximum protein production.

Sastry and Mahajan (1978) studied the Gaddi and cross-bred weaners lambs on white clover and rye grass mixture with and without concentrate mixture. They were kept on chopped hay mixture of white clover and rye grass in the ratio 1,2 with or without concentrate mixture. The mean total live weight gain (kg) and average gain/day (g) were found to have significant difference in the total live weight gain and average gain/day due to feed and sex. Half bred kept in concentrate gained more in total at (15.25 ± 2.00 kg) and showed highest average daily weight (84.25 ±1563 g). When compared with lambs fed roughage alone with those given concentrate showed 51,68 and 38% more weight in Gaddi half bred and higher crosses respectively. Males of all three genetic groups from both feeding require grain 51, 41 and 18% more respectively than females in the respective genetic group.

Ali (1979) studied the growth pattern of Black Bengal goat. The live weight as indicator of growth of all goats of different ages was recorded under farm condition. The average growth period in this real sense of the terms lay within the period immediately following birth day and somewhat little over 2 years and beyond that for one year there was maintenance

of growth only. The analysis of variance of live weight indicated that 3 lots of goats depending on age only had different characteristics of growth and significant difference between age groups was permanent.

Srivastava et al. (1979) reported effect of feeding all roughages ration during early life on growth, nutrient utilization and feed conversion efficacy in cross bred (Bosindicus x BB taurus) 13 male calves upto 3 months of age kept on conventional concentrate and roughage and on all roughage ration (green barseem x barseem hay). The mean intake of dry matter/ calf/day was 3.089 ± 33.76 g in control groups and 2.921 ± 128.08 g in experimental group. The nitrogen balance was 28.55 ± 1.06 in control and 27.97 ± 2.32 g in experimental group. Average daily gain (518.3 ± 21.1 g) in control calf was significantly higher than (397.8 ± 28.9 g) in experimental calves.

Singh and Rakeb (1980) studied the nutritive value of Barseem hay prepared in three methods. Study was conducted with 12 young barberi kids. Barseem hay prepared by fence chaff and ground methods were offered ad lib for 45 days to animal of group AB and C respectively. DM and water consumption were found highest in group A followed by C and B respectively. There was a positive balance of nitrogen, calcium and phosphorus in all three groups. Greatest body weight gain 45 gm/day was recorded in group 'A'. It was concluded that barseem hay prepared by fence chaff method was found to be superior to other hays.

Lippke (1980) studied forage characteristic related to intake, digestibility and gain in ruminants. Seven sorgam x sadan hays and five Barmuda grass hay harvested at three locations and at variouss stages of maturity were fed to yearling steers to determine intake and gain and to growing withers to determine digestibility. Animal response and laboratory analysis all showed decline in forage valuew with increasing maturity within forage species and location except when forage protein was 6% body weight gain appeared to be solely function of digestible energy intake ($r = 0.98$). Intake was better indicator of weight gain ($r = 0.93$) than digestibility ($r = 0.77$) with no significant relationship ($r = 0.77$) with no significant relationship ($r = 0.43$) between intake and digestibility and using is as covariate of digestibility yielded strong association with intake ($r = 0.92$) possibly with common association between NDF excretion rate. DM and digestible organic matter intake were closed correlated to ADF (r^2 0.86) and protein content ($r^2 = 0.73$).

Nasks, and Malechek (1981) studied the digestion and utilization of nutrients in 6 week browse hy goat. Gamble oak (querens gambelic) browse harvested in June when immature and in August when mature was mixed with alfalfa to form two diets containing 40% and 80% immature browse. These three diets were compared with an alfalfa control diet in digestion balance trial in goat. All 6 week containing diets was less digestible

than alfalfa. Tannin reduced apparent digestibility. Animals retained less nitrogen when eating oak diet than when eating alfalfa particularly when they were immature.

None of the four blood factors monitored haemoglobin plasma urea nitrogen, serum GOT and PCV indicated toxicological reactions even though 80% immature diets almost contained 9% Tannins. Mature oak diet when consumed in mixed diet with equally nutritious forages can contribute effectively to the nutrition of growing and lacting goats. Immature oak is low in utilizable energy and contains high level of tannins.

Holeschek et al. (1981) reported diet quality and performance of cattle on forest and grass land range for 3 years. The data indicated that forest and grass land offer diverse environment in terms of forage quality and beef cattle production. Forest diets contain more protein early and late summer. In vitro digestibility of cattle diet was lower on grass land in fall. Cattle gains were similar in both types in late spring but greater for forest cattle in early and late summer.

Holeschek et al. (1982) discussed merits and demerits of different methods for determining nutrient quality of roughages in ruminant diet. The authors suggested that fiscal analysis may have more potential for evaluating nutritive quality of range ruminant diet.

Parthosarathy et al. (1983) reported effect of supplementation on performance of weaning kids. For 90 days crossbred

goats unitial body weight 10.9 to 12.8 kg ranged/browsed under semi arid condition or also were given green fodders or concentrate mixture or both. Average daily weight gains were 19, 42, 111 and 108 g respectively.

Topsy et al. (1983) studied the effect of diet composed entirely of greens feed on the growth of young males Anglo - nubian goats. Sixteen goats were given control diet of 7 kg fodder daily and 0.5 kg concentrate @ 40 live weight (control) or were given mixture of equal quantities of stenotapharm dimediatum, Lencauc lencocephala and litsea glutinosa at 7 kg/ 40 kg live weight. After 126 days of trial there was no significant difference between treatment in growth rates or feed conversion efficiency. The cost of feed/kg live weight gain was more than 3 times than for goats given green feed mixture.

Kacker and Bawa (1983) studied the growth yearling heifers under different system of grazing on sewan (Larinus sindiens) grass land. The study involving 4 grazing treatment with yeaŕling heifers of 75 to 100 kg body weight gained 55.2 to 62.5 kg/heifers/ year. Yearly variation in the live weight gain (36.1 to 88.0 kg/ heifers) were highly significant. Marked seasonal variations in the herbage production which was related to quantity and distribution pattern of rains. Maximum live weight gain 19.4 kg was recorded during rainy period - August and September and mean - 2.02 kg in dry period.

Kundu et al.(1983) studied leaves of Ignadulcis(Malina tamarind) as fodder for goats. The goats about 6 months old were offered to appetite young leaves of ignadulcis a hedge consumed daily 455 kg DM/100 kg body weight. The leaf composition in DM with digestibility in parentheses was C.P. 20.3(71), EE 7.5(40), CF 19.8(30), NFE 43.0(72), ash 9.3, calcium 2.2, phosphorus 3%, DM was 34.3% (58) Total digestible nutrients were 58.4, DCP 14.4% and daily balance of nitrogen was 3.93,calcium 0.64, phosphorus 0.43 g. The goats gained 350 g/wk during 12 week period.

Ghosh and Moitra (1986) reported measurement of plane of nutrition in grazing and stall fed Black Bengal goats in different season on 18 Black Bengal goat of both sexes in order to determine the plane of nutrition derived in grazing and stall fed condition in different seasons.

The DM consumption was 2.0 to 3.5 kg/100 kg body weight in different season. DM consumption was not significantly different ($P < 0.05$) between treatment and season. The DCP intake was also not significantly different in stall fed and grazing groups. DCP intake of does in both stall fed and grazing condition were more ($P < 0.05$) than other sex. The TDN intake ($P < 0.05$) was higher in grazing than stall fed groups. Season and sex had no significant influence on TDN intake.

Coleman et al.(1986) studied the effect of pilleting and maturity on quality of two subtropical forages. Pilleting resulted in significantly higher intake of both organic matter (2.22 vs 1.79) and digestible organic matter (1.25 vs 1.12) when expressed kg/day/100 kg body weight in case of both paragrass vs Stangustine grass. A significant forage x age interaction was observed for both measures of intake and for organic matter digestibility. The variable decreased with advancing maturity within paragrass but no effect was observed within Stangustine grass. The interaction was due probably to different physical characteristics of grasses specially leaf stem ratio. The rate of passage was depressed with ($P < 0.05$) by advancing maturity and was influenced by forage species x processing interaction.

Feeding of high concentrate/high forage ration

Mathur et al.(1963) put the concentrate deficit for bovine in India at around 78 million tonnes. The picture appears gloomy and it is necessary to search for alternate sources mainly roughages to satisfy essential nutrient requirement. Advanced dairy countries like Newzealand, Australia produce most of the milk on pasture alone, but every country does not have this agro-climatic and economic condition. Attempts has also been made in India like other countries to maximize production with high forages. He also replaced 25% production ration (concentrate) with paragrass in milch cattle. The milk and fat production was reported to be satisfactory.

Razdam (1972) in a review reported that in many advanced countries concentrates are fed unrestricted with only limited forage to active maximum milk production. Some earlier reports suggest that a high level of milk production on ad lib concentrate feeding is achieved at the cost of efficiency of nutrients turn over. Apart from this local consideration of availability of protein and grains within a country should be serious and would be a great limiting factor in intensifying animal production.

High forage ration growing cattle :-

Ruminants are basically forage consumers and digest large amount of cellulose and other complex materials. During early calfhood the functional status of rumen is not the same as the adult but the source of digestion is essentially the same as in other young non-ruminants. Milk forms normally the main source of nutrients to the calf during early life. A number of workers in USA have raised young calves on high roughage system for feeding assuming that apart from other considerations this system is beneficial for an early development of rumen function.

Forage as sole ration :

A number of workers have attempted feeding roughage along to meet the requirement of different categories of cattle.

Ware-Austin (1963) reported from Kanya that conventional pasture growth in trans-Nzria are of Rhodes grass along or with Nandi setaria or kanea white clover. He opined that when carefully managed Napier grass as supplement or to conventional grasses could support higher milk yield from Ayrshire and Jersey cows for a longer period. According to him, this practice was economically better than to purchase concentrate under Kanyan condition existing there.

Lodge and Pell (1968) have reported milk yield in cow upto 28 kg/day with high fat percentage could be obtained by feeding rye grass hay as sole ration.

Gupta and Jackson(1968) working at Pantnagar studied the effect of feeding lucern on milk yield when compared with barseem feeding in buffaloes. They observed only yield of FCM of Murrha buffaloes, given green lucern or barseem at similar stages of maturity to be 9.1 or 11.2 kg. There were no adverse effect on health and body weight animals maintained on either of this feed. These workers attributed poorer production on lucern feeding to decreased of 36% in feed intake.

Although the attempts made and the researches conducted on different rations concentrate to roughage or maintaining dairy cattle entirely on roughage feeding have been numerous and no single authoritative conclusion or recommendation can be drawn which would suggest a safe course of action. Many

reports suggest that high roughage feeding could be advocated for dairy cattle production but an equally strong evidence is available advocating addition of concentrate.

The controversy is understandable in view of different in approach, prevailing social, economic out look and the agro-climatic conditions that exists from country to country. India provides a unique situation where climate permits relay cropping, unlike many temperate countries, which remain snow bound for good part of the year. This brings out one conclusion that nutritional research in developing countries which are mostly in the tropical and subtropical belts need to be oriented suitably to cover the prevailing circumstances in their real perspective.

Most of the workers claim about protein deficiency for bovine population but energy deficit need all the more attention. This aspect is going to assume a great importance with introduction of exotic stock for high dairy production. With high roughage feeding there is usually inadequate supply of lysine in ration.

Indicator method to determine pasture consumption by the grazing animals :-

Livestock feed may be defined as any dietary substance that nourishes the animal body for maintenance, reproduction and production. The quality and quantity of pasture consumed by the grazing animals and correct estimate of the digestibility of pasture crop are considered to be prerequisite for evaluation of the nutritional status of the animal maintained on grazing.

Such estimate, in earlier days was not possible due to lack of reliable method. A large number of literature is now available at present for the determination of pasture consumption and digestibility of pasture by indicator methods. Two indicators are used simaltaneously i.e. (1) external indicator which is mixed with the feed and internal indicator which is inherent in the feed staff.

Considerable attention has been directed now a days for indirect determination of pasture intake by combined use of two indicators for proper assessment of nutritional status of the grazing animals.

In this method the amount of indicator in the faeces occuring naturally in the plants serve as an index of indigestibility and that of external indicator dosed to the grazing animals in known and constant amount gives a measure of the total faecal output. From the record the dry matter faecal output may be worked out by following relationship.

$$\text{Faecal output(g D.M./day} = \frac{\text{Total amount of cromic oxide fed/day (mg)}}{\text{Concentration chromic oxide(mg/g dry faeces).}}$$

There are two techniques (1) Ratio technique and (2) Faecal index technique for the determination of pasture intake and digestibility grazing animals.

$$\text{Digestibility (per cent)} = \frac{\text{\% indicator in forage x \% nutrient in faeces}}{\text{\% indicator in faeces x nutrient inf forage}} \times 100$$

Ratio technique

$$\text{Dry matter consumption} = \frac{\text{Weight of internal indicator in faecal output}}{\text{\% indicator in forage}}$$

In the determination of digestibility of a nutrient by indicator technique it is necessary to ascertain concentration of nutrient and indicator both in feed sample and also in the faecal sample. It may be possible to eliminate total collection of faeces and grab faecal sample collection may be employed with advantage provided the indicator is excreted in the faeces at a uniform or in a practicable manner. Such method would undoubtedly reduce the high cost of labour involved in a conventional trial.

The use of some important external and internal indicator are reviewed here :-

1. External indicator :

a) Ferric oxide :-

Bergeim (1924) suggested use of ferric oxide as marker for digestibility studies. It was pointed out here that ferric oxide is practically insoluble, unabsorbable and of suitable physical consistency to follow the food through the intestine and excreted in the faeces.

Gallup (1928) also reported a fairly accurate results when ferric oxide was used as an indicator. Other workers however, discouraged its use due to sonstipating tendency. To avoid this side effect it was further suggested use of equal weight of agar along with ferric oxide.

Hale et al. (1939) observed that a large variation in the amount of ferric oxide passing through the digestive tract make it an unreliable indicator.

b) Polyethyline glycol :

Sperber et al. (1953) suggested use of polyethyline glycol (PEG) as a reference substances since PEG is neither absorbed not destroyed to any considerable extent in the digestive tract of ruminent and more than 90% of the substance was recovered in the faeces.

Lundh (1958) reported use of PEG as water insoluble marker in the absorption studies with man and animals.

Corbett et al. (1958) in their study compared the pattern of excretion of PEG and chromic oxide in cows. A large variation in the concentration of PEG than chromic oxide was observed. The variations recorded were +10% in case of chromic oxide and +40% in case of PEG.

Sinha et al. (1970) reported that the approximate fill and weight of the rumen contents could be calculated using PEG as reference substance but its use as marker in digestibility

study was doubtful.

Clark et al. (1972) recorded much lower recoveries when sheep and cattle were fed with cotton seed hulls than they were fed on lucern to hay as source of fibre. Thus PEG has been considered to have its limitation in its use as a suitable marker.

c) Chromic oxide :

The use of chromic oxide as marker was first proposed by Edin (1918) chromic is non toxic and almost quantitatively recovered in the faeces of the animal.

Hamilton et al. (1927-28) observed good agreement between total collection in sheep and the chromic oxide method when totalc collection period was three days or longer.

Kane et al. (1950,1952) failed to observe any significant differences between conventional and chromic oxide method for determining the apparent digestibility in dairy cattle. The mean recovery of chromic oxide in dairy cow was 99.9%.

Chandra et al. (1951) determined faecal output in goats and sheep with the use of chromic oxide.

Smith and Reid (1955) reported that in grazing cows the mean rate of recovery of chromic oxide was 100.58 ± 0.87%.

Raymond and Minson (1955) reported that the administration of chromic oxide both in gelative capsule and as a liquid drench were statisfactory. It was also reported that the appearance of chromic oxide in the faeces was in less than 7 hours from

the time of drenching to the grazing sheep.

Kameoka et al. (1956) observed that in goat the variation of about 10% in chromic oxide excretion was a normal occurrence.

Kameoka et al. (1956) also administered chromic oxide to goat for determining digestibility of feed.

Lambourne (1957) reported that chromic oxide appeared in the faeces within 5-8 hours after first dosing in sheep.

Gupta and Mazumder (1962) reported that the first appearance of chromic oxide in the faeces of cattle and buffaloes was noteda after 13 hours of its first ingestion.

The peak excretion of chromic oxide was recorded at 12 noon. The concentrations of chromic oxide in grab samples, however, were higher in morning sample than in the evening sample.

Majumder et al. (1962) reported that the recovery of chromic oxide varied widely from animal to animal and also from day to day. On any single day the recovery of chromic oxide in the faeces varied from 80.6 to 121.8 per cent. The best recovery of 101.50% was obtained after a period of 6 days pooling.

Chaudhary and Mazumder (1962) conducted an experiment to determine recovery of ingested chromic oxide and the usefulness of this indicator in digestibility determination in cattle, buffaloes, sheep and goat. They found that the recovery was very

satisfactory in all the species studied and the digestibility coefficient determined by grab sample technique and conventional method were almost similar.

McGuire et al.(1966) studied the effect of frequency of feeding on digestibility and excretion of chromic oxide in Angus cattle. The diet containing 0.5% chromic oxide was given in the pilleted form. The total collection of faeces was carried out in conventional method for 7 days and grab samples were also collected for last two days at two hourly intervals. The mean recovery of chromic oxide in faeces ranged from 94.2% to 106% for cattle fed diet in pilleted form once daily and 94 to 105% in those fed six times a day.

Nelson and Green (1969) in a study with holstein bullock observed that when 39 grams of chromic oxide was dosed daily at 6 a.m. the recovery of indicator was 100% by third day and for the most of the period the average recovery was 103%. When 78 grams of chromic oxide as dosed every alternate day, the recovery on the day the dindicator was given was only 76% and on other days it was 98% while recovery of indicator in the grab samples varied significantly in the later cases. No significant differences among the animals or days or time of sampling were recorded in the former case.

Wilkinson and Presscott (1970) reported that when chromic oxide was given two times daily to bullock the recovery of indicator in total collected faeces ranged from 85 to 91%. The relative

recovery in the grab samples were however 97%.

Faichney (1972) reported that when crossbred sheep were given concentrate diet and chromic oxide the recovery of chromic oxide in the faeces ranged from 91 to 101% and digestibility of the dry matter determined by ratio technique was similar to that obtained by total collection.

Ahuja et al. (1972) studied the execution pattern of chromic oxide in 3 crossbred and 3 Haryana cattle of two years of age. Faecal samples were collected directly from the rectum at 3 hourly intervals, from the time of feeding the peak excretion was recorded at 24 hours in crossbred and 18 hours in Haryana cattle.

Internal Indicator

Silica :

Wildt (1874) suggested that since silica occurs naturally in hay it could serve as an indicator because it is indigestible and is not absorbed.

Gullap (1928) reported that silica could serve as a better index of digestibility.

Legnin :

Legnin is very much resistant to chemical degradation and enzymatic action.

Salo (1958) analysed lignin from hay and its corresponding ingesta in various parts of alimentary tract of cows as well as from the faeces and recorded considerable variations in methoxyl and nitrogen content. It was therefore suggested not to use it as true digestible reference material.

Sapargatiev and Dzariekbsasov (1969) carried out comparative study with three in inert indicators i.e. chromic oxide, silica and ferric oxide for determining digestibility of pasture grass. The average recoveries of three indicators were 99.05%, 94.42% and 99.31% respectively.

Thonney et al. (1979) reported that lignin recovery was too low in comparison to acid insoluble ash.

Chromagen :

Reid et al. (1950) suggested that plant chromogen could be used as indicator for digestibility study. But Coom and Harris (1951) and Haddison et al.(1954) failed to get any satisfactory result with use of plant chromogen as indicator.

Acid insoluble ash :

Srivastava and Talapatra (1962) studied the herbage consumption of sheep from pasture accurately by using acid insoluble ash or phosphorus as indicator. They observed recovery of acid insoluble residue in sheep as 99.82% and phosphorus 99.81%.

Talapatra and Singh (1961-62) also observed a satisfactory recovery using acid insoluble ash as internal indicator.

Chaturvedi (1971) reported that pasture consumption can be determined with accuracy with silica basin using acid insoluble ash as an internal indicator. He observed that the percentage of acid insoluble residue in the sample of pasture and faeces can be predicted by sample determination of percentage of total ash in the pasture and faecal samples and converting the total ash into acid insoluble residue by regression equation. He concluded that consumption can be accurately predicted on the basis of derived acid insoluble residue value from ash percentage in place of complicated acid insoluble residue method.

Thonney et al. (1979) used acid insoluble ash (AIA) and permanganate lignin as indicator to determine the digestibility of cattle ration. They also made conventional trial for comparison of the above methods. Average rates of recovery of indicators were 101.19 ± 4.81 and 98.87 ± 2.98% in acid insoluble ash and 52.21 ± 1.79% and 59.25 ± 1.77 in permanganate lignin for early and late cutting dates respectively. They concluded that digestibility may be determined with AIA with a representative sample of faeces.

Nabi(1980) conducted digestion trial on grazing sheep on alpine pasture. He used acid insoluble ash and chromic oxide as natural and external indicators respectively.

Das(1981) used acid insoluble as an internal indicator and chromic oxide as external indicator for measurement of feed

consumption under grazing condition in Black Bengal goat.

Growth,reproduction and production

Mukherjee and Bhattacharyya (1952) studied seasonal variations in haemoglobin concentration and cell volume of blood of 9 rams and eight goats for one yeaɔ.Haemoglobin and cell volume content were highly variable among animals and among seasons. Cell volume of blood of goat was found to vary significantly between months within season but it was no so in case of rams.

Wilson (1957) studied browsing and reproductive behaviour of East African dwarf goats. It was concluded that pregnant goats obtained sufficient nurishment for maintenance and growth of faetuses from two hours of effective grazing and half pound of concentrate mixture daily.

Bhimaye et al. (1969) in a grazing studies in arid and semi arid zones of Rajasthan reported growth of different kinds of livestock like cattle sheep and goat in natural pasture at pali from young to adult stage. The purpose of this study was to see the impact of grazing on pasture condition as well as to work out the animal equivalent on the basis of pasture utilization in relation to body weight gain of different types of livestock.

Agarwal and Talapatra (1970) reported that when leguminous roughages cowpea (Vigna sinensis) and barseem (Trifolium alexandrium), winter and summer legume respectively were supplemented

over a low calcium basal diet otherwise adequate in quantity to supply calcium for growth the availability of calcium was 45% on cowpea and 50.3 in barseem. It was concluded that calcium from these leguminous roughages are not different from those of tree leaves.

Agarwal and Talapatra (1970,b) reported that availability of calcium and phosphorus may vary considerably according to their chemical combination and physical association with other compounds in the feed. It was pointed out that determination of availability of Ca^{++} is not a very simple process. In ruminant preparation of calcium diet is beset with many practical difficulty. A diet consisting entirely of concentrate may be low in calcium which may hamper peristalytic movement of intestine. A study was made to determine endogenous output of calcium in faeces of browsing ruminants. It was observed that when average intake of calcium was 2.9 g there was positive calcium balance of 0.18 g.

Johari and Talapatra (1971) reported that jamnapari kids when fed by browsing gained 547 gm in 2 weeks against 339 gm under stall feeding. Dabadghao et al.(1976) reported meat production from Barberi kids grazed on cenchrus and siratra pasture with or without concentrate supplementation.

Agarwal and Talapatra (1971) reported that availability of calcium from several states is not very much different from those of roughages and availability of mineral salts when compared with 58% roughages worked out to 60% and 58% concentrate

ruminant.

Dabadghao et al. (1971) studied effect of feeding different levels of urea nitrogen in ration on haematological and chemical compound of blood of growing heifers. No significant effect of feeding different level of urea was observed on haemoglobin, RBC, WBC, serum calcium, inorganic phosphorus in blood. With increase of urea feeding the level of NPN, total nitrogen and urea nitrogen increased at a significantly higher rate ($P < 0.01$). Urea gave maximum NPW value 3 hours after feeding. It was concluded that even upto 3% urea supplementation in the ration. The blood concentration remained in safe limit and no physiological disturbance was observed.

Razifard (1972) studied the blood plasma magnesium and urine magnesium in underfed lactating goats. The effect of low magnesium intake on two young lactating goats indicated magnesium output in urine and in milk decreased. However, inspite of very limited intake of magnesium there was a significant increase ($P < 0.01$) in blood plasma magnesium. On returning to normal feeding level there was immediate significant decrease. It has been concluded that increase in blood plasma magnesium and continued presence of magnesium in the urine during low magnesium intake indicated a marked mobilization of magnesium from the body reserve at this stage. It is suggested that young cattle has same ability.

Srivastava (1972) conducted a digestibility experiment with two lactating Hariana cows grazing on pasture for 16 hours over and above the grazing animals were fed 10 kg cut green pasture and concentrate mixture every day/kg milk yield. The experimental period lasted for a period of 33 days and digestion trial was conducted during last 7 days. The accurate estimate of intake and faecal void were determined by indicator ratio technique using chromic oxide and acid insoluble ash respectively. The digestibility nutritive value of pastures grasses Dub, Anjan and forest grass in terms of various nutrients. Dry matter (DM),CP, NF and total carbohydrate were fairly high and as such it was concluded that pasture herbage may be utilised with advantage.

DCP, TDN, EE were calculated to be 2.53, 21.11 and 16.83 kg/100kg fresh pasture grass.

Sharma et al.(1973) indicated that haematological picture of farm animal, was an important index of health and disease. In health it reflects nutritional status, performance and capacity of animals and in the disease it was essential afor proper diagnosis of disease. Packed cell volume value recorded in their study for adult, young and kid was 29.10 ± 4.32,29.80 ± 2.72 and 31.10 ± 2.88% respectively.

Ahuja and Talapatra (1973) carried out experiment to study the effect of different plane of nutrition on Hariana cows grazing natural pasture. Eighteen Hariana cows were divided into 3 groups, group A received only pasture herbage, group B

pasture herbage and limited concentrate and group C received pasture herbage and concentrate @ 1 kg/ 2.5 kg milk produced. There was no difference in yield and composition of milk in these groups. The fat, total solids, lactose and mineral contains increased in milk (P $<$0.05) with advancing maturity of fibres in pasture. The digestibility of dry matter, protein, fibre and lignin were 59.7, 64.4, 71.8 and 33.5 respectively.

Amos et al. (1975) studied serum magnesium level of ewes grazing orchard grass top dressed with dotomite or calcite. The levels of magnesium in the serum of lactating ewes were used to estimate the combined effect of magnesium lefel and magnesium availability in early spring orchard grass growing on two silts loam soils top dressed with either calcite or dotomite. The study was conducted for 4 years from the time of soil treatment. Mean serum magnesium was higher (P $<$0.05) in ewes on dotomite treated plots in only one trial. However proportion of animals with serum magnesium below 1 mg/100 ml was smaller (P $<$0.05) with dotomite than with calcite when data for four years were combined. Forage magnesium was significantly greater in dotomite plots early in season and turned to decline in both treatments as forage matured.

Faroda and Patil (1975) in a note on micronutrient status in cenchous grass harvested at flowering stage dried in sun shine and chopped prior to feeding observed crude protein (CP) content of grass was 9.45%, hay 9.45% zinc, copper and cobalt 23,18 and 042 ppm respectively. The sheep under control group

given no micro nutrients showed poorest growth while those drenched with 25 mg Zn each day gave best result. Many workers pointed out that growing sheep requires daily about 4-6 mg copper, 0.08 to 0.2 cobalt and 15 to 30 mg Zn.

Gayton (1976) reported that blood plasma is a readily sampled body fluid and representative of extracellular fluid compartment which contains an exchangeable sodium with body. The volume, tonicity and Na^+ concentration in the extracellular fluid is largely maintained by reciprocal interaction of aldosterone and ADH. Thus while mineralocorticoid secbetion may result in change of total electrolyte in ECF there are only minimal changes in the electrolyte concentration. In chronically sodium deplited cattle little or no change is usually found in plasma Na^+ concentration even though the animals may be severely deplited and capable of showing production response to supplemented sodium.

Dehman et al. (1976) studied the effect of dry lot and pasture management on ovulation rate and production in pannama ewes. 172 pannama ewes were alloted at random into two treatments of (1) dry lot - harvested fed feed year rounded and (2) irrigated pasture except harvested feed during winter. Over 10 years period lamb production in dry lot group was consistently poorer than the pasture group. The ewes were flashed each year for about 14 days before breeding by feeding confined ewes 0.45 kg barley and 18 kg alfalfa/head/day or fresh lush pasture

if on pasture treatment had no significant effect on grease fleese Wt. Lamb production in confined lot was significantly lower than pasture ewes. The result suggested that dry lot environment may cause later breeding season.

Hagsten et al. (1976) reported supplemental needs of pregnant ewes wintered on fescue pasture. Three pasture treatments were compared with ewes confined to dry lot with ad lib haylage, pasture treatment consisted of no supplement and ewes pasture of fescue and liquid high urea supplement ad lib (free choice). Minerals were supplied in all treatments and limited cell corn (0.67 or 0.75)lb) was supplied to ewes during late gestation period. With the same pasture there was variation of protein content (7.8 to 10.8%) between 2 years. Ewes in fescue pasture with or without protein supplementation maintained their body weight even during mid and late gestation, wool production was not affected by any of the treatment. Birth weight of lamb was greatest (P $\angle$0.05) for ewes fed alfalfa hays in dry lot. Number of lambs born was not significantly different.

Walker (1977) reported that inclusion of siratro into native and improved pasture greatly increased live weight gain, increased breeders performance and increased weaning weight. Milk prpduction and quality from siratro pasture was superior to that of unimproved pasture but was lower than the tropical pasture due to lower intake.

Karn and Clantou (1977) studied the effect of potassium in range supplement. The results of three experiments with weaning steer calves grazing a range forage (Predominantly grasses) indicated that supplemental potassium presented a depression in weight gains. The optimum supplement rate was not supplements fed at @ 0.68 kg/day. Weaning calves on winter range contains at least 2.0% potassium. Based upon weight changes it appeared that dry bred cows grazing winter range forage also require potassium supplementation. This showed specially be true if supplements contained urea. An apparent potassium maintenance requirements of 75 meq/100 kg B.W./day was determined by yearling cows by balance experiment.

Kiron et al. (1977) reported live weight of farmed feral goats and kids on a hill country in Newzealand. It was observed that the feral kids grew more slowly than the lambs and sannen x feral kids and this was related to their adult body size. During trial the goats ate a large range of fibrous plants like thistle, docks, shurbs, blackberry.

Langlands and Donald (1977) studied the efficiency of wool production in grazing sheep. The wool production was proportional to intake over a range of forages examined.

Hodges et al. (1977) reported grazing studies with penisula bahia grass and worm season annual legumes. Weaned calves were placed on the experiment in October and remained for 50-51 week period. Limited amount of supplemental feed was provided during winter to prevent extreme of body weight

loss. There was no difference in winter daily gain related to either year or forage system effect. Evaluation of year forage system interactions showed summer daily gain/animal to be higher (P 0.05) on grass legumes (0.38 kg) than on grass system (0.28 kg) in any one year.

Agarwal and Bhattacharyya (1978) reported that there was gradual but consistent fall (P 0.01) in milk yield with advancing lactation after peak yield observed between 4th to 5th week post partum. The average milk yield per lactation in Black Bengal goat 39.25 ± 0.37 kg (excluding colostrum) with mean weekly yield of 2.45 ± 0.39 kg/doe.

Spitzer et al. (1978) in their study fed two groups of yearling beef heifers different levels of nutrition to study the effects of reduced energy intake on fertilization rate and blood level of progesterone and LH. Control group diet as per N.R.C. recommendation and experimental group 1/3 of the recommended energy. No difference was found in blood level of progesterone or LH either between nutrition group or energy successive cycles within the number of groups. Diet had no effect on the number of follicles nor follicular or luteal volume. However ovary containing C.L. was 57% larger in heifers fed adequate energy than the restricted group (P < 0.05). The result suggests that reduced pregnancy rate in heifers restricted in energy is not result of fertilization failure but some later causative factor.

Singh and Rakeb (1979) studied the effect of feeding natural grass and barseem hay on growth rate and nutrient utilization by Barberi kids. The study was carried out to find out nutritive value of barseem, hay and its feeding value in goat when mixed with natural grasses in different combinations. Eighteen kids were divided into 3 groups of six in each group. Group A received barseem hay along. Group B and C were fed barseem hay and natural grass (75 : 25 and 50 : 50). There was a positive balance of sodium, calcium and phosphorus in all the three groups but it decreased as the hay increased similar trend in gain in body weight of the experimental animals was also recorded.

Ischii et al. (1979) reported raising of Holstein steers by continuous pasturing. The grazing area was divided into 7 sectors. The experimental animals were rotationally pastured but no concentrate mixture was given. The pasture crops were composed to timothy. Plenty of forage green and hay were available. The average body weight at the beginning and end of the experiment was 208 kg (113-223 kg) and 498 kg respectively. The total gain in body weight per head 290 kg (254-329 kg) during 525 day experimental period and average daily gain in weight/ head was 552 g. It was concluded that it may be possible to raise steers by continuous pasturing without concentrate mixture in East of Hokkaido (Japan.).

Mackenzie(1980) reported that free range grazing and browsing was the ideal system provided frequent change to clean ground was possible. With free range with good browsing kids needed no concentrate, indeed was much better without.

Sanderson et al. (1980) reported that groups of 11 Dorseh Horn x Australian merino lambs after weaning at 9 to 11 wks old grazed on pasture based on irrigated lucerne, red clover and dry land lucerne in New South Wales. The mean daily gain in different pastures was 155, 178 and 124 g during 106 days. Poor growth on dry land lucerne was mainly due to low digestibility of feed as a result of rainfall which also caused feed supply to be limited.

Morris(1980) studied to assess the requirement of sodium in grazing beef cattle. It is concluded that parotid NA:K ratio and adrenal histology are most important sensitive indices of Na inadequacy however when saliva is a readily available body fluid narrow Na:K ratio are not always associated with production responses to supplemental sodium. The concentration of sodium in blood plasma is not regarded, as an useful index of sodium inadequacy with caution is advocated in the interpretation of analysis of animal pasture for Na^+ as Na^+ concentration in forage may exhibit marked seasonal variation. The maximum sodium requirement for non lactating beef cattle does not appear to exceed 0.06 to 0.08% Na^+ in D.M. and for lactating beef cows 0.1% Na^+ in D.M. appear adequate.

Kumar et al. (1980) estimated the variation of plasma protein, their fractions and plasma urea N in Hariana x Holstein calves fed on diet containing normal and low level of protein. The level of dietary protein significantly affected the plasma protein and their fractions. Average value of plasma urea N did not differ significantly. A significantly linear correlation were observed between dietary N nutrient absorbed, nitrogen retained by the animal and plasma protein plasma urea nitrogen. It is concluded that plasma urea nitrogen can be used as an index of nitrogen balance studies in ruminants.

Ghosh et al.(1982) reported lactation length,composition and yield of milk in Black Bengal goat grazed on para pasture 6 hrs/day and supplemented with 250 gm concentrate/doe/day. The average milk yield in 119 days of lactation was 39.25 ± 0.37 kg with mean weekly yield of 2.3 ± 0.39 kg/animal.

Mukundan et al. (1982) reported variation in body weight gain in malbari goats and their saanen half breds in humid tropics. Daily gain over three months period from 0-12 months of age showed that sex had a significant effect on daily gain at 3-6, 0-6 and 0-9 months. The breed type had significant effect in all growth period except 6-9,9-12 and 6-12 months.

Rook and Thomsas (1983) in their report on nutritional physiology of farm animals noted integration of metabolism in the whole animal. It was stated that metabolism in normally fed animals depends on the nature of the diet and pattern of feeding.

Animals that consume their feed as single meal once daily will show marked diurnal variation in metabolism and for the later part of the day will be effectively fasting. This necessiates the build up of reserve glycogen, protein and lipids during the absorptive period for the use during the post absorptive period.

In contrast, animals which graze or nibble continually show much less variation in their metabolism and have less need to accumulate short term reserves although measures are still needed in case of starvation or under nutrition.

Khan and Sahani (1983) studied sources of variation on milk yield in Jamnapuri goat for 3 years period. Milk yield averaged 70.31 kg, lactation length 106.27 days and daily yield 0.69 kg. Lactation yield was significantly affected by year x season interaction and by weight at kidding. It was also affected by year and season of kidding. Average daily milk yield was significantly affected by season and weight at kidding.

Boila (1984) reported that in North Western Manitoba cattle require supplemental copper when grazing forage contains low concentration of copper of high concentration molybdenum of sulphur. The present experiment contained adequate concentration of copper, cobalt and zinc and cenchrus grass did not seem to be deficient in these elements with oral drenching in addition to concentration in forage.

Stoneker (1985) studied beef product system in tropics and extensive production system in infertile soil. It was concluded that in order to develop cattle pasture reserve to their full, economic potential a number of interrelated condition must be considered and improved. It was observed that (1) all weather roads and bridges be constructed (2) rural areas are divided into small holdings. There are few fences and cattle grazed on common pasture. It was presumed that there was principal resources loss in some areas. Land owners have few cattle and few resources for further improvements.

Singh et al. (1986) studied the effect of high nutritional supplement to parurient goats and stylo feeding to kids on birth weight growth rate , and servivability. One group was given 500 gms of concentrate mixture daily along with ad lib stylo grass (mature cuts) as well as 24 hours supply of drinking water containing urea at 1 g/lit. The second group received 200 gms of same concentrate mixture with ad lib growing naturally mixed grass and plain drinking water. For study of the effect of stylo feeding a second set of experiment was conducted on Black Bengal kids aged about 4 months for a period of 8 weeks. The first group of 9 male and 17 females were fed stylo grass and second group 42 kids of equal sexes were fed mixed grasses at lib and acted as control. Both the group was fed equal amount of conc. mixture. It appeared that difference in body weight at birth, 1 month, and 3 months were statistically nonsignificant. The kids of high

nutritional group tended to be heavier than low nutritional group. The average gain in body weight of kids pooled over two sexes were significantly more in mixed grasses than stylo group ($P < 0.01$).

Metabolic profiles

Verma (1967) studied the constituents of plasma protein, urea, cholesterol, sugar, pyruvic acid, GPT of two year old goats. The average values were 7.78 g%, 18.50 mg%, 174 mg%, 54.66 mg%, 0.318 mg% and 67.5 unit/ml for above named parameters.

Cambell and Walts (1970) studied the blood urea in bovine animals. It was observed that high blood urea was associated in many cases with disturbance in fluid and electrolyte balance.

Saha and Sadhu (1971) studied the urea content of blood of goat on diet containing optimum level of dry matter and 13% crude protein. The blood urea level observed in goat on diet containing 13% protein was 24 mg/100 ml.

Kwaitkowski and Pres (1975) studied the influence of high nitrogen fertilization of pasture on metabolism and changes in blood constituents of dairy cows. The studies were conducted at 2 experimental stations each with two groups of eight lactating cows and extended over three grazing seasons. The pasture was fertilized with N 240 and 360 kg/hr. and P_2O_5 80

and K_2O 120 kg/hr. Blood samples were analysed twice in each season from May to September. The red cell count tended to increase during grasing season slightly from 6 to 6.44 million irrespective of N fertilizer used. There was slight increase in Hb content.

Methemoglobin rose in cows in pasture with high nitrogen fertilization on average 1.42 to 2.55 in individual cases to 6.6% of total Hb. Blood calcium was not affected. Inorganic phosphorus in blood declined on pasture from 5.65 to 5.07 with moderate and from 6.19 to 6.00 mg/100 ml with high fertilization. Blood magnesium rose during grazing season from 1.50 to 2.25 mg/100 ml.Sodium decreased slightly and Potassium increased about 10% regardless of degree of fertilization. Boss and Wanner (1979) studied the blood values in 12 Sannen goats in their first lactation and in their 14 kids at different ages 1-19 to 240-259 days. In adult average serum values based on 60 observations were Na^+ 141, K^+ 4.56 cl^- 104 meq/lit. Calcium 9.20 Phosphorus 6.91 mg/100 ml total protein 7.43 range 6.33 to 8.53 g/100 ml. The activities of five enzymes studied were low tith wide fluctuations. In kids there was variation of serum electrolyte not related to age. Phosphorus fell significantly with age. Total protein was significantly less in new born than in adult but from 5 months came within the adult range of variation without reacting the adult average even at 8 months. The activities of serum enzymes studied were not related to age except that of

creatine phosphokinase which fell significantly as kids grow older. Manston et al. (1977) reported influence of system of husbandry upon the blood composition of bulls and steers reared for beef production. The results were presented from analysis of blood samples taken from 31 steers reared on average 18 month system, 38 bulls reared semi intensively on 15 month system 35 bulls reared extensively on barley beef system of beef production. The PCV concentration of Hb, glucose, urea inorganic phosphorus, calcium magnesium, sodium, potassium, total protein albumin, copper iron, total iron binding capacity in the samples were analysed. The concentration of glucose, K^+ and phosphorus were higher than those previcusly found in adult cows. The intensively fed bulls of 15 month and barley beef system had higher concentration of glucose iron and iron binding capacity than steers receiving low plane of nutrition of 18 month system of management.

Bhattacharyya and Chakraborty (1979) reported normal values of SGOT and SGPT activity in the serum of Jammapuri goat as 100 ± 0.91 and 30 + 0.86 respectively. The unit of enzyme activityw was expressed as g Pyruvic acid formed in 1 ml serum at 37°C in 60 minutes.

Parontaud (1979) studied same constituents of blood plasma of dairy cows and their behaviour at the time of calving It was reported that the mineral, protein and hormonal constituents in non-dairy nursing cows around calving time did not show too great difference from the dairy cows inspite of higher yield in dairy cows (about 4 times). Nursing cows were relatively

poor in blood urea and rich in glucose and free fatty acids. Plasma magnesium, phosphorus and urea diminished with age in both the groups.

Khan et al. (1979) reported glomerular filtration rate, blood and urinary urea concentration in Barmer goats of Rajasthan desert.

The groups of 6 goats kept on pasture during dry season received either unrestricted water or were restricted to 25% of the amount taken by the former group. The average daily feed kg/100 0/day and water lit/100 kg/day intake averaged 4.6 kg and 7.7 lit in fully watered animals and 4.5 kg and 2 lit for water restricted animals. The restricted goats showed no loss of body weight nor change in the urinary urea nitrogen but did show an increase in blood urea nitrogen (63 mg/100 ml) compared to control (46 mg/100 ml). The glonerular filtration rate fell to 1/3 the rate in the control group.

Sauvant and Bas (1979) studied the biochemical profiles of milch goat in relation to their nutritional status. It was concluded that plasma glucose estimation was more informative in late pregnancy than in early lactation. It was further reported that blood non-estarified fatty acids and to a lesser extent hydroxybutyric acid provided an estimate of energy balance in goat in late pregnancy and early lactation.

Haßmeyer and Martens (1980) reviewed different aspect of urea metabolism in ruminants with reference to goat.

Haenlein (1980) reviewed the different aspect of mineral nutrition in goat.

Murtuza et al.(1980) reported certain clinically important serum ensymes and serum protein fractions in Hariana cattle under various physiological stages. It was observed that acid phosphatase activity was higher in late pregnant cows than in other groups whereas alkaline phosphatase, aspertate aminotransferase were higher in pregnant cows and alanine aminotransferase was highest in early lactation. The content of albumin, a globulin, B globulin did not differ significantly between different groups Y globulin was highest in non-pregnant dry coes.

Bas et al. (1980) reported diurnal and weekly variation in concentration of certain metabolites in the blood of lactating goats. The results showed that except for lipids, albumin and SGOT, the values of blood constituents varied according to the time of samplingand during the week. Significant individual variations were recorded for lipids, SGOT, urea and glucose.

Marcos (1980) reported that AST value, commenced at a low level and rose sharply along with total cholesterol value before calving, remained at higher level until 3 wks after parturition and then fell again.

Ghosh et al.(1981) studied some cellular and serum biochemical constituents of blood in Black Bengal goat.

Bogin et al. (1981) reported that the level of alkaline phosphatase and acid phosphatase in Israli goats were significantly higher in young goats than in adult goats. No difference was observed in serum transaminase, Total lipids, cholesterol and glucose were higher in young goats while serum total protein, globulin and albumin were lower. Small difference was also seen in the level of serum minerals like calcium, magnesium, sodium and potassium. There was no distinct difference in the level of inorganic phosphorus.

Machado and Ferreira Neto (1981) studied total blood protein electro-phoretic pattern and blood fibrinogun in confined and semi confined goats of mixed breed aged 4-6 months. It was observed that there was tendency for group kept semi intensive to have higher values than the other group.

Chaiyabutr et al.(1982) reported glucose metabolism in vivo in fed and 48 hr starved goats during pregnancy and lactation. It was observed that glucose synthesis and utilization increased during pregnancy and lactation in fed but not starved goats. Recycling of glucose was approximately 10% in fed animals and 15-20% in starved animals and was unaffected by stage of pregnancy and lactation. Plasma glucose concentration were maintained during pregnancy and lactation in fed goats but decreased during 48 hrs. starvation in pregnant goats.

Pyne et al. (1982) reported some haematological and biochemical values on blood of Black Bengal goats. The values were RBC 12.35 ± 0.35 x 10^6/cu mm W.B.C. 10.18 ± 0.28 x 10^3/cu mm, Hb. 9.98 ± 0.56 g/100 ml, serum protein 5.85 ± 0.16 g/100 ml Calcium 9.05 ± 0.12 mg%, inorganic phosphorus 4.53 ± 0.18 mg% and magnesium 2.13 ± 0.06 mg%.

Vidan and Rai (1983) recorded values of some metabolic profiles at different physiological stages (Prepartum, partum and partum) in goat. The values reported during prepartum (120-150 days), partum (6-48 hrs) and post partum(7-15 days) were glucose mg% 32.21 ± 1.91, 50.88 ± 5.03 and 47.14 ± 3.03, Calcium mg% 11.41 ± 0.10, 11.44 ± 0.94 and 10.91 ± 0.53. phosphorus mg% 5.49 ± 0.30, 6.40 ± 0.48 and 7.71 ± 0.44, SGOT unit/ml 32.16 ± 1.50, 57.90 ± 4.43 and 55.61 ± 3.80 total protein g% 6.62 ± 0.20, 8.54 ± 0.32 and 8.21 ± 0.30 albumin g% 4.22, 5.46 and 5.0 and globulin g% 2.44, 3.14 and 3.02 respectively.

Boruah et al.(1984) reported values of serum calcium, inorganic phosphorus and alkaline phosphatase activity in non descript goats of Assam. The values of serum calcium, inorganic phosphorus and alkaline phosphatase activity were 10.53 mg, 4.05 mg, and 3.4 B.U/100 ml respectively. The variation due to age was significant in all these serum constituent showing decreasing trend with advancement of age. All the animals were reared on free grazing system.

Bhattacharyya et al. (1984a) reported effect of age and body weight on serum aminotransferase activity in Black Bengal kids. A significant change in body weight, SGOT and SGPT(P 0.01) and protein (P 0.05) was observed along with age between 9 weeks to 23rd weeks. It was further observed that whereas SGOT (r = 0.60) and SGPT (r = 0.50) exhibited significant positive correlation with body weight it was not observed in case of total serum protein.

Singha et al. (1986) studied the effect of seasonal environment on some plasma enzymes in ewes. It was observed that the alkaline phosphatase enzyme was significantly higher during winter and rainy season as compared to spring and summer. A significantly higher (P 0.01) SGOT and SGPT activity during winter and rainy season was attributed to higher cortisol level.

Bhattacharyya and Duttagupta (1987) reported biochemical constituents of blood serum in growing kids with an overall age 138.65 ± 6.51 days (male 146.94 ± 8.28 and female 126.25 ± 10.15 days). The protein values (g/dl) reported in male and female was respectively 7.86 ± 0.18 and 7.59 ± 0.18. The alkaline phosphatase activity B.U./dl was accordingly reported as 9.76 ± 1.30 and 13.43 ± 2.11 respectively.

C H A P T E R - III

MATERIALS AND METHODS

MATERIALS AND METHODS

All the Black Bengal goats used in this present experiment were selected from the experimental goat farm of this university at Mohanpur, Nadia, West Bengal. The Black Bengal goat of different age, sex and physiological status were used in different groups from time to time. The healthy dewormed goat were selected in different experimental groups.

Housing of animals :

The experimental goats were housed in cemented sheds with provision for adequate ventilation. The different age groups of animals were kept in separate sheds except preweaned suckling kids which were housed along with their mother. When necessary these kids were also kept in separate kid pens.

Grouping of animals :

The experimental animals were divided into different groups on the basis of their age and physiological status.

A) Study on preweaned suckling kids, 1st week to 11th week of age.
B) Study on maturing goats, 12 week to 36 week of age
C) Study on pregnant goat
D) Study on lactating goat upto 13th week post partum

A) Study on preweaned suckling kids from birth to 11th week of age

In this group 12 number of Black Bengal kids (7 males and 5 females) born during the month of January were used. The mothers(doe) of the respective kid were maintained purely on grazing and no supplementation was offered to the does. The experimental kids were reared exclusively on their doe milk upto 2 months and above two months of age nibbling was allowed in addition to the available milk from the respective doe.

Milk record :

The quantity of milk available to the kids from the respective doe during 24 hours period in a day was assessed by indirect method. In this method kids were allowed to suckle their mothers twice a day at 8 a.m. and 5 p.m. The difference of post and pre suckling body weight of individual kid was taken as a measure of quantity of milk consumed. Ultimately weekly milk consumed/kid was calculated.

Measurement of body weight :

Daily body weight of individual kid was measured at 8 a.m. in the morning with the lep of a precesion weighing balance and ultimately weekly body weight was computed.

Measure of body weight gain and body weight gain(%)

The body weight gain and per cent body weight gain from the weekly body weight of individual kid were calcutaled on the

basis of formula,

1) $W_2 - W_1$ (2) $\frac{W_2 - W_1}{W_1} \times 100$

respectively where W_1 stands for initial body weight and W_2 stands for final body weight.

Milk conversion efficiency (MCE)

The weekly milk conversion efficiency of individual kid was calculated as per following formula -

$$\frac{\text{Body weight gain during the week}}{\text{Milk consumed during the week}} \times 100$$

Biochemical estimation :

Some selected haematological and biochemical parameters like haemoglobin (Hb), packed cell volume (PCV), blood glucose, urea, serum total protein, calcium, phosphorus, serum alkaline phosphatase, serum glutamic (oxalo-acetic acid transaminase (SGOT) and serum glutamic Pyruvic acid transaminase(SGPT) activity were estimated from the blood samples collected from the kids by jugular venepuncture at 4 week and at 8 week of their age.

The haematological and biochemical estimations were conducted according to the standard methods.

B) Study on maturing goats from 12 weeks to 36 weeks of age :

In this experiment 10 male and 5 female healthy Black Bengal goat at the age of 12 weeks were selected at random from

the experimental goat farm.

Feeding schedule :

The maturing goats in this group were kept exclusively on grazing in the adjoining pasture on rotational basis from 8 a.m. in the morning till 5 p.m. in the evening. The field cover around the farm yard was mostly of uncultivated para (Brachiariamutica), Dhub (Cyanodon dactylon) and certain other mixed varieties of grasses. No supplementation was allowed to the animals in this group during the entire experimental period. But water was given ad lib.

Measurement of body weight :

The body weight of individual goat was measured at fortnightly interval with the aid of a sping balance at 8 a.m. in the morning. The body weight gain and per cent body weight gain of individual kid were calculated on the basis of formulae already indicated in group A.

Collection of blood samples :

The blood samples from individual goat was drawn at fortnightly interval in the morning, at 8 a.m. by jugular venipuncture. The whole blood was collected in vial containing sodium fluride (10 mg/ ml blood) as an anticoagulant for the estimation of blood glucose, blood urea, haemoglobin (Hb) and PCV. Blood was also collected in dry test tube without any

anticoagulant for collection of serum and estimation of serum protein, calcium, phosphorus, sodium, potassium and enzymes like alkaline phosphatase and transaminases(both SGOT and SGPT). The serum was preserved in deep freeze before analysis of the sample.

C) Study on pregnant goats

Experimentals animals :

In this experiment eight number of healthy female Black Bengal goats were selected at random on the day of natural mating. The experimental animals were observed right from the day of service till the day of parturition.

Feeding schedule :

All the goats included in this group were kept exclusively under grazing management system throughout the pregnancy period. Thus no animal was offered any supplementation throughout the pregnancy period. The animals were taken to the adjoining grazing field right at 8 a.m. in the morning and were allowed to graze till 5 p.m. in the evening. The grazing of the animals were allowed on rotational basis.

The field cover in the grazing field consists mostly of uncultivated paragrass (Brachiaria matica), dhub grass (Cyanodon dactylon) and many other mixed varieties of grasses. Water was allowed ad libidum to experimental goats.

Collection of blood samples :

Blood samples were collected from the individual goat at a fortnightly interval during the entire experimental period The sample of blood was collected each time by jagular venipuncture at a fixed time at 8 a.m. in the morning. The whole blood collected in a vial containing anticoagulant sodium fluride (10 mg/ml blood) for the estimation of blood glucose, blood urea, haemoglobin (Hb) and packed cell volume (PCV). The sample of blood collected in the long test tubes without any anticoagulant was kept for some time and serum was separated centrifused and preserved in deep freeze for estimation of serum biochemical parameters like total protein, albumin, globulin, calcium, phosphorus, sodium, potassium and enzymes like alkaline, phosphatase and transaminases like SGOT and SGPT activity.

Methods for estimation of haematological and biochemical parameters

The different haematological and biochemical parameters were estimated as per the standard method.

D) Study on lactating goats upto 13th week post partum

Experimental animals :

In this group eight number of goats were selected at random immediately after parturition. The experiment started in the morning of January and continuted upto the month of April.

Feeding schedule :

The animals in this group were maintained in exclusively grazing management system. Thus no grain was given to the experimental animals during the entire experimental period. The animals were taken to the field right at 8 a.m. in the morning and were returned back to the shed at 5. p.m. in the evening. The grazing was allowed on rotational basis in the adjoining grazing field. The field cover consist mostly of uncultivated paragrass (Brachiaria mutica), Dub grass (Cyanodon dactylon) and different varieties of mixed grasses as already mentioned.

The estimation of milk yield

The milk yield of the individual experimental doe was measured from second week of postpartal period and continued upto the 13th week of postpartal period. The milk yield was measured by indirect method. In this method the kid(s) of the individual doe was kept separated from the mother from 5 p.m. in the evening. In the morning at 8 a.m. the individual kid was weighed separately by Salter Spring balance and let lose to suckle the mothers' milk. The kids were again weighed after definite interval of time (30 minutes). The pre suckling body weight of the individual kid of the respective mother was subtracted from post suckling body weight to ascertain milk yield of individual doe in the morning.This process was repeated at 5 p.m. in the evening. Thus combined morning and evening milk

yield was taken as milk yield during the 24 hrs. period by the individual doe. From the daily yield of the individual doe the milk yield/week was calculated. The milk yield of the individual doe was thus measured from 2nd week of lactation period to 13th week of lactation period.

Collection of blood samples :

The blood samples of individual goat was collected, at fortnightly interval, for entire experimental period. The sample of blood was collected by jagular veinipuncture at a fixed time at 8 a.m. in the morning. The samples of blood collected in vial with sodium fluride as anticoagulant (10 mg/ml blood collected) were used for the estimation of haemoglobin (Hb), packed cell volume (PCV), blood glucose and blood urea. The samples of blood collected without any anticoagulant were kept for some time for separation of serum. The separated serum was centrifused at 5000 r.p.m. for 10 minutes and kept in deep freeze for analysis of total serum protein albumin, globulin, calcium, phosphorus, sodium, potassium, alkaline phosphatase and SGOT and AGP activity.

Methods for estimation of haematological and biochemical parameters.

The standard methods used for the estimation of different haematological and biochemical parameters in different experimental groups.

Haemoglobin was estimated by conventional acid haematin method of Sahli and Packed cell volume(PCV) by microhaematocrit technique.

The blood glucose and blood urea were estimated from the samples of whole blood collected by modified method of Nelson and Somogyi (1952) and diacetyl monoxime method of Natelson (1957). Total serum protein was estimated by biurel method of Reinhold et al. (1950) as described by Wooton (1982) using bovine serum albumin (BSA) as standard. Serum inorganic phosphorus and alkaline phosphatase activity were estimated by colorimetric method of Fiske and SubbaRow (1925) and serum calcium by method of Roe and Kahn (1929) as suggested by Osser (1954). The SGOT and SGPT activity were estimated according to the method of Yatzidis (1960) and activity was expressed as ug Pyruvic acid liberated/ml serum incubated for 60 minutes at 37°C. Sodium and Potassium were estimated by flame photometric method as described by Osser (1965). All the reagents used in the biochemical estimations were of AnaLar grade.

Preparation of standard curve :

Standard curves for different biochemical estimations were prepared as per instruction in the respective methods.These standard curves were checked for each batch of fresh reagents used for estimation of different biochemical parameters.

e) The study of feed consumption under grazing condition :

The study of feed consumption by different groups of grazing goats were studied during the month of July. In this study five number of maturing goats, six number of pregnant and six number of lactating goats were used. At the beginning of this

feeding experiment individual animal of the respective group was weighed and weight of the individual animal was recorded.

The chromic oxide method (Hill and Anderson 1958) as external indicator and acid insoluble ash method (Srivastava and Talapatra 1962) both in feed and faeces as internal indicators were used in this experiment.

The preliminary period of feeding of chromic oxide was continued for 7 days and the experimental period was extended further for consecutive 3 days. In each day individual animal was fed 1 gm of chromic oxide. The accurately weighed chromic oxide was packed previously in the filter paper in the form of capsule. The capsule containing chromic oxide was inserted into the buccal cavity of the individual goat with the aid of finger tips right at 8 a.m. in the morning before the animals were taken to the grazing field. During the days of experimental period faecal grab samples were collected at 6 hours interval and pooled grab samples were analysed for concentration of chromic oxide/gm of dry faecal sample. The forage sample was also collected as the animals grazed in the grazing field. The pooled forage sample and pooled faecal sample of individual goat were also analysed for acid insoluble ash.

The pasture consumption was determined by the following formula .

$$\text{Faecal output of DM(g)/day} = \frac{\text{Total amount of external indicator fed (mg/day)}}{\text{Concentration of external indicator (mg/g dry faeces)}}$$

$$\text{Dry matter(DM) consumption/day} = \frac{\text{Weight of internal indicator in faecal output}}{\text{\% internal indicator in forage}}$$

Pasture collection and analysis :

The samples of pasture were collected as the animals grazed by hand plucking method. The samples of pasture thus collected were pooled together, dried in oven at 107°C and powdered in pulvarizing machine. The representative sample of pasture was then analysed in triplicate for estimatation of crude protein in the forage sample as per following procedure:

Accurately weighed 200 mg of dried samples was transferred into a 100 ml Kjeldahl flask. To this 1 gm of catalyst mixture (Potassium sulphate and copper sulphate mixed in the ratio of 10:1 and 10 ml of concentrated sulphuric acid were added and heated in an electric heater first gently and then more strongly when frothing has ceased. After completion of the digestion the flask was removed and cooled. To 5-10 ml of this digestion mixture in a distillation apparatus were added to 10 ml of 40% NaOH and distilled. The distillate collected in 10 ml of N/100 H_2SO_4 and titrated against N/100 NaOH using methyl red as indicator.

Calculation :

Nitrogen(%) in the sample =

$$\frac{\text{Volume of N/100 } H_2SO_4 \text{ consumed x 0.00014 x 100}}{\text{Volume of digested x weight of sample material taken}} \times 100$$

Protein(%) = Nitrogen(%) x 6.25

Callection of Meteoriological data :

The meteoriological data during the entire experimental period covering different experimental groups were collected. The meteoriological data include temperature both maximum and minimum in celcius, relative humidity(%) and rainfall in mm.The data so collected were presented in table-51 after being partitioned into three distinct seasons of the year.

Statistical analysis of data :

Thed data collected during the experiment were subjected to statistical test of significance through analysis of variance and when necessary by Duncan's multiple range test according to the method of Snedecor and Cochrun (1967) and were interpretated.

C H A P T E R - IV

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

The present experimental design mimics the village management system, since we have dearth of knowledge about the performance of suckling kids vis-a-vis their nutritional status at farmers door. The performance of kids in terms of body weight, body weight gain, milk conversion efficiency and biochemical parameters were recorded.

Under village management system where goats are maintained in one or two by the small and marginal farmers, the kids born havea access only to their mothers' milk as source of nutrients.

The results of work presented in the succeding sections cover the study of growth reproductive and productive performance and a number of biochemical parameters of practical importance in Black Bengal goats.

The experiment was partitioned into following different groups on the basis of the physiological status of the experimental animals as (A) preweaned suckling group (1st week to 11th week of age) (B) postweaned maturing group (12th week to 36 week of age (C) pregnant group and (D) post parturient lactating group of animals (1st week to 13th week of lactation period).

A. Preweaned suckling group (1st week to 11th week of age)

In this phase of experiment the body weight of the kids, body weight gain of different weeks, gain in body weight expressed

as per cent of body weight, milk conversion efficiency were recorded. The haematological as well as certain biochemical parameters of blood were also studied only at 4 weeks and 8 weeks of their age.

The results are presented below.

Body weight :

The mean value of body weight (kg) from 1st week to 11th week of age in male and female is given in Table-1 and Fig.1a (sexes are not shown separately). The value in 0 at 11th week in male was 4.38±0.184 and that in female 4.44±0.117.The overall mean irrespective of sex of the kid at 11th week was 4.41±0.110.

Table - 1

Showing body weight (kg) Mean ±SE in preweaned suckling kids in the age group between 1st week to 11th week along with the result of Duncan's multiple range test

Age in week	Sex		Overall Mean ±SE
	Male Mean ±SE	Female Mean ±SE	
1st week	1.96±0.131	1.83±0.086	1.91±0.007 h
2nd week	2.16±0.137	2.05±0.080	2.11±0.085 gh
3rd week	2.45±0.141	2.33±0.092	2.40±0.089 fgh
4th week	2.64±0.146	2.56±0.115	2.63±0.095 efgh
5th week	2.90±0.159	2.82±0.114	2.86±0.100 defg
6th week	3.15±0.169	3.07±0.117	3.12±0.106 cdef
7th week	3.37±0.170	3.34±0.116	3.36±0.106 bcdc
8th week	3.61±0.167	3.64±0.136	3.62±0.108 abcd
9th week	3.86±0.168	3.92±0.123	3.88±0.106 ab
10 week	4.10±0.168	4.18±0.137	4.14±0.110 ab
11th week	4.38±0.184	4.44±0.117	4.41±0.110 a
Overall Mean ±SE	3.15±0.097	3.11±0.117	3.13±0.074

P < 0.05

Values with atleast one superscript in common are not significantly different.

The analysis of variance of body weight from 1st week to 11th week of age showed a highly significant difference (P 0.01) between week but variation between sex of the kid and interaction between sex x week were found to be nonsignificant.

Table 1.1

Analysis of variance of body weight (kg) in preweaned suckling Black Bengal kids from 1st to 11th week age

Source of variation	Degree of freedom	Mean square
		Body weight
Bet sex	1	0.0460^{NS}
Bet week	10	8.2727^{**}
Bet sex x week	10	0.0207^{NS}
Error	110	0.8863

** P $<$ 0.01, NS = Nonsignificant

The result of the Duncan's multiple range test is presented in table 1 with superscript in common are not significantly different.

Body weight gain :

The mean value of body weight gain (Table-2) recorded in male on second week and 11th week were 0.20 $\pm$ 0.022 and 0.28 $\pm$ 0.044 respectively. In female the mean value on second and 11th week were recorded as 0.22 $\pm$ 0.022 and 0.26 $\pm$ 0.048 with an overall mean of 0.27 $\pm$ 0.031 at 11th week of age.

Table - 2

Showing gain in weight (kg) Mean ±SE in preweaned suckling Black Bengal kids between 1st week to 11th week of age

Age in week	Sex		Overall Mean ±SE
	Male Mean ±SE	Female Mean ±SE	
2nd week	0.20±0.022	0.22±0.022	0.21±0.014
3rd week	0.28±0.063	0.28±0.031	0.28±0.037
4th week	0.23±0.026	0.23±0.031	0.23±0.020
5th week	0.22±0.014	0.25±0.028	0.23±0.014
6th week	0.25±0.014	0.25±0.010	0.25±0.010
7th week	0.21±0.022	0.27±0.017	0.24±0.017
8th week	0.24±0.017	0.30±0.022	0.26±0.014
9th week	0.25±0.028	0.28±0.014	0.26±0.017
10th week	0.25±0.031	0.26±0.020	0.25±0.020
11th week	0.28+0.044	0.26+0.048	0.27+0.031
Overall Mean ±SE	0.24±0.010	0.26±0.010	0.25±0.001

Gain in body weight(%) :

The mean value of gain in body weight (%) alongwith the result of Duncan's multiple range test are presented in Table-3 and Fig. 1a(sexes are not shown separately). In male the mean gain in body weight (%) on second week and 11th week of age was 10.36±1.315 and 6.80±1.033 respectively. The overall mean value irrespective of sex of the kid on 11th week was 6.62±0.790.

Table - 3

Showing gain in body weight (%) (Mean ±SE) in preweaned suckling kids in the age group between 2nd to 11th week of age alongwith the result of Duncan's multiple range test

Age in week	Sex		Overall Mean
	Male(Mean ±SE)	Female(Mean ±SE)	
2nd week	10.36±1.315	11.99±1.497	11.04±0.974^{ab}
3rd week	13.47±2.879	13.91±1.433	13.66±1.718^{a}
4th week	9.52±1.128	9.96±1.248	9.71±0.803^{bc}
5th week	8.71±0.445	10.03±1.223	9.26±0.573^{c}
6th week	8.87±0.371	9.06±0.427	8.95±0.281^{c}
7th week	6.92±0.727	8.79±0.768	7.70±0.579^{c}
8th week	7.22±0.690	8.94±0.467	7 .94±0.500^{c}
9th week	7.04±0.816	7.92±0.694	7.41±0.549^{c}
10th week	6.50±0.847	6.61±0.426	6.55±0.506^{c}
11th week	6.80±1.033	6.38±1.360	6.62±0.790
Overall Mean ±SE	8.54±0.439	9.36±0.431	8.88±0.314

$P < 0.05$

Values with atleast one superscript in common are not significantly different.

Milk conversion efficiency :

The figures on total milk intake, body weight of the kids and the gain in weight at different stages have been presented in Table-4.

The values of milk conversion efficiency in preweaned suckling kids thus worked out alongwith the result of Duncan's multiple range test are given in Table-5.

The calculated milk conversion efficiency from second week and 11th week of age in suckling male kids was 6.80±0.710 and 26.00±3.818 respectively. In case of female the value was 7.03 ± 1.100 and 25.50 + 4.825 respectively, during 2nd w and 11th week of age. The overall mean value irrespective of week and sex of the kid was 12.39 + 0.658 during the experimental period.

The result of the analysis of variance of body weight gain as such, expressed as per cent and the milk conversion efficiency are presented in Table-6.

The result of the analysis of variance of body weight gain showed that variations between sex, between week and interaction between sex and week were nonsignificant.

The analysis of variance of per cent body weight gain showed a highly significant difference ($P < 0.01$) between weeks only.

Table - 4

Showing quantity of milk consumed (kg), body weight gain (kg) milk conversion efficiency of preweaned suckling Black Bengal kids in the age group between 1st week to 11th week of age

Parameters	Sex	Age in week									
		2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th
Milk consumed (kg) Mean ±SE	M	3.27± 0.053	3.37 ± 0.060	3.37 ± 0.046	2.96 ± 0.084	2.77 ± 0.076	2.41 ± 0.084	1.96 ± 0.046	1.59 ± 0.043	1.38 ± 0.022	1.06 + 0.031
	F	3.15 ± 0.152	3.30 ± 0.173	3.40 ± 0.173	3.04 ± 0.142	2.80 ± 0.086	2.59 ± 0.084	1.92 ± 0.189	1.72 ± 0.034	1.46 ± 0.040	1.02 ± 0.01
Body wt gain (kg) Mean ±SE	M	0.20 ± 0.022	0.28 ± 0.063	0.23 ± 0.026	0.22 ± 0.014	0.25 ± 0.014	0.21 ± 0.022	0.024± 0.017	0.25 ± 0.028	0.25 ± 0.031	0.28 ± 0.044
	F	0.22 ± 0.022	0.28 ± 0.031	0.23 ± 0.031	0.25 ± 0.028	0.25 ± 0.010	0.27 ± 0.017	0.30 ± 0.022	0.28 ± 0.014	0.26 ± 0.020	0.26 ± 0.048
Milk conversion efficiency Mean ±SE	M	6.80 ± 0.710	8.85 ± 2.172	6.88 ± 0.841	7.55 ± 0.725	9.35 ± 0.745	8.94 ± 0.909	12.24 ± 0.969	15.81 ± 1.230	17.81 ± 2.262	26.00 ± 3.818
	F	7.03 ± 1.100	8.66 ± 0.962	7.08 ± 1.190	8.54 ± 0.769	9.13 ± 0.416	10.39 ± 0.724	18.06 ± 1.208	16.58 ± 1.094	17.98 ± 1.724	25.50 ± 1.826

M = Male, F = Female

Table - 5

Milk conversion efficiency in preweaned Black Bengal kids in the age groups between 2nd week to 11th week of age alongwith the result of Duncan's multiple range test

Week	Milk conversion efficiency(%)		
	Sex		Overall Mean ±SE
	Male Mean ±SE	Female Mean ±SE	
2nd week	6.80±0.710	7.03±1.100	6.89±0.587^{e}
3rd week	8.85±2.172	8.66±0.962	8.77±1.281^{de}
4th week	6.88±0.841	7.08±1.190	6.96±0.663^{e}
5th week	7.55±0.725	8.54±0.769	7.97±0.528^{de}
6th week	9.35±0.745	9.13±0.416	9.26±0.451^{cde}
7th week	8.94±0.909	10.39±0.724	9.55±0.624^{cde}
8th week	12.24±0.969	18.06±1.208	14.67±1.123^{bcd}
9th week	15.81±1.830	16.58±1.094	16.13±1.123^{bc}
10th week	17.91±2.262	17.98±1.724	17.94±1.441^{b}
11th week	26.00±3.818	25.50±4.826	25.79±2.859^{a}
Overall Mean ±SE	12.03±0.881	12.90±0.995	12.39±0.658

$P < 0.05$

Values with atleast one superscript in common are not significantly different.

Table - 6

Analysis of variance of body weight gain, body weight gain (%) and milk conversion efficiency of suckling Black Bengal kids from 1st to 11th week of age

Source of variation	Degree of freedom	Mean square		
		Body weight gain	Body weight gain %	Milk conversion efficiency
Bet sex	1	0.0107^{NS}	19.4494^{NS}	21.6521^{NS}
Bet week	9	0.0060^{NS}	57.7552**	453.1740**
Bet sex x week	9	0.0019^{NS}	1.7980^{NS}	9.8893^{NS}
Error	100	0.0066	14.0734	62.0083

$P < 0.01$

Means with atleast one superscript in common are not significantly different.

The sex and interaction effect were however found to be nonsignificant (Table-6).

The analysis of variance of milk conversion efficiency (Table-6) showed significant variation ($P < 0.01$) between week but thee effect of sex and interaction effect of sex were not significant. The Duncan's multiple range test showed some overlaping effects. The means with atleast one superscript in common are not significantly different.

Haematological and biochemical parameters :

The study on some selected haematological and biochemical parameters were also taken up during 4th week and 8th weeks of age in preweaned suckling kids. The mean values of different haematological and biochemical parameters are presented in table-7. The value of Hb (g/100 ml) during 4th week and 8th week of age were 8.01±0.055 and 8.66+0.1001. Similar rising trend was observed in case of PCV% (27.53±0.194 vs 28.74±0.195) and serum total protein value g/100 ml (5.87±0.052 vs 6.04±0.059). In case of other parameters studied except blood glucose (mg/100ml) the values obtained during 8th week of age were comparatively higher than the values obtained during 4th week of age. The values of glucose during 4th weekand 8th week of age were respectively 53.50±1.118 and 53.33±0.996 mg/100 ml, Urea 12.28±0.648 and 14.90±0.750 mg/100 ml, serum calcium 10.83±0.256 and 11.01±0.234 mg/100 ml, phosphorus 4.71+0.150 and 4.88+0.196 mg/100 ml, serum alkaline

phosphatase 8.14±0.495 and 8.50±0.535 B.U./100 ml, GOT 104.83 ± 1.565 and 107.67+1.951 and GPT 31.75+0.729 and 33.08+1.316 (g Pyrivic acid liberated/ml serum at 37°C for 1 hr.)

Table - 7

Body weight (g) and some haematological and biochemical parameters (Mean ±SE) during 4th and 8th week of age in preweaned suckling kids (sexes are not shown separately) along with the result of Duncan's multiple range test

Parameters	Age in week	
	4th week	8th week
Body weight(g)	2630.00±95.00^{b}	3620.00±106.00^{a}
Hb g%	8.01± 0.055^{b}	8.66± 0.100^{a}
PCV%	27.53± 0.194^{b}	28.74± 0.195^{a}
Glucose mg/100 ml	53.50± 1.118	53.33±0.096
Urea mg/100 ml	12.28± 0.648	14.90± 0.750
Serum total protein g/ 100 ml	5.87± 0.052^{b}	6.04± 0.059^{a}
Serum calcium mg/100 ml	10.83± 0.256	11.01± 0.234
Serum phosphorus mg/100ml	4.71± 0.150	4.88± 0.196
Alkaline phosphatase B.K./ 100 ml	8.14± 0.495	8.50± 0.535
Serum GOT ug/Pyruvic acid liberated/ml serum	104.83± 1.565	107.67± 1.951
Serum GPT	31.75+0.729	33.08+ 1.316

$P < 0.01$

Means with atleast one superscript in common are not significantly different.

The analysis of variance revealed that there were only significant variation ($P < 0.01$) of body weight, haemoglobin, packed cell volume and serum total protein between weeks(table-8). Sex and interaction effect were nonsignificant.

Other biochemical parameters studied (tables - 9 and 10) like blood glucose, urea, serum calcium, phosphorus, enzyme activity like alkaline phosphatase, GOT and GPT failed to show any significant difference between sex between week and the interaction effect was also not significant.

Table - 8

Analysis of variance of body weight (g), some haematological and biochemical parameters in preweaned suckling Black Bengal kids between 4th week to 8th weeks of age.

Source of variation	Degree of freedom	Mean square			
		Body wt.	Haemoglobin	Packed cell volume	Serum total protein
Bet sex	1	456462.5^{NS}	0.0026^{NS}	0.0903^{NS}	0.0224^{NS}
Bet week	1	5851000.0**	2.509**	8.7603**	0.1073**
Bet sex x week	1	41537.5^{NS}	0.2632^{NS}	0.9398^{NS}	0.0046^{NS}
Error	20	114650.0	0.0741	0.4483	0.0403

** $P < 0.01$ NS = Nonsignificant

Table - 9

Analysis of variance of some biochemical parameters in preweaned suckling Black Bengal kids between 4th weeks to 8th weeks of age.

Source of variation	df	Mean square			
		Urea	Blood glucose	Calcium	Phosphorus
Bet sex	1	10.0653^{NS}	5.5043^{NS}	0.2889^{NS}	0.8128^{NS}
Bet week	1	0.8626^{NS}	0.1663^{NS}	0.1944^{NS}	0.1751^{NS}
Bet sex x wk	1	2.8878^{NS}	0.0767^{NS}	0.1419^{NS}	0.3388^{NS}
Error	20	5.8463	14.1043	0.7730	0.3457

** $P < 0.01$, * $P < 0.05$, NS = Nonsignificant

Table - 10

Analysis of variance of some biochemical parameters in preweaned suckling Black Bengal kids between 4th weeks and 8 weeks of age

Source of variation	d.f.	Mean square		
		Alk Phosphatase activity	SGOT activity	SGPT activity
Bet sex	1	1.4039^{NS}	9.64^{NS}	39.4433^{NS}
Bet week	1	0.7776^{NS}	48.17^{NS}	10.6663^{NS}
Bet sex x wk	1	1.4219^{NS}	423.8^{NS}	2.3047^{NS}
Error	20	3.3727	38.6855	12.8715

NS = Nonsignificant

Discussion :

In the preweaned suckling group the experimental observation were recorded on a group of kids from birth till the age of 11 weeks of their life. The kids were reared exclusively on their monthers' milk.

The weekly mean body weight of kids of both sexes in the present experiment showed a consistent increase and variation between week, irrespective of sex was found to be significant ($P < 0.05$).

The calculated rate of gain in body weight depicted a low but almost uniform rate of gain and the variation in weight gain between week and also between sexes were statistically nonsignificant.

The per cent gain in body weight showed a significant decrease ($P < 0.05$) between weeks under study as age progressed.

The available records indicate that different breeds of goats show variable growth rates. Further very limited data are available on the growth rate of Black Bengal goats. The most of the experiments, carried out with goat are mainly related to determine optimum age of slaughter for meat producing breeds and optimum milk production ability in case of lactating type of animals. All these experiments of similar types have been conducted under strict experimental condition and experimental design. Very little information is available with animals

at the natural habitat and natural condition without being supplemented in any form. Hence, the present experimental findings can hardly be compared with the findings of other workers for some effective conclusion but no doubt furnish some base level information not readily available.

McGregor (1980) carried out an experiment with sunnel goat. He recorded the gain in weight at different weight groups of animals between the body weight ranging from 5-10,10-15,15-20 and 20-25 kg body weight. The daily gain in weight was recorded to be 154, 211, 216 and 206 respectively.

In Assam local goat Sharma et al.(1981) recorded birth weight and 90 day weaning weight at 1.17 kg and 4.75 kg respectively. The birth weight and daily gain in the period 1-12, 13-24, 25-36, 37-48 weeks in Black Bengal kids recorded by Singh et al. (1983) averaged 1.3, 41.50, 28.56, 22.56 and 20.70 g respectively. The present experiment clearly indicates that the daily gain in weight of kids in early phase of their life under indifferent managemental condition may vary between 30 to 40 g.It must be kept in mid that these animals were never looked after by the farmers and neither the kids nor the doe were ever supplemented.

In the present experiment the animals recorded 1.91 kg body weight on an average on week one. The average body weight of these animals were found to be 4.41 kg at 11 weeks of age(table 1).

Under physiological norms the animals gain weight during the active phase of their life. The rate of gain/day without any supplementary management varied from 30 to 40 g in the early growth phase of the animals. These figures exactly stand with those of the findings of Singh et al. (1983)

The milk consumption of the kids increased progressively and attained its highest value at the 4th week. The milk consumption started declining on and from 5th week of age of the kids. The consumption is governed by the milk production ability of the does. The present experimental findings clearly indicate the normal lactation hebaviour of the Black Bengal does. The peak period of lactation behaviour of the Black Bengal does. The peak period of lactation in a lactation curve is expected to occur between 4th to 5th week and exactly the same thing has appeared here also.

The milk conversion efficiency progressively increased (with the exception of 4th to 5th week) with the increasing age of the kids. When the feed (milk) intake was expressed on the basis of per cent body weight it indicated much interesting observation.

During the second week of age the kids consumed 153% of feed (milk) when expressed on per cent body weight. This value went on decreasing progressively with the advancing age or in other words with increasing body weight at 11th week this

was recorded around 25%. Naturally it may be questioned that how these animals gained body weight inspite of lower feed consumption. This apparent observation can only be explained in terms of additional energy source to the growing kids. In fact this true in case of all ruminants including goat. It has been observed that in ruminant nibbling starts at the age of 4 weeks and by 8 weeks of age considerable quantity of forages are consumed by these animals to serve as energy source (Swenson 1977) under free range condition.

The observed haematological values both at 4 week and 8 weeks of age were found to be within normal physiological range The values of blood glucose observed during 4th and 8th week of age was within the normal range (Swenson, 1977) but the values were observed to be much higher when compared with the values recorded in case of adult goats in this experiment.

In ruminants prior to the establishment of functional activity of rumen microflura and microfauna the animals behave likes simple stomached animals and blood sugar level remains high. Thus observed higher blood sugar level in the preweaned suckling kids in this study is physiologically normal and is acceptable.

The total serum protein value at 8 weeks of age was significantly higher ($P < 0.05$) than the values observed at 4 weeks of age. The rest of the biochemical parameters studied did not show any significant variation between the weeks under study.

Bhattacharyya et al.(1984a) observed a significant (P 0.05) change in body weight and serum protein and amino-transferase activity from 9 weeks to 23 weeks of age in Black Bengal kids. But no positive correlation of serum protein with body weight was found. Thus growth performances observed in this group of preweaned suckling Black Bengal kids indicate that the kids were in positive nutritional balance.

Haematological and biochemical parameters studied at 4th week and 8th week of their age further support that there was no apparant indication on nutritional stress at the cellular level.

In any case the observed values of different biochemical parameters are within normal physiological range.

But whether additional flow of nutrients during this early growth phase in this breed of goat could improve their overall performance to the maximum of inherited genetic potentiality is a matter of speculation only. Thus nothing more could be predicted within the frame work of present experimental design and the presented results thus could be considered as base level information only.

B. Post weaned maturing group (12th week to 36 week of age)

The results of the different parameters investigated during the period are being placed below.

Body weight :

The mean body weight (kg) on 12 week and 36 week of age in male was respectively 5.63 ± 0.228. In case of female the mean body weight was 5.68 ± 0.153. The overall mean body weight (kg) irrespective of sex during the experimental period was 8.70 + 0.177. The values are given in table-11 and fig.11b.

The highest mean value was recorded on 36 week of age and lowest mean value was recorded on 12th week of age.

Table - 11

Table showing body weight (kg) of post weaned maturing in the age between 12 week to 36 week along with the result of Duncan's multiple rante test

Age and week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female (Mean ±SE)	
12 wk	5.63±0.228	5.68±0.153	5.64 ± 0.194^{g}
14 wk	6.30±0.298	6.30±0.250	6.30 ± 0.210^{fg}
16 wk	6.85±0.301	6.78±0.320	6.82 ± 0.221^{fg}
18 wk	7.59±0.329	7.22±0.307	7.47 ± 0.240^{ef}
20 wk	8.11±0.343	7.68±0.461	7.97 ± 0.271^{de}
22 wk	8.59±0.371	8.22±0.572	8.47 ± 0.303^{de}
24 wk	9.95±0.361	8.52±0.571	8.81 ± 0.300^{cde}
26 wk	9.35±0.359	8.80±0.531	9.17 ± 0.295^{bcd}
28 wk	9.86±0.376	9.28±0.487	9.67 ± 0.297^{abc}
30 wk	10.26±0.370	9.74±0.546	10.08 ± 0.302^{ab}
32 wk	10.70±0.362	9.98±0.511	10.46 ± 0.298^{ab}
34 wk	11.15±0.330	10.50±0.502	10.93 ± 0.278^{ab}
36 wk	11.63±0.320	10.96±0.571	11.44 ± 0.286^{a}
Overall Mean ±SE	8.84±2.239	8.43±1.079	8.70±0.177

* P< 0.05

Means with atleast one superscript common are not significantly different.

The analysis of variance of body weight (kg) from 12 week to 36 week of age showed a highly significant ($P < 0.01$) difference week (Table - 12). The effect of sex of the experimental animals and interaction effect between sex x week during the experimental period were found to be nonsignificant.

Table - 12

Analysis of variance of body weight (kg) in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age.

Source of variation	Degree of freedom	Mean square
		Body weight
Bet sex	1	7.2081^{NS}
Bet week	12	49.0296^{**}
Bet sex x week	12	0.2184^{NS}
Error	169	3.5034

** $P < 0.01$

NS - Nonsignificant

The results of Duncan's multiple range test (Table - 11) represented by superscripts indicated nonsignificant difference between two consecutive weeks and therefore effect was observed to be overlaping.

Body weight gain :

The mean body weight gain (kg)from 12 week to 36 week is presented in Table-13. In male the mean body weight gain on 14 week and 36 week of age was 0.68 ± 0.110 and 0.48 ± 0.085 respectively. In case of female the mean value during the same week was 0.62 ± 0.162 and 0.54 ± 0.040 respectively.

The overall mean value irrespective of sex from 14th week to 36 week was 0.48 ± 0.020 kg;

Table - 13

Showing gain in wt (kg) in maturing Black Bengal goat in the age group between 12 wk to 36 wk alongwith the result of Duncan's multiple range test

Age in wk	Sex		Overall Mean ±SE
	Male(mean ±SE)	Female (mean ±SE)	
14 wk	0.68±0.110	0.62±0.162	0.66 ± 0.088^{a}
16 wk	0.54±0.098	0.50±0.149	0.53 ± 0.078^{abc}
18 wk	0.75±0.144	0.40±0.094	0.63 ± 0.108^{ab}
20 wk	0.52±0.997	0.46±0.163	0.50 ± 0.081^{abc}
22 wk	0.48±0.066	0.54±0.120	0.50 ± 0.057^{abc}
24 wk	0.36±0.040	0.30±0.031	0.34 ± 0.028^{c}
26 wk	0.40±0.051	0.28±0.073	0.36 ± 0.043^{c}
28 wk	0.51±0.043	0.48±0.058	0.50 ± 0.033^{abc}
30 wk	0.42±0.078	0.46±0.067	0.43 ± 0.055^{bc}
32 wk	0.42±0.053	0.28±0.020	0.37 ± 0.040^{c}
34 wk	0.45±0.087	0.52±0.048	0.47 ± 0.060^{abc}
36 wk	0.48±0.085	0.54±0.040	0.50 ± 0.057^{abc}
Overall (MEAN±SE)	0.50±0.024	0.45±0.030	0.48±0.020

$P < 0.05$

Means with atleast one superscript in common are not significantly different

The analysis of variance of the data on body weight gain in kg showed a significant ($P < 0.05$) difference between week but the effect of sex and interaction effect of sex x week were found to be non-significant (table - 14).

Table - 14

Showing gain in weight (%) in post weaned maturing Black Bengal goat in the age group between 12 wk to 36 wk of age along with the result of Duncan's multiple range test

Age in wk	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
14 wk	12.47±2.082	10.87±2.745	11.93±1.617^{a}
16 wk	8.97±1.879	7.75±2.106	8.56±1.400^{abc}
18 wk	11.21±2.282	5.99±1.539	9.47±1.700^{ab}
20 wk	6.96±1.276	6.10±1.815	6.67±1.012^{bcd}
22 wk	5.92±0.712	6.83±1.082	6.22±0.584^{bcd}
24 wk	4.31±0.588	3.72±0.477	4.11±0.419^{d}
26 wk	4.56±0.660	3.45±0.956	4.19±0.541^{d}
28 wk	5.48±0.439	5.63±0.856	5.53±0.391^{cd}
30 wk	4.35±0.880	4.89±0.498	4.53±0.600^{d}
32 wk	4.16±0.621	2.90±0.238	3.74±0.443^{d}
34 wk	4.37±0.902	5.28±0.625	4.67±0.632^{d}
36 wk	4.39±0.823	5.12±0.123	4.63±0.547^{d}

$P < 0.05$

Mean with atleast one superscript in common are not significantly different.

The result of Duncan's multiple range test (table-13) whowed by superscripts in the overall mean values in different weeks were found to be significant ($P < 0.05$). The values of different weeks with atleast one superscript in common are not significantly different. Thus value of 12th week was significantly different from the values of 24th, 26th and 32nd week and value of 18th week differed significantly from 24th, 26th and 32 nd week of age.

Gain in body weight (%) :

The mean value of body weight gain(%) from 14 week to 36 week is shown in Table-14, Fig. IIb. The mean body weight starting on 14 weeks of age and on 36 week ofa age in case of male was respectively 12.47 ± 2.082 and 4.39 ± 0.823. In case of female the value recorded on the above weeks was 10.87 ± 2.745 and 5.12 ± 0.123 respectively.

The overall mean starting from the age at 14 week till the age at 36 week of age irrespective of sex was 6.19 ± 0.321.

The analysis of variance of body weight gain % showed significant difference ($P < 0.01$) between week (Table-14). But the effect of sex and interaction effect between sex x week were nonsignificant.

The result of Duncan's multiple range test (table-14) showed a significant difference ($P < 0.05$) between weeks and are indicated by superscripts and the means with atleast one superscript in common were not significantly different. Thus

overall mean values starting from 20th week till 36 week and similarly values starting from 14th week to 18th week, values of 16th week to 22nd week and values of 16th week, 20th week, 22nd week and 28th week were statistically nonsignificant.

Table - 15

Analysis of variance of body weight gain(kg) and body weight gain (%) in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age

Source of variation	Degree of freedom	Mean square	
		Body wt.gain	Body weight gain %
Bet sex	1	0.1085^{NS}	20.5636
Bet week	11	0.1445^{*}	97.9739^{**}
Bet sex x wk	11	0.0445^{NS}	9.5603
Error	156	0.0791	21.3302

** $P < 0.01$

* $P < 0.05$

NS = Nonsignificant

Haemoglobin (Hb%) :

The mean values of haemoglobin(g/100 ml) is shown in the Table - 16 and Fig, III.In case of male on 12 weeks and on 36 week of age the value was respectively 8.22±0.104 and 8.79±0.319. The mean haemoglobin value in case of female on 12 weeks and on 36 week of age was 8.36+0.170 and 8.26+0.328 respectively.The overall mean haemoglobin value during 12 week of age to 36 week of age irrespective of sex was 8.52±0.052

Table - 16

Showing haemoglobin (g/100 ml) value (Mean ±SE) alongwith the result of Duncan's multiple range test in postweaned maturing Black Bengal goat in the age group between 12 wk 36 wk of age

Age in week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female (Mean ±SE)	
12 wk	8.22±0.104	8.36±0.170	8.26±0.089
14 wk	8.18±0.187	8.10±0.134	8.15±0.130
16 wk	8.14±0.189	8.14±0.100	8.32±0.134
18 wk	8.63±0.137	8.08±0.134	8.45±0.126
20 wk	8.73±0.225	8.36±0.194	8.61±0.176
22 wk	8.64±0.212	8.28±0.325	8.52±0.187
24 wk	8.49±0.242	8.46±0.282	8.48±0.189
26 wk	8.53±0.238	8.42±0.357	8.49±0.202
28 wk	8.77±0.328	8.38±0.379	8.64±0.262
30 wk	8.93±0.272	8.42±0.322	8.76±0.225
32 wk	8.85±0.313	8.36±0.293	8.69±0.244
34 wk	8.94±0.324	8.36±0.382	8.75±0.266
36 wk	8.79±0.319	8.26±0.328	8.61±0.254
Overall Mean ±SE	8.62 ± 0.068^{a}	8.30 ± 0.071^{b}	8.52±0.052

* P $\angle$ 0.05

Means with atleast one superscript common are not significantly different

The analysis of variance of haemoglobin value from 12 wees of age to 36th week of age showed significantly higher ($P < 0.01$) values of haemoglobin ♂ in case of male compared to values in case of female (Table - 18). The effect of age and interaction between age x week were found to be nonsignificant

The result of Duncan's multiple range test (table-16) showed significantly higher value ($P < 0.05$) of haemoglobin in case of male than in case of female as indicated by superscript in the overall mean value of both male and female.

Packed cell volume (PCV%) :

The mean PCV% value is presented in Table - 17,Fig.III. In case of male the mean value on 12 weeks and on 36 weeks of age was respectively 26.02 ± 0.216 and 27.39 ± 0.595.

In case of female the mean values of PCV during 12 week and on 36 week of age was 26.16 ± 0.353 and 26.26 ± 0.622 respectively. The overall mean value irrespective of sex from 12 week to 36 week of age was 26.68 ± 0.105.

The analysis of variance of the data on packed cell volume (PCV%) per cent (Table - 17) showed that male had significantly higher ($P < 0.01$) value than the female. The effect of age in week and interaction between age in weeks x sex were nonsignificant.

Table - 17

Showing values (Mean ±SE) of packed cell volume (PCV%) along with the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 wk to 36 wk of age

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	26.02±0.216	26.16±0.353	26.06±0.178
14 wk	25.88±0.303	25.70±0.371	25.82±0.238
16 wk	26.61±0.506	26.14±0.100	26.45±0.339
18 wk	27.20±0.408	25.88±0.325	26.76±0.330
20 wk	26.89±0.406	26.44±0.515	26.74±0.314
22 wk	26.84±0.450	26.28±0.637	26.65±0.361
24 wk	26.69±0.524	26.46±0.524	26.61±0.387
26 wk	26.53±0.441	26.60±0.709	26.55±0.363
28 wk	27.15±0.658	26.89±0.490	26.89±0.490
30 wk	27.51±0.564	26.42±0.619	27.15±0.438
32 wk	27.32±0.570	26.36±0.738	27.00±0.453
34 wk	27.41±0.575	26.56±0.754	27.12±0.465
36 wk	27.39±0.595	26.26±0.622	27.01±0.457
Overall mean ±SE 6	26.88+0.137[a]	26.28+0.146[b]	26.68+0.105

* $P < 0.05$

Means with atleast one superscript common are not significantly different.

Table - 18

Analysis of variance of haemoglobin (Hb%) and packed volume (PCV%) in the blood of Black Bengal goat in the age group between 12 week to 36 week of age

Source of variation	Degree of freedom	Mean square	
		Hb	PCV
Bet sex	1	4.3740^{**}	15.60^{**}
Bet week	12	0.5170^{NS}	2.3430^{NS}
Bet sex x wk	12	0.1770^{NS}	0.7250^{NS}
Error	169	0.5460	2.1930

** $P < 0.01$

NS = Nonsignificant

The result of Duhcan's multiple range test (table-17) showed significantly higher ($P < 0.05$) values in case of male compared to values in case of female.

Blood glucose :

The mean glucose value is presented in table-19 and Fig. IV. The mean glucose value (mg/100 ml) in case of male starting on 12 week of age and on 36 weeks of age was respectively 49.36 ± 1.492 and 42.81 ± 0.585. In case of female the mean value of glucose during the same age was 44.80 ± 1.787 and 43.44 ± 0.991. Irrespective of sex of the experimental goats the overall mean value from 12 week to 36 week of age was 44.69+0.264.

The analysis of variance (table-21) of blood glucose (mg%) in experimental goats from 12 week to 36 week of age showed a significantly higher ($P < 0.01$) values in case of male than in case of female. A significant difference between age in weeks (P 0.01) and effect of interaction between week x sed (P 0.05) were also observed.

The Duncan's multiple range test (table - 19) showed a significantly high values ($P < 0.05$) in male than in female. A significant difference between week (P 0.05) was also observed. Thus values of glucose on 12th and 14th week were significantly higher ($P < 0.05$) than the values observed in rest of the weeks and values of glucose observed in 16th week of age significantly differed from the values observed on 12th week,

Table - 19

Showing blood glucose (mg/100 ml) value (Mean ±SE) alongwith Duncan's multiple range test in Black Bengal goat in the age group between 12 week to 36 week of age

Age in week	Sex		Overall Mean ±SE
	Male Mean ±SE	Female Mean ±SE	
12 wk	49.35 ± 1.492^{b}	44.80 ± 1.787^{defg}	47.83 ± 1.259^{a}
14 wk	50.86 ± 1.308^{a}	46.95 ± 0.570^{c}	49.56 ± 1.003^{a}
16 wk	46.38 ± 1.003^{c}	44.92 ± 0.821^{def}	45.89 ± 0.727^{bc}
18 wk	44.56 ± 0.611^{efgh}	44.96 ± 1.399^{def}	44.69 ± 0.590^{cd}
20 wk	45.18 ± 0.575^{de}	40.90 ± 0.376^{m}	43.76 ± 0.667^{d}
22 wk	45.46 ± 0.724^{e}	43.65 ± 0.594^{ijk}	44.86 ± 0.557^{cd}
24 wk	44.42 ± 0.668^{efghi}	42.73 ± 0.662^{e}	43.86 ± 0.527^{d}
26 wk	43.16 ± 0.640^{kl}	42.68 ± 0.347^{e}	43.00 ± 0.436^{d}
28 wk	43.90 ± 0.736^{hijk}	42.73 ± 0.777^{e}	43.51 ± 0.558^{d}
30 wk	43.84 ± 0.765^{hijk}	43.94 ± 0.661^{ghijk}	43.87 ± 0.541
32 wk	44.90 ± 0.566^{ghij}	43.74 ± 0.206^{jija}	43.97 ± 0.378^{cd}
34 wk	42.72 ± 0.615^{e}	44.18 ± 0.276^{fghij}	43.20 ± 0.451^{d}
36 wk	42.81 ± 0.585^{e}	43.44 ± 0.991^{jkl}	43.02 ± 0.496^{d}

* $P < 0.05$

Means with atleast one superscript common are not significantly different.

14th week, 20th week and 24th week to 36 week of age. There was no statistically significant difference in glucose values observed from 18th week to 36 week of age, The interaction effect between week x sex was also found to be significantly(P 0.05) different as donated by superscripts where common superscripts between means were however not statistically significant. The values did not exhibit a definite trend except at the lower age values were higher than the higher age.

Blood urea :

The mean blood urea value is presented in table 20 and Fig. Va (sexes shown separately). The mean blood urea values starting on 12 week and on 36 week of age in male was 23.85± 1.138 and 18.11±0.64 respectively. In case of female the mean value of blood urea on 12 week and on 36 week of age was respectively 23.25+2.168 and 19.52+1.632. The overall mean irrespective of sex of the experimental goat from 12 week to 36 weeks of age was 20.62±0.271.

The analysis of variance (Table 21) of the values of blood urea (mg/100 ml) showed a significant difference (P 0.05) between weeks of age. A significantly higher value (P 0.05) in female compared to male was also observed. The interaction effect between sex x week was however found to be nonsignificant(table-21).

Table - 20

Showing blood urea (mg/100 ml) value (Mean ±SE) along with the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age

Age in week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female(Mean ±SE)	
12 wk	23.85±1.738	23.25±2.168	23.65±1.321^{a}
14 wk	23.08±1.885	22.64±1.409	22.93±1.309^{ab}
16 wk	22.14±1.478	24.23±1.386	22.84±1.090^{ab}
18 wk	18.78±1.240	21.34±3.153	19.63±1.308^{d}
20 wk	19.91±1.507	21.93±3.001	20.58±1.377^{ab}
22 wk	20.53±1.330	18.63±1.591	19.89±1.027^{b}
24 wk	19.63±0.726	19.57±0.739	19.61±0.527^{d}
26 wk	19.69±0.876	19.98±0.691	19.79±0.613^{b}
28 wk	20.84±0.624	21.76±01901	21.14±0.258^{ab}
30 wk	19.37±0.495	20.47±1.107	19.76±0.420^{b}
32 wk	19.23±0.414	20.27±0.956	19.58±0.422^{d}
34 wk	19.60±0.405	21.19±0.987	20.13±0.457^{b}
36 wk	18.11±0.640	19.52±1.632	18.58±0.679^{d}

$P < 0.05$

Means with atleast one superscript common are not significantly different.

Table - 21

Analysis of variance of blood glucose and urea in post weaned maturing Black Bengal goat in the age group between 12-36 week of age.

Source of variation	d.f.	Mean square	
		Glucose	Urea
Bet sex	1	74.8367**	26.2680*
Bet week	12	58.7819**	35.3880*
Bet sex x wk	12	12.3623*	5.3220NS
Error	169	6.0075	13.4360

** $P < 0.01$

* $P < 0.05$

NS = Nonsignificant

The result of Duncan's multiple range test (Table-20) showed that female goat had significantly higher (P 0.05) blood urea value than the male goat. The difference between week was also found to be statistically significant(P 0.05) The mean blood urea value at 12 weeks, 14th week, 16th week, 20th week, 28th week of age were nonsignificant. Similarly blood urea values of 14the week, 16th week, 20th week, 22nd week, 26th week, 28th week, 30the week and 34th week of age were nonsignificant and the values of 18th week, 24th week, 32nd week and 36th week of age were also not significantly different.

Total serum protein :

The mean value of total serum protein is presented in table 22 and Fig. IIIb. The value of total serum protein on 12 week and on 36 week of age of the experimental male goat was found to be 6.53±0.144 and 6.41±0.044 respectively.

In case of female the mean value of total serum protein (g/100 ml) starting on week 12 and on week 36 of age was respectively 6.80±0.144 and 6.44±0.310. The mean value of total serum protein irrespective of sex of the experimental goats during the 12th to 36 week of age was 6.48±0.024.

Analysis of variance showed that in case of total serum protein (table 26) there was highly significant difference (P 0.01) between sex but the effect of age in week and the interaction effect between sex x week were statistically non-significant.

Table - 22

Showing serum total protein (g/100 ml) value (Mean ±SE) alongwith the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age.

Age in week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female(Mean ±SE)	
12 wk	6.53±0.144	6.80±0.144	6.62±0.118
14 wk	6.43±0.141	6.65±0.158	6.50±0.114
16 wk	6.43±0.089	6.48±0.207	6.44±0.094
18 wk	6.44±0.104	6.63±0.223	6.51±0.104
20 wk	6.44±0.071	6.53±0.240	6.47±0.089
22 wk	6.40±0.089	6.51±0.151	6.44±0.083
24 wk	6.53±0.144	6.22±0.094	6.42±0.114
26 wk	6.51±0.114	6.32±0.122	6.44±0.089
28 wk	6.67±0.077	6.67±0.122	6.67±0.070
30 wk	6.45±0.094	6.70±0.063	6.54±0.077
32 wk	6.30±0.089	6.66±0.122	6.42±0.089
34 wk	6.42±0.094	6.29±0.054	6.38±0.070
36 wk	6.41±0.044	6.44±0.31	6.42±0.031
Overall Mean ±SE	6.46±0.028[b]	6.57±0.042[a]	6.48±0.024

$P < 0.05$

Means with atleast one superscript in common are not significantly different.

The result of Duncan's multiple range test(table-22) showed a significant ($P < 0.05$) higher values of total serum protein fn female compared in values obtained in case of male.

Serum albumin :

The mean value of serum albumin is presented in table-23 Fig.IIIb. The mean value of serum albumin(g/100 ml) in male on 12 weeks and on 36 weeks of age was respectively 3.43 ± 0.090 and 3.32 ± 0.083.

In female starting with 12 weeks of age and on 36 week of age the mean value of serum albumin was respectively 3.60 ± 0.070 and 3.49 ± 0.114 . The overall mean value during week 12 to week 36 of age irrespective of sex of the experimental goat was 3.42 ± 0.020.

Analysis of variance(table-26) showed that in case of serum albumin there was highly significant difference($P < 0.05$) between sex but the effect of age in week and the interaction effect between sex x week were statistically nonsignificant.

The Duncan's multiple range test(table-23) showed female showed a significantly higher ($P < 0.05$) albumin value when compared with the albumin value of the male goat.

Serum globulin :

The mean globulin value is shown in table 24 and Fig. IIIb. In case of male on 12 weeks and on 36 week of age, the mean value was respectively 3.10 ± 0.100 and 3.05 ± 0.79. In case of female the mean value on 12 week and 36 week was respectively 3.16 ± 0.097 The overall mean value from 12 week to 36 week of age was 3.05 ± 0.026.

Table 23

Showing serum albumin (g/100 ml) value (Mean ±SE) alongwith the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age

Age in week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female(Mean ±SE)	
12 wk	3.43±0.900	3.60±0.070	3.49±0.070
14 wk	3.35±0.071	3.57±0.170	3.43±0.077
16 wk	3.33±0.044	3.64±0.089	3.44±0.054
18 wk	3.40±0.114	3.47±0.167	3.42±0.089
20 wk	3.38±0.054	3.57±0.164	3.44±0.063
22 wk	3.41±0.077	3.45±0.164	3.43±0.070
24 wk	3.37±0.070	3.57±0.187	3.44±0.077
26 wk	3.42±0.104	3.35±0.144	3.40±0.083
28 wk	3.39±0.070	3.45±0.077	3.41±0.054
30 wk	3.46±0.054	3.30±0.094	3.40±0.054
32 wk	3.30±0.077	3.54±0.114	3.38±0.070
34 wk	3.45±0.077	3.54±0.130	3.48±0.063
36 wk	3.32±0.083	3.49±0.114	3.38±0.070
Overall Mean ±SE	3.39±0.022[b]	3.50±0.036	3.42±0.020

* $P < 0.05$

Means with atleast one superscript in common are not significantly different.

Table - 24

Showing serum globulin (g/100 ml) value (Mean ±SE) alongwith the result of Duncan's multiple range test in post weaned maturing goat in the age group between 12 week to 36 week of age

Serum glubulin (g/100 ml)

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female(Mean ±SE)	
12 wk	3.10 ± 0.100^{def}	3.16 ± 0.097^{bcde}	3.12 ± 0.72
14 wk	3.07 ± 0.144^{defghi}	3.08 ± 0.286^{defgh}	3.07 ± 0.017
16 wk	3.12 ± 0.086^{cdef}	3.03 ± 0.179^{fghij}	3.09 ± 0.079
18 wk	3.04 ± 0.099^{efghij}	3.17 ± 0.325^{bcd}	3.08 ± 0.121
20 wk	3.06 ± 0.079^{defhij}	2.95 ± 0.189^{ejk}	3.03 ± 0.079
22 wk	2.99 ± 0.078^{gjokl}	$3.02\pm$fghijk	3.00 ± 0.075
24 wk	3.17 ± 0.099^{bcd}	2.55 ± 0.173^{m}	2.96 ± 0.115
26 wk	3.09 ± 0.129^{def}	2.97 ± 0.172^{ghijk}	3.05 ± 0.101
28 wk	3.27 ± 0.081^{b}	3.22 ± 0.162^{bc}	3.25 ± 0.073
30 wk	2.93 ± 0.131^{jk}	3.41 ± 0.153^{a}	3.09 ± 0.115
32 wk	3.00 ± 0.101^{fghijk}	3.12 ± 0.088^{cdef}	3.04 ± 0.073
34 wk	2.96 ± 0.126^{hijk}	2.76 ± 0.108^{l}	2.89 ± 0.093
36 wk	3.05 ± 0.079^{defghij}	2.91 ± 0.118^{k}	3.00 ± 0.075
Overall Mean ±SE	3.07 ± 0.028	$3.03+0.052$	3.05 ± 0.026

* $P < 0.05$

Means with atleast one superscript in common are not significantly different.

In case of serum globulin the analysis of variance showed that neither effect of sex nor effect of age was statistically found to be significant. But the effects of interaction between sex x week was observed to be statistically significant ($P < 0.05$).

The Duncan's multiple range test (table-24) indicated a significant difference ($P < 0.05$) in the interaction effect of sex x week as indicated by superscripts in the mean value. The means with atleast one superscript in common, however, are not significantly different. Thus the result of present study failed to show any definite trend in respect to interaction effect.

Albukin Globulin ratio(A/G ratio) :

The mean value of A/G ratio is shown in table 25 and Fig. IIIb. On 12th week and on 36th weeks of age in case of male the value was respectively 1.07 ± 0.026 and 1.08 ± 0.056. In case of female starting with 12thweeks and on 36 weeks of age, the mean value was respectively 1.15+0.038 and 1.21+0.095. The overall mean irrespective of sex from 12 to 36 week of age was 1.13 ± 0.014.

The analysis of variance of A/G ratio(table-26) showed that variation between sex of the experimental animals was highly significant ($P < 0.01$). But the variation between week and also interaction between week x sex were not statistically significant.

Table - 25

Showing values (Mean ±SE) of A/G ratio alongwith the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age under grazing condition

A/G ratio

Age in week	Sex		Overall Mean ±SE
	Male(Mean ±SE)	Female (Mean ±SE)	
12 wk	1.07±0.026	1.15±0.038	1.10±0.023
14 wk	1.14±0.061	1.22±0.169	1.17±0.069
16 wk	1.08±0.025	1.21±0.073	1.22±0.033
18 wk	1.19±0.104	1.12±0.144	1.17±0.082
20 wk	1.10±0.039	1.19±0.013	1.13±0.045
22 wk	1.14±0.043	1.17±0.107	1.15±0.044
24 wk	1.07±0.027	1.44±0.023	1.19±0.069
26 wk	1.11±0.078	1.15±0.106	1.12±0.061
28 wk	1.02±0.043	1.08±0.079	1.04±0.038
30 wk	1.10±0.062	0.97±0.069	1.12±0.066
32 wk	1.10±0.057	1.14±0.054	1.12±0.041
34 wk	1.16±0.056	1.30±0.014	1.20±0.062
36 wk	1.08±0.056	1.21±0.095	1.12±0.050
Overall Mean ±SE	1.11±0.017[a]	1.18±0.030[a]	1.13±0.014

*P < 0.05

Means with atleast one superscript in common are not significantly different

Table - 26

Analysis of variance of total serum protein, albumin, globulin and post weaned maturing maturing Black Bengal goat in the age group between 12-36 week of age

Source of variation	d.f.	Mean square			
		Serum total protein	Serum albunin	Serum globulin	A/G ratio
Bet sex	1	0.2360^{*}	0.600^{**}	0.0649^{NS}	0.2002^{**}
Bet wk	12	0.1050^{NS}	0.016^{NS}	0.1083^{NS}	0.0276^{NS}
Bet sex x wk	12	0.1240^{NS}	0.057	0.3656^{*}	0.0612^{NS}
Error	169	0.1090	0.072	0.1300	0.0412

** P $<$ 0.01

* P $<$ 0.05

NS = Nonsignificant

The Duncan's multiple range test showed a significantly higher value (P $<$ 0.05) in case of female compared to male (table-25).

Serum calcium :

The mean serum calcium values are presented in table-27 and fig. VIIa. The mean serum calcium level in male experimental goat starting with 12th weeks and on 36th weeks of age was respectively 9.53±2.473 and 10.64±0.230. In case of female on 12th weeks of age and on 36th weeks of age the mean value was 9.94+0.708 and 10.35+0.232. The overall mean irrespective of sex during the experimental period was 10.19±0.148.

The analysis of variance of values of serum calcium (mg/100 ml) Table - 31) showed that variation between week was highly significant ($P < 0.05$). The effect of sex and the effect of interaction between sex x week were nonsignificant.

The result of Duncan's multiple range test(table-27) indicated that variation between weeks was significant ($P < 0.05$) as indicated by the superscript in the respective mean value. The mean values of 12th weeks to 24th weeks and also 28th week failed to show any significant difference amongst themselves. Similarly mean values from 16th week to 36 week were statistically nonsignificant. The rest of the values were however found to have significant difference between themselves.

Serum phosphorus :

The mean serum phosphorus values are shown in table-28 and Fig. VIIb. The mean serum phosphorus(values(mg/100 ml) starting with 12th week and on 36th weeks of age in male was 6.59±0.919 and 5.20+0.081. In case of female the mean value during period was 6.97+0.414 and 5.22+0.060 respectively with an overall mean of 5.99±0.060.

Table - 27

Showing serum calcium (mg/100 ml) value (Mean ±SE) alongwith the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12-36 week of age.

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	9.53±2.473	9.94±0.608	9.67±1.634^{b}
14 wk	9.77±0.263	9.83±0.537	9.74±0.235^{b}
16 wk	9.99±0.268	9.90±0.385	9.97±0.212^{ab}
18 wk	9.99±0.246	9.93±0.165	9.97±0.169^{ab}
20 wk	9.98±0.322	10.30±0.418	10.09±0.250^{ab}
22 wk	10.20±0.283	10.32±0.246	10.24±0.200^{ab}
24 wk	10.23±0.261	10.48±0.248	10.32±0.190^{ab}
26 wk	10.31±0.316	10.62±0.267	10.41±0.226^{a}
28 wk	10.33±0.354	10.51±0.283	10.39±0.249^{ab}
30 wk	10.34±0.355	10.68±0.339	10.45±0.260^{a}
32 wk	10.46±0.267	10.55±0.233	10.49±0.190^{a}
34 wk	10.59±0.282	10.34±0.232	10.51±0.200^{a}
36 wk	10.64±0.250	10.35±0.232	10.55±0.182^{a}
Overall mean ±SE	10.14±0.212	10.29±0.100	10.19±0.148

* $P < 0.05$

Means with atleast one superscript common are not significantly different.

Table - 28

Showing serum phosphorus (mg/100 ml) value (Mean ±SE) in Black Bengal goat in the age group between 12-36 week of age under grazing condition.

Phosphorus (mg/100 ml)

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female(Mean ±SE)	
12 wk	6.69±0.919	6.97±0.414	6.72±0.617^{a}
14 wk	6.46±0.169	6.15±0.435	6.36±0.178^{b}
16 wk	6.44±0.137	5.98±0.207	6.29±0.125^{b}
18 wk	6.35±0.084	6.39±0.308	6.37±0.109^{b}
20 wk	6.18±0.114	6.14±0.264	6.17±0.189^{bc}
22 wk	5.94±0.142	5.99±0.011	5.96±0.093^{cd}
24 wk	6.21±0.092	6.50±0.127	6.31±0.080^{b}
26 wk	5.77±0.108	5.77±0.164	5.77±0.087^{d}
28 wk	5.87±0.061	5.94±0.078	5.89±0.047^{d}
30 wk	5.92±0.145	5.76±0.142	5.87±0.107^{d}
32 wk	5.50±0.075	5.54±0.155	5.52±0.068^{e}
34 wk	5.48±0.098	5.43±0.156	5.46±0.081^{e}
36 wk	5.20±0.081	5.22±0.060	5.21±0.038^{f}
Overall mean ±SE	5.99±0.081	5.98±0.080	5.99±0.060

* $P < 0.05$

Means with atleast one superscript common are not significantly different

The analysis of variance of serum phosphorus values is presented in table-31. The result showed that the variation between week was highly significant ($P < 0.01$). But the variation between sex and interaction effect was nonsignificant.

The result of Duncan's multiple range test (table-28) in this case indicated significant difference ($P < 0.05$) between difference weeks of age, as indicated by the superscript in the respective mean. Thus mean values of 14th week to 28th week and 24th week did not show any differences amongst themselves. Similarly values between 20th week and 22nd week, 22nd week and 26th week to 30th week and 32nd week and 34th week were found statistically nonsignificant. Rest of the values however were found to be significant ($P < 0.05$) amongst themselves.

Serum sodium :

The mean value of serum sodium is shown in table-29, fig. VIIIa. The mean values of serum sodium (megqlitre) in experimental male goat on 12th week and on 36th weeks of age was 118.50 ± 3.821 and 129.60+3.893 respectively. In case of female, the mean value during thes same period was 116.40±3.043.

The overall mean of serum sodium irrespective of sex during the experimental period was 123.49+0.733.

The result of analysis of variance of serum sodium(meq/litre) is presented in table-31). The value showed a highly significant difference ($P < 0.01$) between sex and also between age in weeks under study. The interaction effect between sex and age however was found to be nonsignificant.

Table - 29

Showing serum sodium (meq/lit) values (Mean ±SE) alongwith the result of Duncan's multiple range test in Black Bengal goat in the age group between 12 week to 36 week of age under grazing condition.

Sodium (meq/lit).

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	118.50±3.821	116.40±3.043	117.80±0.268^{g}
14 wk	117.00±2.357	114.20±4.476	116.07±2.100^{g}
16 wk	126.40±3.015	123.00±3.714	125.27±2.322^{f}
18 wk	124.60±2.864	123.20±4.079	124.00±2.269^{f}
20 wk	129.40±2.329	124.20±3.852	127.67±2.041^{ef}
22 wk	129.70±0.931	128.60±3.400	129.33±2.571^{de}
24 wk	130.60±0.956	125.20±4.109	128.80±2.380^{de}
26 wk	133.60±1.318	124.80±3.813	130.67±1.832^{cd}
28 wk	134.30±1.155	128.40±4.354	132.33±1.711^{c}
30 wk	137.90±1.205	133.00±5.488	136.27±1.960^{b}
32 wk	139.30±0.973	139.00±2.00	139.20±0.656^{a}
34 wk	132.60±3.703	127.80±6.216	131.00±3.150^{cd}
36 wk	129.60±3.893	137.00±3.714	132.87±2.946^{c}
Overall Mean ±SE	129.50±0.859^{a}	126.94±1.444^{b}	128.49±0.753

* $P < 0.05$

Means with atleast one superscript common are not significantly different

The result of Duncan's multiple range test (table-29) registered a significantly higher value ($P < 0.05$) in case of male, compared with values obtained in case of female experimental goats. The Duncan's multiple range test further indicated that there was significant difference ($P < 0.05$) between age in weeks as indicated by superscript in the respective values where means with atleast one superscript common are statistically non-significant. Thus mean value between 12th weeks and 14th weeks, 16th to 20 weeks, 20th to 24the weeks and 34th week, 24th to 26th weeks, 26th to 28th weeks and 34th to 36 weeks of age were statistically nonsignificant. The rest of the values, however different significantly amongst themselves.

Serum potassium :

The mean potassium values during the experimental period from 12 week to 36 week of age are presented in table 30. The mean serum potassium value (meq/lit) starting with 12th weeks of age and on 36th week of age in male was 3.25 ± 0.097 and 3.41 ± 0.062 respectively. In case of female the mean value during this period was 3.14 ± 0.051 and 3.58 ± 0.128 respectively.

The overall mean value irrespective of sex during the experimental period was 3.34 ± 0.030.

The result of analysis of variance of serum potassium value is presented in table-31. The result indicated that the values differed significantly between both week and sex. The interaction effect was however nonsignificant.

Table - 30

Showing serum potassium (meq/lit) value (Mean ±SE) alongwith the result of Duncan's multiple range test in Black Bengal goat in the age group between 12 week to 36 week of age under grazing condition

Potassium (meq/lit)

Age in week	Sex		Overall Mean ± SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	3.25±0.097	3.14±0.051	3.01 ± 0.067^{e}
14 wk	3.31±0.129	3.14±0.112	3.25 ± 0.069^{d}
16 wk	3.14±0.151	3.28±0.049	3.19 ± 0.057^{d}
18 wk	3.25±0.173	3.30±0.045	3.27 ± 0.057^{d}
20 wk	3.23±0.196	3.32±0.064	3.26 ± 0.062^{d}
22 wk	3.22±0.141	3.36±0.068	3.27 ± 0.096^{d}
24 wk	3.19±0.174	3.32±0.080	3.23 ± 0.073^{d}
26 wk	3.24±0.177	3.32±0.132	3.27 ± 0.088^{d}
28 wk	3.34±0.093	3.54±0.121	3.41 ± 0.076^{c}
30 wk	3.47±0.083	3.48±0.116	3.47 ± 0.065^{bc}
32 wk	3.47±0.716	3.66±0.081	3.53 ± 0.058^{ab}
34 wk	3.59±0.071	3.52±0.969	3.56 ± 0.056^{a}
36 wk	3.41±0.062	3.58±0.128	3.47 ± 0.061^{bc}
Overall Mean ±SE	3.32 ± 0.024^{b}	3.38 ± 0.030^{a}	3.34±0.020

* $P < 0.05$

Means with atleast one superscript common are not significantly different

Table - 31

Analysis of variance of serum calcium,phosphorus, sodium and potassium of post weaned maturing Black Bengal goat in the age group between 12-36 wk of age

Source of variation	d.f.	Mean square			
		Calcium	Phosphorus	Sodium	Potassium
Bet sex	1	0.9121^{NS}	0.0060^{NS}	392.0025**	091852**
Bet wk	12	9.8129**	2.7697**	643.6482**	0.2599**
Bet sex x wk	12	0.1046^{NS}	0.1613^{NS}	50.2804^{NS}	0.1468^{NS}
Error	169	4.0043	0.6122	75.4609	0.0730

** $P < 0.01$

NS = Nonsignificant

The result of Duncan's multiple range test (table-30) showed the significantly higher values ($P < 0.05$) in case of female compared to values obtained in case of male. The variation between weeks in the experimental animal was also found to be significant ($P < 0.05$).

Thus mean value of week 14th to week 26th, week 20th to 30th and week 30th to week 32 and 36 and week 32 to week 34 were nonsignificant. The resto of the mean values showed significant difference amongst themselves.

Serum alkaline phosphatase activity :

The mean value of serum alkaline phosphatase activity (Bodanski unit/100 ml) is presented in table-32 and Fig. IXa. In case of male starting with 12th weeks of age and on 36th weeks of age the value of enzyme activity was 9.41 ± 0.730 and 6.33 ± 0.468 respectively. In case of female the mean value during thep period was 7.91 ± 1.547 and 6.26 ± 0.953 respectively. The overall mean value from 12th to 36th week irrespective of sex was 7.68 ± 3.64.

The result of analysis of variance is presented in table 35 subsequently. The result showed that there were a significant variation ($P < 0.01$) between week and also between sex. The effect of interaction between sex x week was not significant.

Table - 32

Showing serum alkaline phosphatase activity (B.U./100ml) value (Mean ±SE) along with the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age.

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	9.41±0.730	7.91±1.547	8.91 ± 0.702^{ab}
14 wk	9.41±0.699	9.74 ±2.398	9.53 ± 0.870^{a}
16 wk	8.80±0.722	7.33±1.228	8.31 ± 0.634^{bc}
18 wk	8.15±0.766	7.19±1.014	7.83 ± 0.603^{cde}
20 wk	8.35±0.668	7.47±1.453	8.05 ± 0.554^{cd}
22 wk	8.48±0.643	7.74±1.017	8.23 ± 0.533^{bc}
24 wk	7.51±0.642	7.47±1.099	7.49 ± 0.540^{dc}
26 wk	7.52±0.517	7.10±1.483	7.38 ± 0.460^{de}
28 wk	7.43±0.314	7.03±0.934	7.29 ± 0.357^{e}
30 wk	7.40±0.886	7.07±0.888	7.29 ± 0.643^{e}
32 wk	6.91±0.969	6.57±1.008	6.80 ± 0.405^{ef}
34 wk	6.55±0.444	6.24±0.904	6.45 ± 0.405^{f}
36 wk	6.33±0.468	6.26±0.953	6.31 ± 0.425^{f}
Overall Mean ±SE	7.87 ± 0.186^{a}	7.31 ± 0.323^{b}	7.68±0.164

* $P < 0.05$

Mean with atleast one superscript common are not significantly different

The result of Duncan's multiple range test (table-32) showed a significantly higher value ($P < 0.05$) in case of male compared to female. The result of this test also showed that between week variation was also significant ($P < 0.05$) as indicated by superscript in the mean values. The means with atleast one superscript common are found to be nonsignificant. Thus mean value of 12th week and 14th week, 12th week and 16th week and 22nd week of age was nonsignificant. Similarly mean value at 18th week, 20th week, 24th week, 26th week to 32nd week and 32nd week to 36 week of age were nonsignificant but rest of the values were statistically significant.

Serum glutamic oxalo acetic acid transaminase(SGOT) :

The mean value of serum glutamic oxalautic acid transaminase (SGOT) activity is shown in table-33 and Fig. IXa. Values of SGOT activity on 12th week and on 36thweeks of age was respectively 126.99±3.617 and 116.38±1.387. In case of female, the mean value during this period was 126.76±5.025 and 116.56±1.826. The overall mean value irrespective of sex was 118.31+0.525.

The result of analysis of variance of transaminase activity is presented in table-35 subsequently. The serum transaminases (SGOT) registered a highly significant difference ($P < 0.01$) between age in weeks during the experimental periods. The effect of sex and also the interaction effect between sex x week were found to be nonsignificant.

Table - 33

Showing serum glutamic oxaloacetic acid transaminase (SGOT) activity value (Mean ±SE) alongwith the result of Duncan's multiple range test in post weaned maturing Black Bengal goat with the age group between 12 week to 36 week of age SGOT activity (ug/Pyruvic acid liberated/ml serum at 37°C for 1hr)

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female (Mean ±SE)	
12 wk	126.99±3.617	126.76±5.025	126.92±2.831[a]
14 wk	122.70±0.900	122.12±6.400	122.50±2.062[b]
16 wk	123.36±2.296	122.41±2.638	123.04±1.713[b]
18 wk	119.70±1.442	116.17±1.924	118.52±1.201[cd]
20 wk	119.26±2.503	121.58±2.735	120.04±1.866[c]
22 wk	117.01±1.638	119.40±2.270	117.81±1.394[de]
24 wk	117.01±1.638	119.40±2.270	117.81±1.394[de]
26 wk	114.15±2.002	118.16±1.531	115.49±1.481[f]
28 wk	110.88±2.029	115.41±1.550	112.39±1.523[h]
30 wk	115.25±2.123	114.99±2.917	115.16±1.659[g]
32 wk	117.68±1.772	112.46±3.123	115.94±1.645[efg]
34 wk	116.01±1.366	117.29±1.478	116.44±1.016[efg]
36 wk	116.38±1.387	116.56±1.826	116.44±1.069[efg]

* $P < 0.05$

Means with atleast one superscript in common are not significantly different.

The result of Duncan's multiple range test(table-34) indicated a significant differences ($P < 0.05$) between weeks under study. Thus the mean value of 12th weeks and 16th weeks 18th week and 20th week, 18th week, 22nd, 24th, 32nd and 36th weeks of age were statistically nonsignificant. Further values of 24th, 26th, 34th, 36th and that of 30th to 34th, 34th,36th were statistically nonsignificant. The rest of the mean values were however statistically significant ($P < 0.05$).

Serum glutamic Pyruvic acid transaminase (SGPT) :

The mean values of serum SGPT activity during the experimental period was presented in table 34 and Fig. IXa. The mean serum SGPT activity starting on 12th week and on 36th week of age in case of male in this experimental goat was 54.89 ± 2.950 In case of female the mean value during this period was 55.22 ± 1.693.

The overall mean value irrespective of sex was 53.24 ± 0.580.

The result of analysis of variance is shown in table-35 below. The result indicated that there was a significant ($P < 0.01$) differences between week. But the effect ofs sex and interaction between week x sex were nonsignificant.

The result of Duncan's multiple range test(table34) showed by significant differences($P < 0.05$) between week. However,mean value at 12th to 18th week,14th,18th,24th and 28th week,12th week to 18th week were found to be nonsignificant. The rest of the mean values showed significant differences among themselves.

Table - 34

Showing serum glutamic pyruvic acid transamenase(SGPT) value (Mean ±SE) along with the result of Duncan's multiple range test in post weaned maturing Black Bengal goat in the age group between 12 week to 36 week of age.

Age in week	Sex		Overall Mean ±SE
	Male (Mean ±SE)	Female(Mean ±SE)	
12wk	54.43±2.950	55.22±1.693	54.33±2.002^{c}
14 wk	54.43±3.360	53.25±3.072	54.70±2.403^{bc}
16 wk	54.95±3.020	52.82±3.679	54.74±2.298^{c}
18 wk	56.58±2.277	55.69±1.862	56.29±1.602^{abc}
20 wk	58.81±2.408	55.75±1.478	57.29±1.730^{a}
22 wk	57.30±2.220	58.80±1.356	57.80±1.524^{a}
24 wk	56.13±2.394	58.50±1.643	56.92±1.674^{ab}
26 wk	56.93±1.774	57.96±2.555	57.27±1.409^{a}
28 wk	54.52±2.317	56.37±2.342	55.14±1.587^{b}
30 wk	51.55±2.260	52.74±2.077	51.66±1.872^{d}
32 wk	47.22±2.090	49.14±2.077	47.86±1.530^{e}
34 wk	45.37±1.857	42.30±2.304	44.35±1.469^{f}
36 wk	45.24±1.330	40.85±2.780	43.78±1.343^{f}
Overall Mean ±SE	53.35±0.749	53.02±0.895	53.24±0.580

* $P < 0.05$.

Mean with atleast one superscript in common are not significantly different.

Table - 35

Analysis of variance of serum alkaline phosphatase (ALK Phosphatase) Glutamic oxalo-acetic acid transaminase (SGOT) and Glutamic pyruvic acid transaminase (SGPT) activity in post weaned maturing Black Bengal goat in the age group between 12-36 week of age.

Source of variation	d.f.	Mean square		
		Alk Phosphatase	SGOT	SGPT
Bet sex	1	12.9700**	1.1765NS	4.3170NS
Bet week	12	12.9840**	229.5088**	361.2516**
Bet sex x wk	12	1.0001NS	26.1114	17.3011NS
Error	169	5.0216	43.6460	48.6155

** P $<$ 0.01

* P $<$ 0.05

NS = Nonsignificant

Discussion

The observations recorded and results presented in this group cover physiological performance in the form of body weight gain in body weight and perfentage gain in body weight together with different haematological and biochemical parameters in the post weaned Black Bengal goats from 12 weeks till 36 week of their age.

As already pointed out the animals in this group were exclusively reared under grazing management system each day from 8 a.m. in the morning till 5 p.m. in the evening on uncultivated pasture on rotational basis. The results on body weight of the experimental goats showed a significant difference ($P < 0.01$) between weeks under observation. But the effect of sex and also interaction effect were found to be nonsignificant. The change in body weight shown in table-11 and Fig.IIb. showed a consistent rising trend during the period under study. The gain in body weight (table - 13) though showed a significant variation between weeks under observation failed to exhibit any definite trend. The per cent gain in body weight (table-14) Fig. IIB on the other hand showed a decreasing trend with advancement of age with occasional peaks at 18, 22, 28, 34 and 36 weeks of age. This variation between week was also found to be statistically significant ($P < 0.01$) but neither the effect of sex nor the interaction effect was found to be significant.

Singh et al. (1983) studied the growth rate of crossbred and pure breed Black Bengal goat. The daily gain in weight in

the period 0-12, 13-24, 25-36 and 37-48 week averaged 41.50, 28.56, 22.46 and 20.70 g respectively in Black Bengal goat and 50.12, 32.68, 29.97 and 23.73 g in crossbred. Bhimaye et al. (1969) conducted a grazing studies in the arid and semiarid zones of Rajasthan and reported growth of different kinds of livestock like cattle, sheep and goat in natural pasture. Walker (1977) reported that inclusion of siratro into native and improved pasture greatly increased live weight gain, weaning weight and breeders performance.

Singh and Rakeb (1979) studied the effect of feeding natural grass and barseem hay on growth rate and nutrient utilization by Barberi kids. There was a positive balance, indicated by gain in body weight and also there was a positive balance of sodium calcium and phosphorus.

Since the animals in this group during their prime growth phase exhibited positive growth response during the entire experimental period it could be concluded that the experimental animals derived optimum nutrition from the field cover for maintenance as well as for anabolic effect. The result of study in digestibility, DM intake/100 kg body weight and also the results of analysis of protein value of the pooled pasture samples presented in the subsequent section further confirm that the animals were not in dearth of available nutrients from the field cover. But whether available nutrient was quite sufficient for full expression of genetic potentiality in this breed can hardly be predicted within the frame work of this experimental design.

The haematological values recorded in this study appear a little lower than the reported values elsewhere for this species (Pyne et al., 1982)

Pyne et al. (1982) reported haemoglobin value of Black Bengal goat as 9.98±0.56 g/100 ml. The overall mean value observation in this study varied from 8.15 to 8.75 g/100 ml during the week 14th and 34th respectively. Biseas et al.(1986) in their study on seasonal variation of parasitic load on performance of grazing sheep indicated that grazing sheep without any supplementation showed a low Hb and PCV value compared with group given supplementation in addition. The animals in this experimental group and other animals in subsequent system. Thus a competition between host and gastro-intestinal parasite for a common pool of nutrients might have affected the overall physiological performance and thus a lower haematological values might be a reflection to this effect.

The values of blood glucose recorded in this study(table-19) and 21) showed a significant variation ($P < 0.01$) between weeks, between sex and interaction effect between week x sex was also found to be significant ($P < 0.01$). The values of blood glucose recorded for the suckling preweaned group of kids in the previous section were a little higher than the values recorded for this group and subsequent other groups of mature goats. In general the ruminant animals including goat had a lower blood glucose value compared to the blood glucose value in case of

nonruminant. Further within the ruminant species blood glucose value of the adult animal is lower than the values observed in new born animal prior to the establishment of functional activity of the ruminant stomach. This was the reason for higher blood glucose value in preweaned suckling kids compared to the other groups of goats.

Bogin et al. (1981) reported higher blood glucose values in young than adult local Israli goats. In any case the blood glucose values recorded in this group of goat appeared within the limit of normal range for this species. Swenson (1971) reported blood glucose value of goat to be 45-60 mg/100 ml As already pointed out blood glucose value is considerably lower in ruminants. The adult ruminant derives benefit from fermentation of dietary components in the rumino-reticulums. Thus only a small amount of glucose is absorbed from the lower gut. This does not mean that glucose is lesss important metabolite in ruminant animals. Thelevel of blood glucose at any time merely reflects the point of balance of input into plasma, i.e. gluconeogenesis, glycogenolysis and absorption of glucose from the gut and glucose uptake by the tissues. The changes in the blood level of glucose and other metabolites may represant a change in either the input or uptake or both process at different rates.

The values of total serum protein, albumin and globulin in this study failed to show any significant difference between the weeks under study but the effect of sex was found to be significant ($P < 0.01$) both in case of total protein and albumin

but not in case of globulin. The values of blood urea showed a significant difference ($P < 0.01$) both between weeks under study and between sex of thegoat.

Boss and Wanner (1979) observed that in adult Sannen goat serum total protein ranged from 6.33 to 8.53 g/100 ml. It was also reported that serum total protein was significantly less in new born than in adult but from 5 months the value attained within the adult range of variation without reaching adult average of 7.43 g/100 ml even at 8 months.

Bogin et al. (1981) studied the levels of enzymes, metabolite and electrolytes in young Israeli goat. The total serum protein albumin and globulin values were reported to be lower in young goats.

Pyne et al. (1982) reported total serum protein value in Black Bengal goat as 5.85 ± 0.16 g/100 ml.

Bhattacharyya et al. (1984) failed to observe any significant correlation between body weight and total serum protein in case of Black Bengal kids but the concentration of serum protein as function of age in case of pure and cross breed dairy cattle was observed by a number of workers(Tumbleson et al.,1973, Peterson and Waldern 1981, Shaffer et al.,1981, Bhattacharyya et al. (1984). Thus it appears that there is a contradictory report on the relationship of age/body weight with serum protein value in different species of livestock. In any case the values recorded during the experimental period were within the normal

range ffor this species and therefore may be regarded as an index ofn normal nutritional status.

Saha and Sadhu (1971) studied the urea content of the blood of goat on a diet containing optimum level of dry matter and 13% crude protein (CP). The blood urea level observed was 24 mg/100 ml.

Swnson (1977) reported range of blood urea level in goat from 13 to 28 mg/100 ml. The reports are available to show that blood urea increased with increased consumption ofp protein or NPN(Pollan et al., 1970, Egan and Kellaway, 1971, Cross et al. 1974). In addition, blood urea is also related to ammonia level in the rumen. Blood urea level may also be high as a result of catabolism ofb body protein when consumption of feed is not adequate to maintain the animal in starvation or in certain disease condition. Bhattacharyya and Duttagupta (1987) reported serum biochemical constituents of growing Black Bengal goat. The protein value (9/dl) in case of male and female was 7.86+0.18 and 7.59±0.18 respectively. The alkaline phosphatase activity (B.U./dl) was 9.76±1.30 and 13.43±2.11 respectively. The average age reported for male and female was 146.96±8.28 and 126.75 ± 10.15 days respectively.

The animals in this group reared on grazing management system were physiologically normal, and exhibited anabolic response in the form of body weight growth. The values of blood urea were also within the limit of normal range and any adverse

effect could hardly be considered in this case.

The value of serum calcium, inorganic phosphorus, sodium and potassium observed in this group (table 27 to 30) showed a significant variation ($P < 0.01$) between the week. The variation between sex was also found to be significant ($P < 0.01$) in case of sodium and potassium but not in case of serum calcium and inorganic phosphorus values. The trend of serum calcium and inorganic phosphorus (table 27 and 28) showed that whereas the values of serum calcium showed a gradual increasing trend the serum phosphorus value showed a decreasing trend. The values of serum sodium (table 29, Fig VIII) showed a consistent increasing value but no such definite trend was evident in case of serum potassium (table 30). The serum calcium, inorganic phosphorus, sodium and potassium are known as nacrominerals. Apart from certain general physiological functions absolutely critical for the support of animal life and these are mainly osmotic pressure, buffering action stabilizing pH in the tissues, maintenance of irritability in the nerves and muscles and catalytic function.

Boss and Wanner (1979) studied the blood values in 14 Sannen goats in their first lactation and in their 14 kids at different ages. In adult the average serum values of sodium, potassium, calcium and phosphorus were 141 meq/lit, 4.56 meq/lit, 9.20 mg/100 ml and 6.91 mg/100 ml. In kids the variation of serum electrolytes was not related to age except phosphorus which fell significantly with age.

Normal values of serum calcium and also phosphorus in goat were reported by many workers (Murty and Kehar, 1951, Louw et al. 1966 and Bhattacharyya et al. 1977). Stillings et al. (1964) have shown that calcium retention was greater in animals consuming high nitrogen forages as compared to low nitrogen forages even though calcium intake was low. Supplemental vit.D improved calcium absorption and retension even on low nitrogen forages. The grains are believed to facilitate calcium absorption in dairy cattle (Brochart 1965). It has also been observed that high ratio of calcium and phosphorus (4:1 and 8:1) depressedr rate of gain and feed efficiency (Frontenot 1964).

The level of blood calcium is regulated by the action of hormones. The hormone, parathormone from the parathyroid gland exerts controlling effect on calcium absorption in presence of vit. D and maintenance of blood level and thyrocalcitonin from the cells in the thyrid gland also exerts depressing effect on blood calcium by decreasing absorption and/or by reducing mobilization. The sodium content of the blood is under the control of aldosterone. In absence of proper functioning of aldosterone the sodium content of blood and other body fluids decrease with the concommitant increase in potassium level.

Pandiya etal. (1977) studied the serum calcium and inorganic phosphorus level in cross bred dairy cattle. The average values reported for calcium and phosphorus were 10.32±0.104 and 5.70±0.087 mg/100 ml.

Mostaghni (1979) reported haemoglobin type and some blood minerals of goat in Iran. Based on four haemoglobin phenotypes B, AB, BC and ABC the sodium and potassium values were 93.4, 113.7, 108.8 and 113.6 meq/lit and 15.4, 15.3, 19.5 and 17.7 meq/lit respectively.

Pyne etq al.(1982) reported that values of serum calcium and inorganic phosphorus in Black Bengal goat was 9.05±0.12 and 4.53+0.18 mg/100 ml respectively.

Catarsini et al. (1984) studied some metabolic profiles in Tibetian and cross Tibetian goats. The values reported were 8 and 7.33 mg%, 10.13 and 9.63 mg% for calcium and phosphorus respectively.

Thus it appears that the level of macrominerals observed in this study are within the range reported elsewhere in literature.

The different types of enzyme activity studied in this group of experimental goats from 12 week to 36 week of age were alkaline phosphatase, SGOT and SGPT activity (table 32 and 33 to 34). The alkaline phosphatase, SGOT and SGPT activity all showed a significant variation ($P < 0.01$) between theweeks under study.

The alkaline phosphatase activity further showed a significant variation ($P < 0.01$) between sex but such variation was non significant in case of SGOT and SGPT activity(Table 35, Fig 9) The overall trend of alkaline phosphatase, SGOT and SGPT activity of these enzymes as the age progressed and this reduction in

in activity was comparatively more marked in case of alkaline phosphatase activity (Fig. IX a).

Verma (1967) reported that the SGPT activity in two year old goat was 67.5 unit/ml. Bhattacharyya (1979) recorded normal values of SGOT and SGPT activity in case of Jamnapari goat as 100+0.91 and 30+0.86. The unit of enzyme activity was expressed as ug of pyruvic acid liberated in 1 ml serum at 37°C for 60 minutes.

Adaval et al.(1969) reported serum alkaline phosphatase activity in different age groups in goat. In the age group betweek 5 to 6 months the enzyme activity in male ranged from 3.2 to 16.73 with a mean of 6.897 and in case of female it ranged from 2-8 to 14.44 with a mean of 7.556. Between age group 1 year to 1½ year value in case of male was 2.16 to 4.2 (Mean 2.733) and in female 1.67 to 7.86 (Mean 3.537) B.U/100 ml respectively.

Bogin et al. (1981) reported that the level of alkaline phosphatase activity in Israeli goats were significantly higher in young goats then in adult goats.

Baruah et al. (1984) reported a very low serum alkaline phosphatase activity in non-descript breed of goat of Assam. The mean value reported was 3.4 B.U./100 ml. It was indicated that the enzymes activity showed that showed a decreasing trend with advancement of age. All the animals were reared on free grazing system.

Bhattacharyya et al. (1984a) studied the effect of age and body weight on serum aminotransferase activity in Black Bengal goat. A significant change in body weight SGOT and SGPT activity ($P < 0.01$) was observed along with 9 week to 23rd week of age.

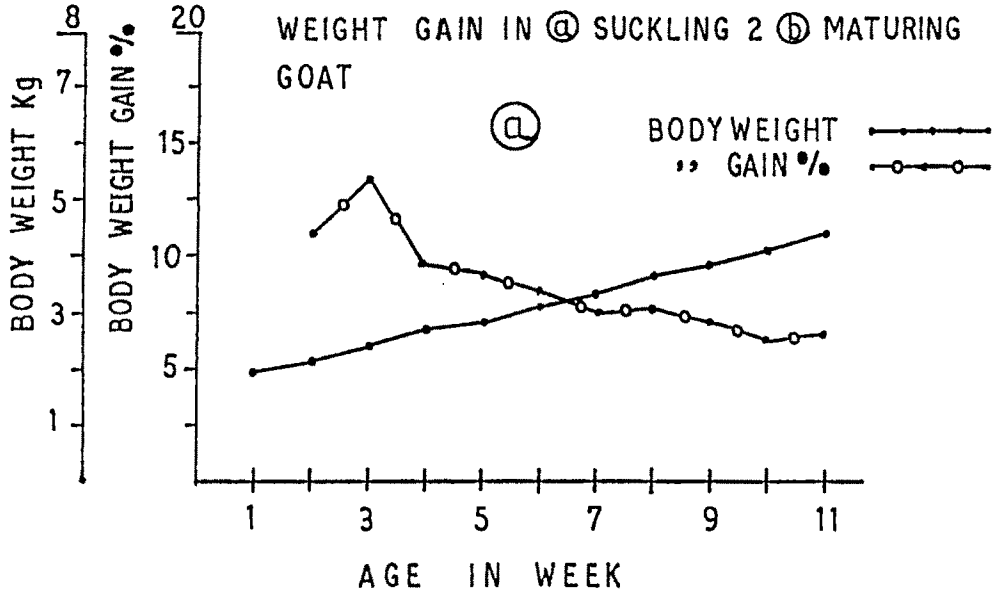
Singha et al. (1986) studied the effect of seasonal environment on some plasma enzymes in ewes. It was observed that the alkaline phosphatase enzyme was significantly higher during winter and rainy season as compared to spring and summer. A significantly higher ($P < 0.01$) SGOT and SGPT activity during winter and rainy season was attributed by them to higher control level.

Shaffer et al. (1981) in a study on different blood constituents in Holstein, Guernsey, Jersey and Brown Swiss cows observed that total serum protein increased with increasing age but did not record any significant relationship of SGOT with age.

Bhattacharyya et al. (1984b) observed that SGOT activity showed a significant ($P < 0.01$) variation both in age and weight groups in Jersey x Hariana cross breds but in Brown Swiss x Hariana a significant variation was recorded only in weight group.

The serum alkaline phosphatase enzyme is relatively non-specific and stable enzyme hydrolysing all orthophosphoric acid monoesters. This enzyme is known to be concerned with metabolic osteoblastic activity and mineral deposition in the long bones. As such younger animals are having more activity than the older

FIG. I&II- SHOWING TREND OF BODY WEIGHT & BODY WEIGHT GAIN IN @ SUCKLING 2 ⓑ MATURING GOAT



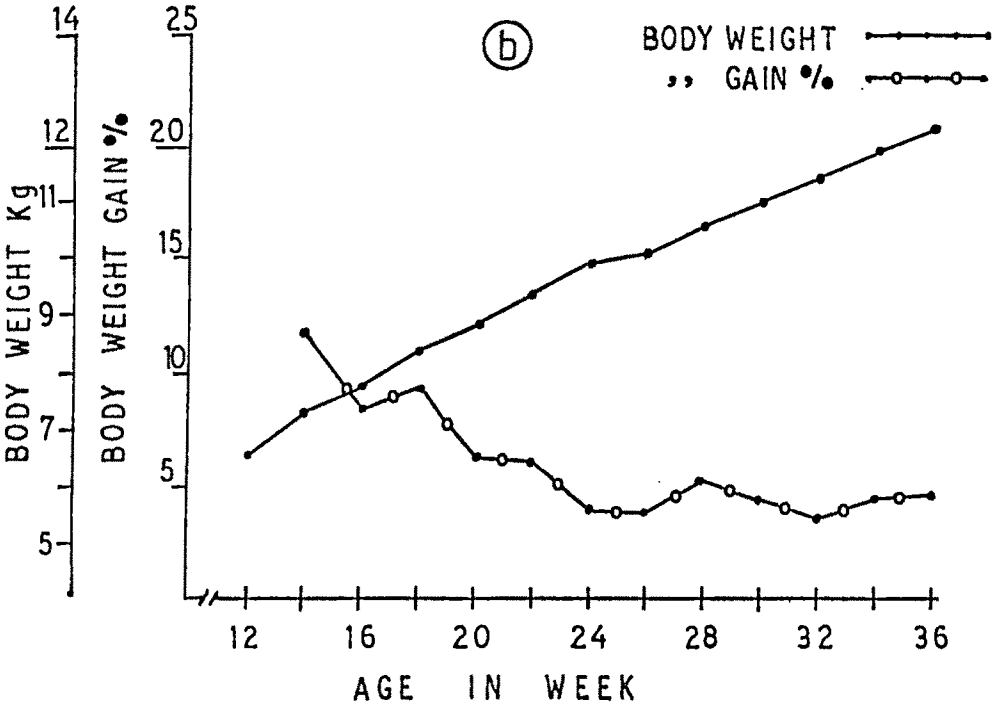
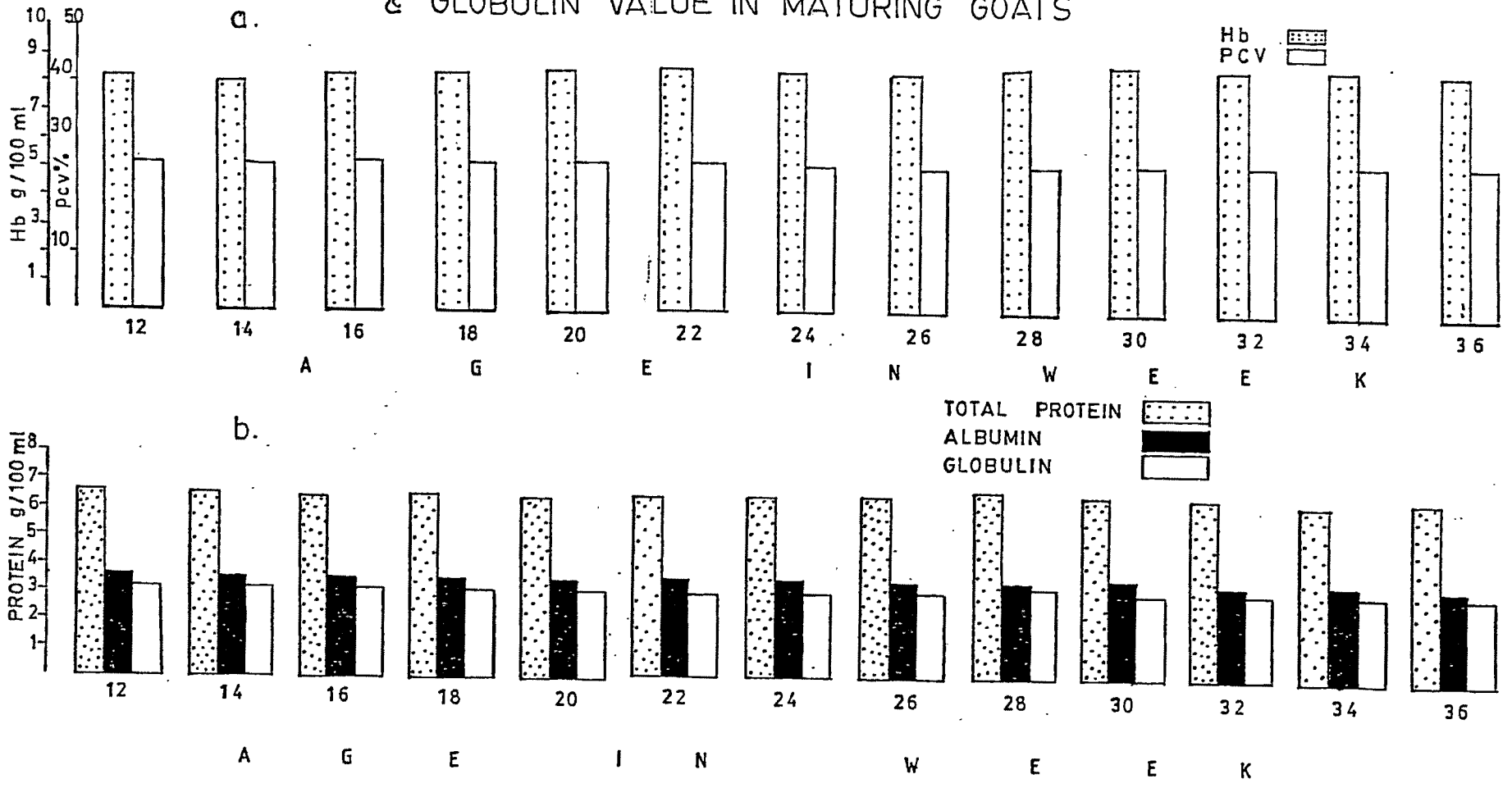


Fig III SHOWING TREND OF MEAN Hb, PCV, TOTAL PROTEIN, ALBUMIN & GLOBULIN VALUE IN MATURING GOATS



animals. In farm animals this enzyme activity is increasingly used as genetic marker for production and disease traits. This enzyme is said to be controlled by both genetic and nongenetic factors. The enzymes transaminases are normally concerned with transfer of alfa amino group of either aspartic acid or alanine to alfa keto-glutaric acid and resulting in the formation of oxaloacetic acid and pyruvic acid respectively (Cornelias and Bishop 1969). The estimation of serum concentration of these enzymes active in normal intermediary metabolism has further become useful in showing necrosis and degeneration of tissue cells rich in these enzymes which resulted escape from the cells into the blood stream during the process of necrosis and degeneration and thus act as valuable diagnostic aid under pathological condition.

Thus the study of these enzymes like alkaline phosphatase and transamenases are considered very relevant to assess the physiological state of the goat reared on exclusive grazing management system.

Since the observed values in respect to the above mentioned enzymes agree well with the published values in the literature and no abnormal deviation was observed the experimental animals may be considered as physiologically normal.

C. Pregnant goat :

Haemoglobin and packed cell volume (PCV) :

The mean haemoglobin volume (g/100 ml) is shown in table-36 and Fig. VIa. During 1st, mid and end term of pregnancy the haemoglobin value was respectively 8.38±0.146, 8.36±0.117, and 8.40+0.138 respectively. Thev values of PCV% in 1st, mid and end term period was respectively 26.41±3.00, 26.29±0.269 and 26.50± 0.281 (table 36 and Fig. VIa)

The result of analysis of variance in respect to haematological parameters haemoglobin and packed cell volume (PCV%) are presented in the table 37. The result of analysis of haemoglobin (g/100 ml) value and packed cell volume (PCV%) value indicated that variation of haemoglobin and PCV between terms of pregnancy was nonsignificant. But the variation between individual was highly significant ($P < 0.01$) both in case of haemoglobin and PCV.

Blood glucose :

The mean blood glucose (mg/100 ml) value presented in table 36 and Fig. IVb during first, mid and end term of pregnancy was recorded respectively as 42.64±2.649, 39.69±1.923 and 36.30± 1.525.

The result of analysis of variance of blood glucose is presented in table 37. The blood glucose value showed a highly significant variation ($P < 0.01$) between term of pregnancy. A highly significant ($P < 0.10$) variation between individual was also observed.

The result of Duncan's multiple range test (table-36) showed that variation of blood glucose value between 1st and mid term of pregnancy was nonsignificant. When mean values of 1st term and mid term were compared with the mean value obtained in the end term of pregnancy the variation was found to be significant ($P < 0.05$) statistically.

Blood urea :

The mean blood urea values 1st, mid and end term pregnancy are presented in table and Fig. Vc. The blood urea value during 1st, mid and end term of pregnancy was respectively 24.38±1.244, 22.57±0.087 and 22.15±0.152.

Total serum protein, albumin,globulin and A/G ration

The values of mean total serum protein, albumin,globulin and A/G ratio are shown in table 36, FigV.

The mean total serum protein (g/100 ml) during first,mid and end term of pregnancy was respectively 6.26±0.144, 6.14±0.168 and 6.15±0.085.

The mean value of serum albumin (g/100 ml) was 3.37±0.060, 3.34±0.115a and 3.34±0.052 respectively in case of 1st mid and end term of pregnancy in experimental goat.

The mean serum globulin (g/100 ml) value during 1st,mid and end term of pregnancy in the experimental goat was respectively 2.88+0.086, 2.76+0.078 and 2.92+0.051(table-36).

The mean A/G ratio recorded was 1.19±0.036, 1.12±0.027 and 1.11±0.021 respectively during 1st, mid and end term of pregnancy in the experimental goats(table-36).

The result of analysis of variance of total serum protein albumin, globulin and A/G ratio are presented in table 37 and 38 The result showed no significant variation between term in case of total serum protein, albumin,globulin and also in case of A/G ratio. The variation between individual was also found to be non-significant in case of total serum protein, albumin,globulin and A/G ratio.

Serum calcium :

The mean serum calcium values (mg/100 ml) during 1st,mid and end term pregnancy are presented in the table-39 and Fig. VIIb. The mean serum calcium value during 1st,mid and end term of pregnancy was 10.01±0.139, 10.02±0.151 and 9.49±0.134 respectively.

The analysis of variance of serum calcium value are shown in table-40. The result indicated that there was a highly significant variation ($P < 0.01$) of serum calcium value(mg/100 ml) between the terms of pregnancy. It was further observed that the variation between individual was also highly significant ($P < 0.01$).

The result of Duncan's multiple range test table-39 further indicated that the serum calcium value observed during first and mid term of pregnancy were significantly higher($P < 0.05$) when compared with the values obtained in the end term of pregnancy

Table - 36

Showing values (mean ±SE) of some haematological and biochemical parameters in pregnant Black Bengal goat with the result of Duncan's multiple range test.

Parameters	Pregnancy period		
	1st term	Mid term	End term
Hb g%	8.38±0.146	8.36±0.117	8.40±0.138
PCV%	26.41±0.300	26.29±0.209	26.50±0.281
Glucose mg/ 100 ml	42.64 ± 2.649^{a}	39.69 ± 1.923^{a}	36.30 ± 1.525^{b}
Serum albumin g/100 ml	24.38±1.244	22.54±0.870	22.15±1.152
Total serum protein g/100 ml	6.26+0.144	6.14+0.168	6.15+0.085
Serum albumin g/100 ml	3.37±0.060	3.34±0.115	3.24±0.052
Serum globulin g/100 ml	2.88±0.086	2.76±0.078	2.92±0.051
A/G ratio	1.19+0.036	1.12+0.027	1.11+0.021

$P < 0.05$

Means with atleast one superscript in common are not significantly different.

Table - 37

Analysis of variance of some haematological and biochemical parameters in pregnant Black Bengal goat

Source of variation	d.f.	Mean square			
		Haemoglobin	Packed cell volume	Blood glucose	Blood urea
Bet terms	2	0.0030^{NS}	0.0880^{NS}	80.4627**	11.3390^{NS}
Bet individuals	7	0.3646**	1.3600**	84.6822**	15.6496^{NS}
Error	14	0.0351	0.1718	9.8774	0.0988

** P $\angle$ 0.01

NS = Nonsignificant

Table - 38

Analysis of variance of some biochemical parameters (total serum protein, albumin, globulin and A/G ratio) in pregnant Black Bengal goat.

Source of variation	d.f.	Mean square			
		Total serum protein	Albumin	Globulin	A/G ratio
Bet terms	2	0.0349^{NS}	0.0501^{NS}	0.0532^{NS}	0.0162^{NS}
Bet individual	7	0.1911^{NS}	0.0597^{NS}	0.0431^{NS}	0.0049^{NS}
Error	14	0.1312	0.0437	0.437	0.0078

NS = Nonsignificant

It was further observed that mean values of serum calcium observed during 1st term and mid term were nonsignificant.

Serum inorganic phosphorus :

The mean serum organic phosphorus values(mg/100 ml) during 1st, mid and end term pregnancy are shown in table-39 and Fig. VIIb. During 1st, mid and end term of pregnancy the value was respectively 6.16±0.079, 5.58±0.130 and 5.75±0.135.

The result of analysis of variance of serum inorganic phosphorus is presented in table-40. The analysis of variance value registered a highly significant ($P < 0.01$) variation between terms of pregnancy in the experimental group of animals. But the variation between the individual was not statistically significant.

The result of Duncan's multiple range test (table 39) indicated that serum inorganic phosphorus was significantly higher ($P < 0.05$) during 1st term of pregnancy when compared with the values obtained during mid and end term of pregnancy. The values of mid and end term when compared, failed to show any significant difference among themselves.

Serum sodium and potassium :

The mean values of serum sodium and potassium are presented in table 39 and Fig. VIIIb. The mean value of serum sodium(meq/lit) was 118.92±3.499, 116.21±2.497 and 114.00 ± 2.317 respectively during 1st, mid and end term of pregnancy in the experimental group of animals.

The mean serum potassium (meq/lit) value (table-39 and Fig. VIII b) on the other hand was recorded to be 3.23±0.124, 3.32+0.099 and 3.22+0.087 respectively during 1st, mid and end term of pregnancy in the experimental group of goats.

The result of analysis of variance of serum sodium (meq/lit) and potassium (meq/lit) are shown in the table 40. The values indicated that variations between terms oboth in respect to sodium and potassium were not statistically significant. But individual variation was highly significant ($P < 0.01$).

Serum alkaline phosphatase activity :

The mean serum alkaline phosphatase activity (B.U./100ml) during 1st, mid and end term pregnancy is presented in table-39 Fig. IXb. The mean serum alkaline phosphatase activity recorded in this study was 5.84 ± 0.369, 5.67±0.515 and 5.86±0.455 respectively during 1st, mid and end term of pregnancy in the experimental groups of goats.

The result of analysis of variance of serum alkaline phosphatase activity (BU/100 ml) is presented in table-41. The value registered a highly significant difference between individual but when compared between the terms of pregnancy the variation was found to be nonsignificant.

Serum glutamic oxalo-acetic acid and serum glutamic pyruvic transaminase(SGOT and SGPT)activity :

The mean SGOT and SGPT is presented in table 39 and Fig. IXB. The SGOT activity during 1st, mid and end term of pregnancy

was recorded respectively 109.30±2.252, 108.08±2.879 and 109.06+2.150. The mean value of SGPT activity during 1st, mid and end term of pregnancy were recorded to be 38.16±1.359, 34.31±1.034 and 34.61±1.040.

The result of analysis of variance of serum GOT and GPT activity is shown in the table-41. The SGOT activity failed to show any significant difference both between terms of pregnancy and also between the individual. But SGPT activity showed significant variation between the individual. But SGPT activity showed significant variation between term (P 0.10) and individual (P ∠ 0.05).

The result of Duncan's multiple range test (table-39) indicated that the SGPT activity was significantly higher (P∠ 0.05) during 1st term compared to mid and end term of pregnancy. The variation between mid and end term of pregnancy was found to be nonsignificant in the experimental group of pregnant goats.

The observations recorded under this section were different haematological and biochemical parameters throughout the entire length of pregnancy period. The entire pregnancy period was partitioned as early, mid and end term (late) pregnancy.The pooled data for early mid and end term pregnancy were analysed in order to find out effect of a particular term pregnancy on different parameter studied. The parameters studied under different groups of animal of variable physiological stages were common

Table - 39

Showing values (Mean ±SE) of some biochemical parameters in pregnant Black Bengal goat with the result of Duncan's Multiple range test.

Parameters	Pregnancy period		
	1st term	Mid term	End term
Serum calcium mg/ 100 ml	10.01±0.139[a]	10.02±0.151[a]	9.49±0.134[b]
Serum inorganic phosphorus mg/ 100 ml	6.16±0.079[a]	5.58±0.130[b]	5.75±0.135[b]
Serum sodium meq/ lit	118.92±3.499	116.21±2.497	114 ±2.317
Serum potassium meq/lit	3.23+0.124	3.32+0.099	3.22+0.078
Serum Alkaline phosphatase activity B.U./100 ml	5.84±0.369	5.67±0.515	5.86±0.455
Serum GOT(ug/ pyruvic acid liberated/ml serum) activity	109.30±2.252	108.08±2.879	109.06±2.150
Serum GPT(ug/ pyruvic acid liberated/ml serum) activity.	38.16±1.359[a]	34.31±1.034[b]	34.61±1.040

$* P < 0.05$

Means with atleast one superscript in common are not significantly different.

Table - 40

Analysis of variance of some biochemical parameters in pregnant Black Bengal goat

Source of variation	d.f.	Mean square			
		Calcium	Inorganic phosphorus	Sodium	Potassium
Bet. Terms	2	0.7391^{**}	0.7121^{**}	48.4800^{NS}	0.0274^{NS}
Bet indi-vidual	7	0.3674^{**}	0.1589^{NS}	147.3443^{**}	0.2177^{**}
Error	14	0.0591	0.0875	24.2564	0.0165

** P $\angle$ 0.01

* P $\angle$ 0.05

NS = Nonsignificant

Table - 41

Analysis of variance of some biochemical parameters in pregnant Black Bengal goat

Source of variation	d.f.	Mean square		
		Alkaline phosphatase	SGOT activity	SGPT activity
Bet term	2	0.0874^{NS}	3.3319^{NS}	36.7500^{**}
Bet individual	7	3.9792^{**}	101.6363^{NS}	19.9840^{*}
Error	14	0.4500	64.6870	6.0146

** $P < 0.01$

* $P < 0.05$

NS = Nonsignificant

to facilitate a meaningful comparison. As already stated the Black Bengal goats in this group were likewise reared and maintained under grazing management system and no concentrate was made available during any part of their pregnancy period.

The values of haematological parameters studied in this period failed to show significant difference between three different terms of pregnancy. The haematological values observed in this study appeared a little lower than the reported value in the literature (Pyne et al., 1982) Similar observation was recorded in case of haematological values of post weaned maturing Black Bengal goats already discussed in the previous section. The reason for this low haematological value as already indicated might be the result of a competition between the host animal and gastrointestinal parasite for a common pool of nutrients. Under complete grazing condition there remained ample scope for recurrent parasitic infection and animals that were heavily parasitisized might have bleeding ulcers and resultant imparement in the absorption of nutrients and minerals including iron. The level of bloodg glucose recorded in this study showed a significant variation ($P < 0.05$) between three terms of pregnancy.The level of blood glucose during 1st and mid term differ significantly. The level of blood glucose during and term was however significantly lower ($P < 0.05$) than other two terms of pregnancy Further the level of blood glucose observed in this group irrespective of term was much lower than the values recorded in

preweaned and postweaned maturing goat. Swenson(1977) reported normal blood glucose value of adult goat to be as 45-60 mg/100 ml .In the adult goat VFAs mainly acetic, propionic and butyric acids produced in the rumen as a result of fermentation of dietary components are utilised largely for energy purpose. The pregnancy period, particularly the later half, may be marked as period of highest metabolic activity. Since glucose is very essential metabolite for some tissues and a sudden significant drop in the circulating level of glucose during this period is suggestive of a stress in the input-uptake system and resultant negative shift in the points of balance. It is well known that pregnancy stimulates feed intake,increases nutrient absorption and utilization efficiency. The partition of absorbed nutrients by the grased female has been explained on the basis of tissue metabolic rate. The maternal requirement for energy, mineral and protein exceeds usual maintenance level increasing progressivsly with testation age and faetal development.

Sauvant and Bas(1979) studied the metabolic profiles in milch goat. It was reported that blood non-estarified fatty acids and to a lesser extent hydroxy butyric acid provided an estimate of the energy balance of goat in late pregnancy and early lactation. It was further concluded that plasma glucose estimation was more informative in late pregnancy than early lactation.

Chaiyabutr et al. (1982) reported that glucose synthesis and utilization increased during pregnancy and lactation in fed but not in starved goats. Tt was further observed that plasma glucose concentrations were maintained during pregnancy and lactation in fed goat but decreased during 48 hours of starvation in pregnant goat.

The result of study of digestibility and DM intake kg/100 kg body weight presented in subsequent section indicated that DM intake in pregnant group of goat was a little lower than the values obtained in case of post weaned maturing goat and lactating group of goat. This lower level of DM intake in the pregnant group of goat might be the result of increased body weight due to faetal growth which hindered adequate energy intake under continuous grazing. The values of total serum protein,albumin,globulin, A/g ratio and also serum urea did not show significant difference between the terms of pregnancy. The values of total serum protein, albumin, globulina and A/G ratio were comparable with the values recorded for post weaned maturing goat presented in the previous section.

Vidan and Rai (1983) reported values of some metabolic profiles at different physiological stages (Prepartum, partum and post partum) in goat. The values of total serum protein albumin, globulin during preparatum and at the time of parturition were 6.62±0.20 and 8.54±0.32, 4.22, 5.46 and 2.44 and 3.14 respectively. The values reported appear little higher than the values recorded in this study. The total serum protein

value in Black Bengal goat reportedb by Pyne et al.(1982) was 5.85+0.16 g/100 ml. Thus values recorded for this group were within normal range for the species. The serum urea value recorded for this group was a little higher than the post weaned maturing toat but was much lower than the values recorded for lactating goat presented in the subsequent section. However the values recorded here were within the normal range for the species.

The values of macroelements likec calcium, phosphorus, sodium and potassium presented in this group showed that the ($P < 0.05$) different between the terms of pregnancy. It was further observed thatwhereas values of calcium was significantly higher both in 1st and mid term compared to the values recorded for end term of pregnancy the serum inorganic phosphorus value was only significantly higher in the first term compared to the values observed in mid term and end term. On the other hand values of both sodium and potassium did not record any significant difference between the terms of pregnancy.

Vidan and Rai(1983) recorded serum calcium and inorganic phosphorus values in preparatum and parturient goats as 11.41+ 0.10, 11.44 + 0.94 and 5.49 + 0.30 and 6.40 + 0.48 mg/100 ml respectively.

Baruah et al. (1984) reported serum calcium and inorganic phosphorus values in non-descript Assam goat as 10.53 and 4.05 mg/100 ml whereas in Black Bengal goat the recorded values were

calcium 9.05±0.12 and phosphorus 4.53±0.18 mg% (Pyne et al. 1982). These two reports however did not indicate the physiological state of the animals under investigation. The values recorded for pregnant group of goats were comparable to the values recorded in case of postweaned maturing goats presented in preceding section and lactating group of goats in succeding section.

Based on the observation on three different terms of pregnancy it may be concluded that during the later part of pregnancy period (end term) possibly there was certain imbalance in mineral nutrition particularly calcium and phosphorus. As will be seen subsequently that pregnant animals showed comparatively lesser amount of DM intake/100 kg body weight. Pregnancy period is marked by enhanced nutritional requirement since maternal need is coupled with the faetal requirement. But animals during later part of the pregnancy period (end term) might have failed to cope with their nutritional demand due to some physiological barrier or availability of nutrients were sub optimal.

The lower blood glucose level observed during later phase of pregnancy in this group further supports this. Both calcium and phosphorus, as already explained have vital functions to play in metabolic process in the body apart from their role in oestoblastic process.

Level of serum sodium and potassium observed in this group were found to be in the normal range. Both potassium and sodium have a number of vital function in the body. Potassium and sodium influence osmotic equilibrium and facilitates several enzyme reactions like pyruvic kinase and myosin ATPase. Sodium in addition is necessary for amino acid and glucose transport across the mucosa and cell membrancs thus acts as an integral part of carrier mediated transport system. One of the major function of sodium appears to be connected with regulating acid-base balance and nerve irritability (Oser 1965).

The values of alkaline phosphatase recorded in this group did not show any significant variations between terms of pregnancy under investigation (Table 39 and figure IXb). The values were, however, comparatively lower than the values recorded preweaned suckling and post weaned maturing group presented earlier. It is well known that alkaline phosphatase activity is related with growth and osteoblastic activity under normal physiological condition and thus values are inversely related with age of the animal and adult stable value is lesser than values observed during their growth phase.

The values of alkaline phosphatase activity in this group is within normal range.

The concentration of SGOT and SGPT during pregnancy in goats showed that between terms of pregnancy SGOT did not show any significant difference whereas the values of SGPT showed significantly higher ($P < 0.05$) value during the first term

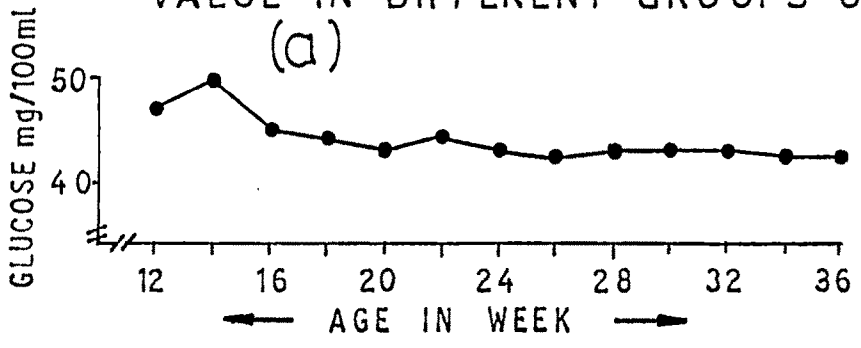
compared to mid and end terms of pregnancy. The SGPT activity also showed significant ($P < 0.05$) variation between individuals. The concentration of both SGOT and SGPT activity were much higher during growth of postweaned maturing goat and post parturient lactating goats.

Marcos (1980) observed that AST values commenced at the low level and rose sharply alone with total cholesterol before calving and remained higher until 3 weeks after parturition and then fell again.

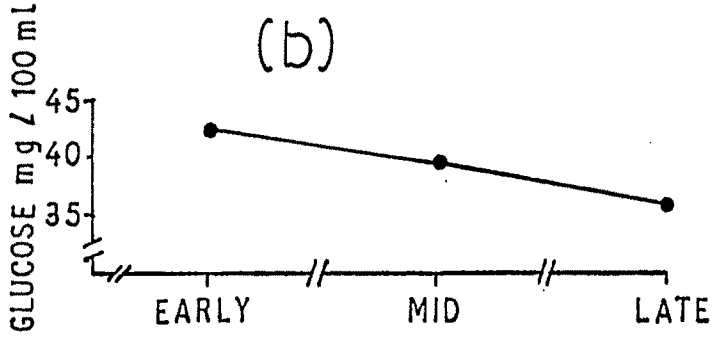
Martuza et al. (1980) reported certain clinically important serum enzymes in Hariana cattle under various physiological stages. It was observed that aspertate amino-transferase activity was higher in pregnant cow and alanine amino transferase was higher in early lactation. The overall trend of these two enzymes during growth, reproduction and milk production agrees well with literatures available.

Thus from the study of different haematological and biochemical parameters during pregnancy it appeared that animals maintained on grazing alone exhibited sign of some marginal nutritional inadequacy particularly in the later half of pregnancy in the form of lower serum concentration of glucose, calcium and phosphorus but even in the face of this anticipated marginal nutritional stress experimental animals carried well and gave birth to normal featuses.

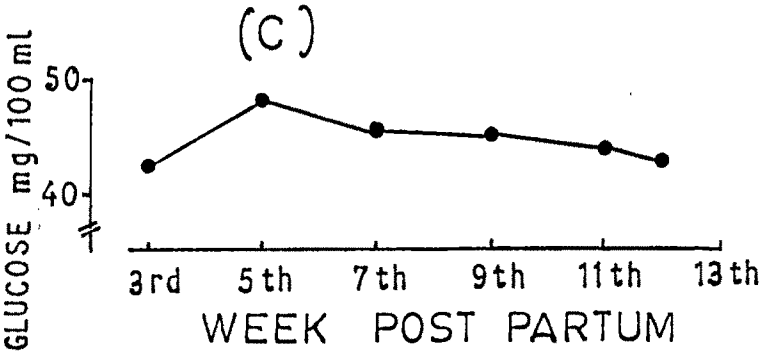
FIG IV SHOWING TREND OF MEAN GLUCOSE VALUE IN DIFFERENT GROUPS OF GOAT



MATURING GOAT



PREGNANT GOAT



LACTATING GOAT

FIG V SHOWING TREND OF BLOOD UREA (MEAN) IN DIFFERENT EXPERIMENTAL GROUPS

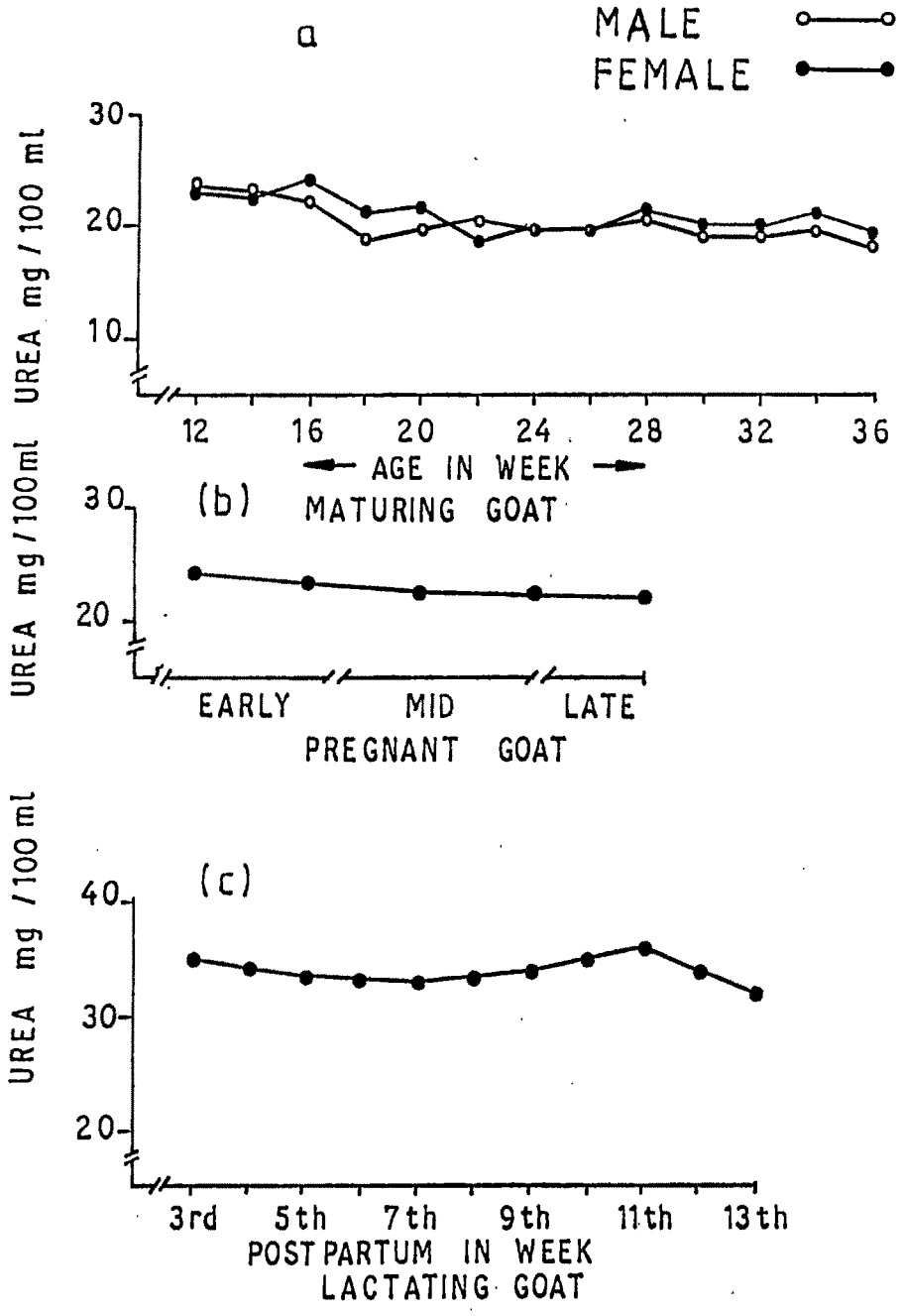


FIG. VI; SHOWING TREND OF MEAN Hb, PCV, TOTAL PROTEIN ALBUMIN & GLOBULIN IN PREGNANT GOAT

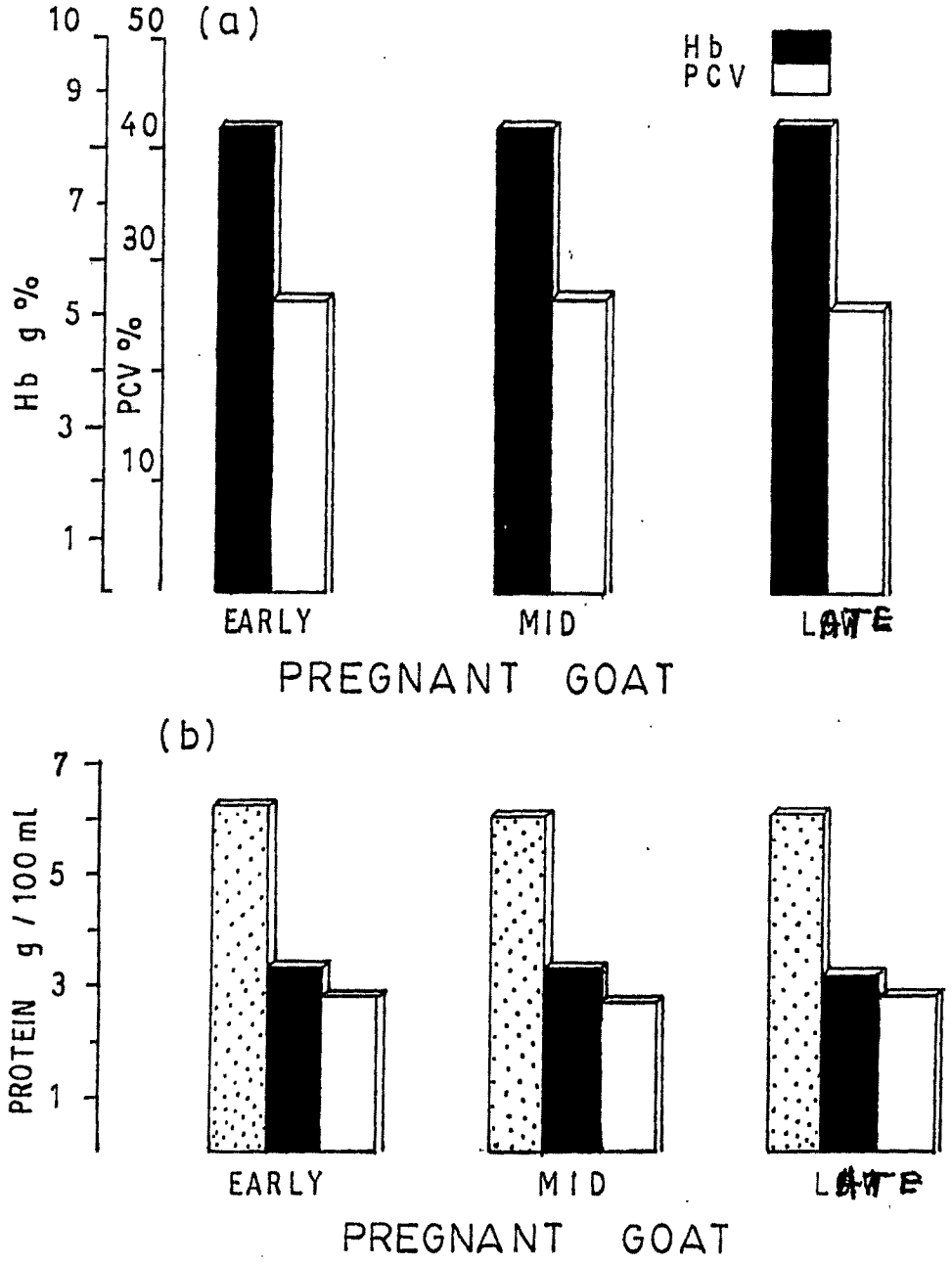


FIG VII SHOWING TREND OF MEAN CALCIUM & PHOSPHORUS VALUE IN DIFFERENT GROUPS OF GOAT (SEX NOT SHOWN SEPERATELY IN MATURING GROUP)

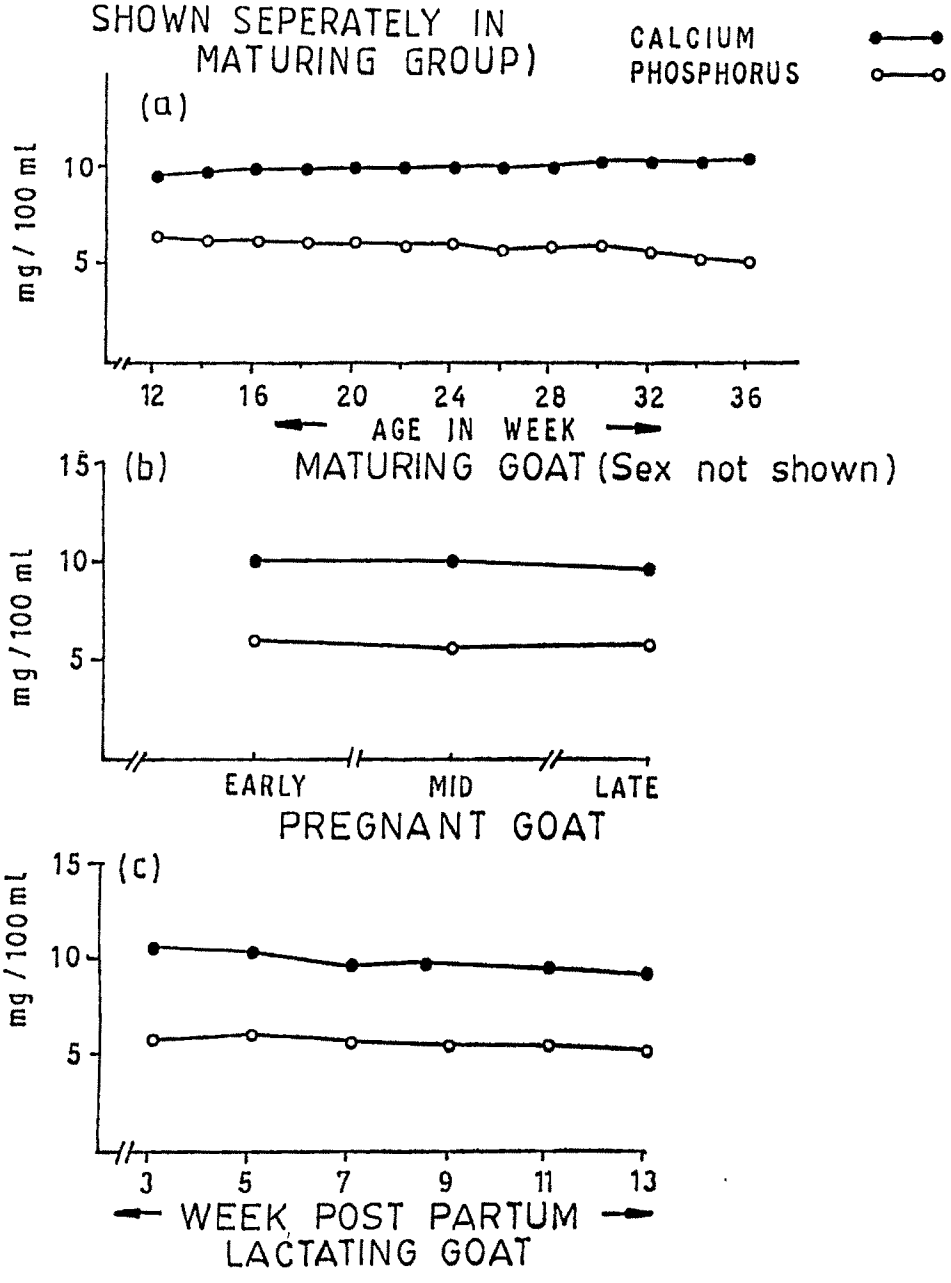


FIG VIII SHOWING TREND OF SERUM SODIUM(MEAN) IN DIFFERENT EXPERIMENTAL GROUPS

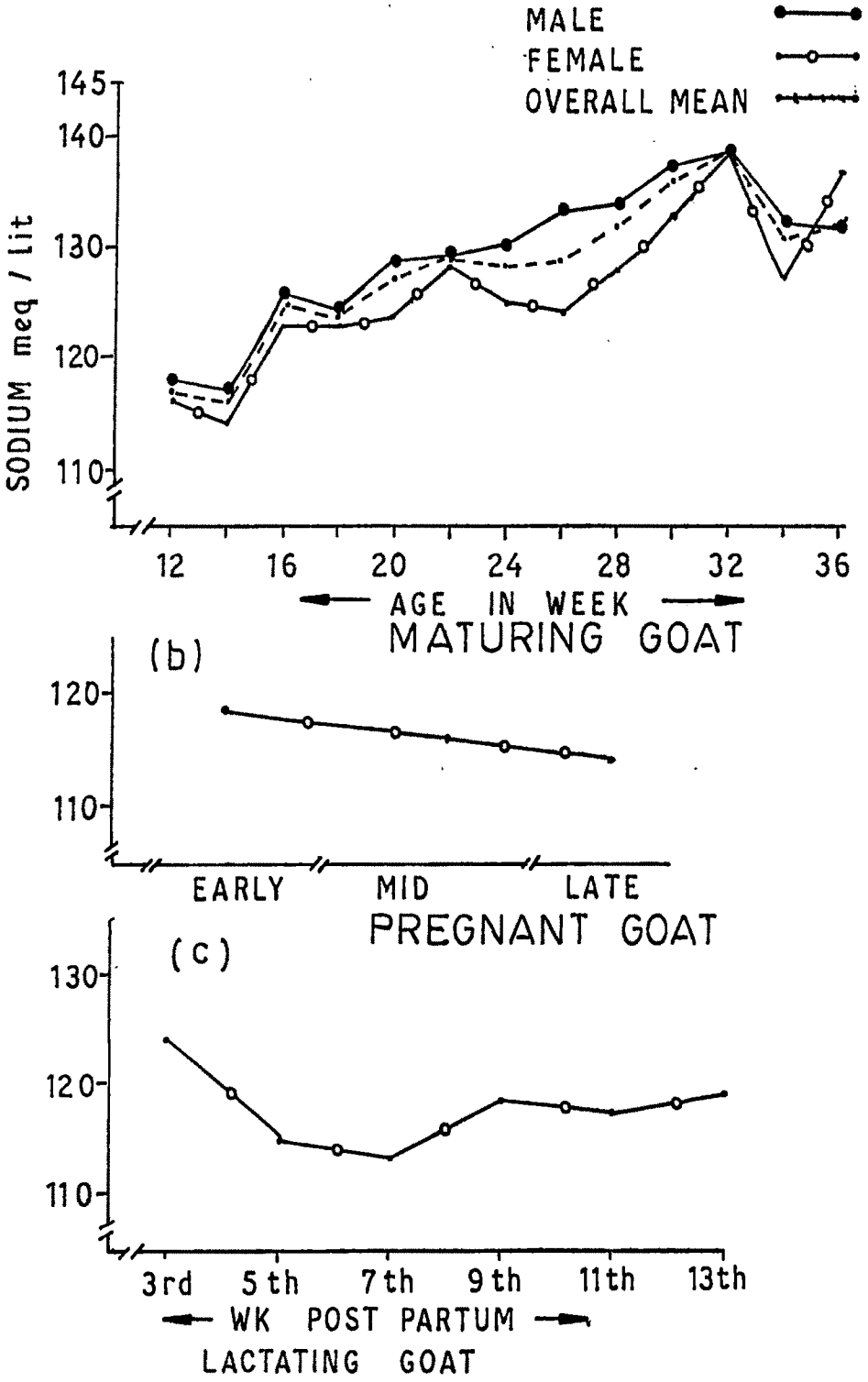
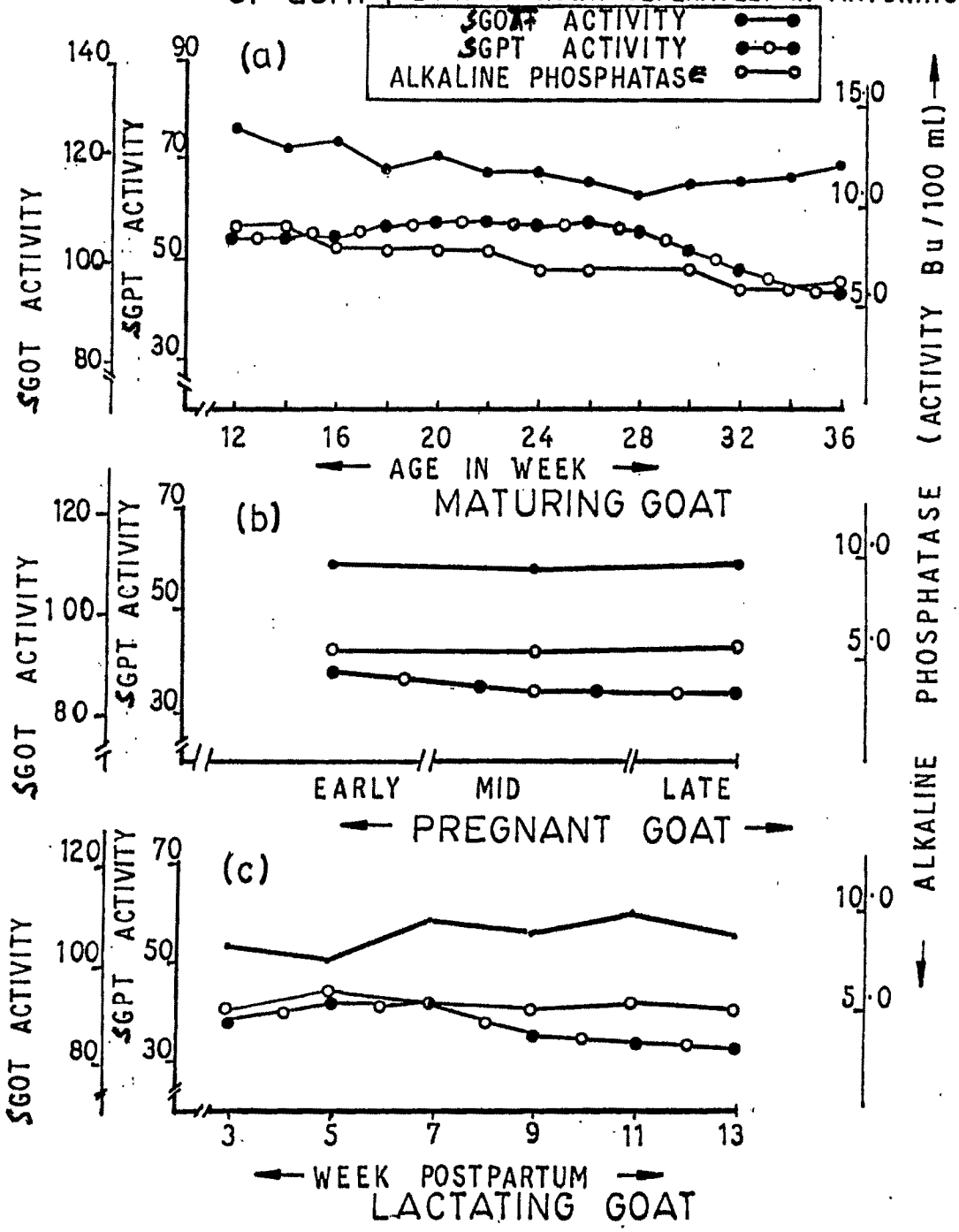


FIG. IX SHOWING TREND OF MEAN SGOT SGPT & ALK PHOSPHATASE ACTIVITY IN DIFFERENT GROUPS OF GOAT (SEX NOT SHOWN SEPERATELY IN MATURING GROUP)



D. Lactating goat (1st week to 13th week of lactation period)

Haemoglobin (Hb%) and packed cell volume (PCV%) :

The mean haematological value is presented in table-42, and Fig. XIa. The mean value of haemoglobin (g/100 ml) in the blood during lactation period on fortnightly interval from 3rd to 13th week of postpartal period was respectively 8.38±0.360, 8.45±0.263, 8.08±0.0266, 8.16±0.293, 8.35±0.216, and 8.44±0.187. The mean value of PCV% in the same period was 26.25+0.645, 26.33±0.548, 25.70±0.577, 25.93±0.591, 26.35±0.538 and 26.56± 0.388 respectively.

The results of analysis of variance of haematological value are presented in table-43. The results of haemoglobin (g% 100 ml) and packed cell volume (PCV%) during the lactation period showed variation between week were nonsignificant in both the cases. Ont the other hand the variation between individual was found to be highly significant (P $<$ 0.01).

Blood glucose and blood urea :

The blood glucose and blood urea values are presented in the table 42 and fig. IV and Vc. The mean value of blood glucose (mg/100 ml) during the different weeks during the experimental period in lactating goat was 42.65±1.520, 48.56±2.371,45.95 ± 3.136, 45.35±5.150, 44.27±2.303 and 43.20±2.510 respectively.

The mean urea (mg/100 ml) starting from 3rd week to 13th week of lactation period at fortnightly interval was respectively

35.09±1.055, 33.87±1.350, 33.02±1.342, 34.82±2.018, 36.80± 1.481 and 32.07+1.963 (table-42).

The result of analysis of variance of blood glucose and blood urea are in the table-43. The result showed that there was no significant variation between week in both the cases. The variation between individual was however found to be significant (P 0.05) in case of blood glucose value but not in case of values of blood urea.

Total serum protein, albumin,globulin and A/G ratio :

The mean values of total serum protein, albumin,globulin and A/G ratio are presented in table 42 and Fig.XIb. The total serum protein value (g/100 ml) recorded in this study during experimental period starting with 3rd week of lactation to 13th week of lactation was respectively 6.24+0.174, 5.79+0.350, 6.18±0.268, 5.89±0.259, 5.69±0.211, 5.67±0.193. The mean value of serum albumin (g/100 ml) and serum globulin (g/100 ml) during this experimental period was 3.37±0.116, 3.25±0.250, 3.52±0.142, 3.00±0.207, 3.17±0.175 and 3.13±0.102 respectively and 2.82± 0.142, 2.52±0.267, 2.62±0.183, 2.98±0.096,2.65±0.152 and 2.63± 0.142 respectively.

The mean value of A/G ratio observed during the lactation period under study was 1.29±0.080, 1.22±0.096, 1.39±0.145, 1.04±0.058, 1.28±0.111 and 1.22±0.096, 1.39±0.145, 1.04±0.058 1.28±0.111 and 1.22±0.071 respectively.

The result of analysis of variance of total serum protein, serum albumin, serum globulin and A/G ratio are presented in table-43 and 44. The result showed a nonsignificant variation between the weeks of lactation period in respect to all protein constituents studied. The individual variation however was found to be significant ($P < 0.05$) in case of total serum protein and serum globulin. The individual variation in case of serum albumin and A/G ratio was nonsignificant.

Serum calcium and phosphorus :

The mean serum calcium value (mg/100 ml) (table 45 and Fig. VIIIc) from 3rd week to 13th week of collection period in the lactating goat was recorded to be 10.51±0.186, 10.43±0.147, 9.93±0.280, 9.85±0.441, 9.52±0.349 and 9.03±0.301. The mean value of serum inorganic phosphorus from 3rd week to 13th week of lactation period was 5.86±0.232, 6.00±0.106, 5.85±0.149, 5.54±0.232, 5.70±0.168 and 5.60±0.147 respectively.

The result of analysis of variance of serum calcium and serum inorganic phosphorus are presented in table-46. The result showed that whereas serum calcium value registered a significant variation ($P < 0.05$) between the weeks under study the serum inorganic phosphorus did not show any significant variation between week weeks under study. The variation between individual was observed to be highly significant ($P < 0.01$) inc case of serum inorganic phosphorus but nonsignificant in case of serum calcium values.

Table - 42

Showing values (Mean ±SE) ofsome haematological and biochemical parameters in lactating Black Bengal goat under grazing system(3rd to 134h week) along witht the result of Duncan's multiple range test.

Parameters	DAYS POST PARTUM IN WEEK					
	3rd	5th	7th	9th	11th	13th
Hb g%	8.38±0.360	8.45±0.263	8.08±0.266	8.16±0.293	8.35±0.216	8.44±0.187
PCV%	26.25±0.645	26.33±0.548	25.70±0.577	25.93±0.591	26.35±0.538	26.56±0.388
Glucose mg/ 100 ml	42.65±1.520	48.56±2.371	45.95±3.136	45.35±5.150	44.27±2.303	43.20±2.514
Urea mg/100ml	35.09±1.055	33.87±1.350	33.02±1.342	34.82±2.018	36.80±1.481	32.07±1.963
Total serum protein g/100 ml	6.24±0.174	5.79±0.350	6.18±0.268	5.89±0.259	5.69±0.211	5.67±0.193
Serum albumin g/100 ml	3.37±0.116	3.25±0.250	3.52±0.142	3.00±0.207	3.17±0.175	3.13±0.102
Serum globulin g/100 ml	2.82±0.142	2.52±0.267	2.62±0.185	2.89±0.096	2.65±0.152	2.63±0.142
A/g ratio	1.29±0.080	1.22±0.096	1.39±0.145	1.04±0.058	1.28±0.111	1.22±0.071

Table - 43

Analysis of variance of some haematological (PCV,Hb) and biochemical (glucose and urea) parameters in lactating Black Bengal goat.

Source of variation	d.f.	Mean square			
		Haemoglobin	Packed cell volume	Blood glucose	Blood urea
Bet week	5	0.1898^{NS}	0.0800^{NS}	36.8046^{NS}	22.2844^{NS}
Bet individual	7	2.5076^{**}	11.2862^{**}	113.5676^{*}	29.4506^{NS}
Error	35	0.2010	0.6877	40.2122	17.8874

** P $<$ 0.01

* P $<$ 0.05

NS = Nonsignificant

Table - 44

Analysis of variance of (serum total protein,albumin, globulin and A/G ration in lactating Black Bengal goat

Source of variation	d.f.	Mean square			
		Serum total protein	Serum Albumin	Serum globulin	A/G ratio
Bet weeks	5	0.4773^{NS}	0.2751^{NS}	0.1488^{NS}	0.1066^{NS}
Bet individual	7	1.1388^{*}	0.3292^{NS}	0.4841^{*}	0.0929^{NS}
Error	35	0.3716	0.2233	0.1899	0.0738

* $P < 0.05$

NS = Nonsignificant

The result of Duncan's multiple range test (table-45) indicated that there was a significant variation ($P < 0.05$) of serum calcium between the weeks under study as represented by the superssript in the mean values. However mean values of 3rd 5th and 7th week, mean values of 5th, 7th and 9th weekand also mean values of 7th to 13th week failed to show a significant difference among themselves. Rest of the values were found to differ significantly.

Serum sodium and potassium :

The mean serum sodium and potassium valuesa are presented in table 45, Fig. VIIIc. The mean serum sodium (meq/lit) value during the lactation period under study was 124.75 ± 4.558, 115.00 ± 3.401, 113.75 ± 3.867, 118.88 ± 2.039, 117.88 ± 3.414 and 119.13 ± 3.084 respectively.

The mean value of serum potassium (meq/lit)during different weeks under studyw was respectively 3.09 ± 0.076, 3.01 ± 0.028, 3.00 ± 0.053, 3.11 ± 0.117, 3.20 ± 0.090 and 3.38 ± 0.103.

The result of analysis of variance of serum sodium and serum potassium are presented in table-46. The result showed that there was a significant ($P < 0.05$) variation between week in case of serum sodium but not in case of serum potassium.The variation between individuals on the other hand was highly significant ($P < 0.01$) in case of sodium but not in case of serum potassium values.

The result of Duncan's multiple range test (table 45) showed that there was a significant ($P < 0.05$) variation int the mean values of sodium during different weeks. The mean values with common superscripts were not however significantly different among themselves. Thus mean value of 3rd week was significantly higher than mean value of any one of the rest of the weeks but the mean values from 5th week to 13th week were found to be nonsignificant indifference among themselves.

Serum alkaline phosphatase activity :

The mean serum alkaline phosphatase activity is presented in table-45 and Fig. IXc. The result showed from 3rd week to 134th week of experimental period in the lactating toat the value was 5.01±0.352, 6.09±0.448, 5.72±0.472, 5.34±0.551,5.49±0.405, 5.12± 0.460 respectively.

The result of analysis of varianne of serum alkalinep phosphatase activity is presented in table-47. The value registered a nonsignificant variation between weeks and also between individual under study.

Serum glutamic oxalo acetic acid and serum glutamic pyruvic acid transaminase (SGOT and SGPT) activity :

The mean values of SGOT and SGPT activity are presented in table 45 and Fig. IXc.

The mean SGOT activity recorded in this study was 103.62± 7.678, 100.25+4.538, 109.15+4.385, 106.09+3.113, 110.27+3.777

and 105.41+4.344 respectively. The mean SGPT activity on the other hand was respectively 39.55±2.592, 42.10±3.084, 41.64 ± 1.836, 35.13+3.368, 33.54+0.870 and 32.03+0.896.

The result of analysis of variance of serum glutamic oxaloacetic acid transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) activity in lactating goat are shown in table -47. The result showed that variation between week was nonsignificant in case of SGOT and it was highly significant ($P < 0.01$) in case of SGPT. The variation between individual on the other hand was highly significant ($P < 0.01$) in case of SGOT butdi difference was nonsignificant in case of SGPT value.

The result of Duncan's multiple range test (table-45) showed a significant difference ($P < 0.05$) in SGPT activity between different weeks of lactation period. The mean values during 5th week and 7th week and also 9th week and 13th week were found to be nonsignificant among themselves. The rest of the values however were significantly different.

Milk yield :

The mean milk yield in lactating goat is presented in table 48 Fig. X. The mean milk yield (kg)/week starting from 2nd week to 13th week of lactation period was respectively 3.06±0.070 3.28±0.075, 3.38±0.072, 2.99±0.73, 2.78±0.055, 2.48±0.063,2.01± 0.036, 1.64±0.034, 1.41±0.029, 1.04±0.019, 0.80±0.18 and 0.65± 0.013. Thus highest average milk yield was on 4th week and lowest on 13th week of lactation period under study.

Table - 45

Showing values (Mean ±SE) ofsome biochemical parameters in lactating Black Bengal goat under grazing system (3rd to 13th week) alongwith the result of Duncan's multiple range test.

Parameters	DAYS POSTPARTUM IN WEEK					
	3rd	5th	7th	9th	11th	13th
Serum calcium mg/100 ml	10.51±0.186^{a}	10.43±0.147^{ab}	9.93±0.380^{abc}	9.85±0.441^{bc}	9.52±0.349^{c}	9.03±0.301^{c}
Serum inorg. phosphorus mg/ 100 ml	5.86±0.232	6.00±0.106	5.85±0.149	5.54±0.233	5.70±0.168	5.60±0.147
Serum sodium meq/lit	124.75±4.558^{a}	115.00±3.401^{b}	113.75±3.867^{b}	118.88±2.039^{b}	117.88±3.414^{b}	119.13±3.084^{b}
Serum potassium meq/lit	3.09±0.076	3.01±0.028	3.00±0.53	3.11±0.117	3.20±0.090	3.38±0.103
Alkaline phosphatase activity B.U./100 ml	5.10±0.352	6.09±0.448	5.72±0.472	5.34±0.551	5.49±0.405	5.12±0.460
SGOT activity (ug pyruvic acid liberated/ ml serum)	103.62±7.678	100.25±4.538	109.15±4.385	106.09±3.113	110.27±3.777	105.41±4.344
SGPT (ug pyruvic acid liberated/ml serum)	39.58±2.592^{b}	42.10±3.084^{a}	41.64±1.836^{a}	35.13±3.368^{c}	33.54±0.878^{d}	32.03±0.896^{c}

* $P < 0.05$

Means with atleast one superscript a in common are not significantly different

Table - 46

Analysis of variance of some biochemical parameters (calcium, phosphorus, sodium and potassium) in lactating Black Bengal goat

Source of variation	d.f.	Mean square			
		Calcium	Inorganic Phosphorus	Sodium	Potassium
Bet weeks	5	2.4767*	0.2400NS	193.5720*	0.1564NS
Bet individual	7	1.3798NS	0.6156**	272.9500**	0.1102NS
Error	35	0.6990	0.1855	61.6277	0.0706

** P $<$ 0.01

* P $<$ 0.05

NS = Nonsignificant

Table - 47

Analysis of variance of some biochemical parameters (alkaline phosphatase, SGOT and SGPT activity) in lactating Black Bengal goat.

Source of variation	d.f.	Mean square		
		Alkaline phosphatase activity	SGOT activity	SGPT activity
Bet weeks	5	1.2698^{NS}	107.1712^{NS}	149.9266^{**}
Bet individual	7	3.2403^{NS}	501.3194^{**}	37.6443^{NS}
Error	35	1.3337	126.3261	29.3625

** P $<$ 0.01

* P $<$ 0.05

NS = Nonsignificant

The average milk yield(kg) individual animal during 12 weeks of experimental period was also found to be highly variable (table 48) and was statistically significant.

The result of analysis of variance of milk yield from 2nd week to 13th week of lactation period under study showed a highly significant variation ($P < 0.01$) both between weeks and between individual lactation goat(table-49).

The result of Duncan's multiple range test (table-48) indicated a significant ($P < 0.05$) difference in milk yield amongst different weeks. In this case the mean values of 3rd and 4th week and also mean values of second and fifth week did not show any significant difference among themselves. Other values when compared among themselves showed a significant differences ($P < 0.05$).

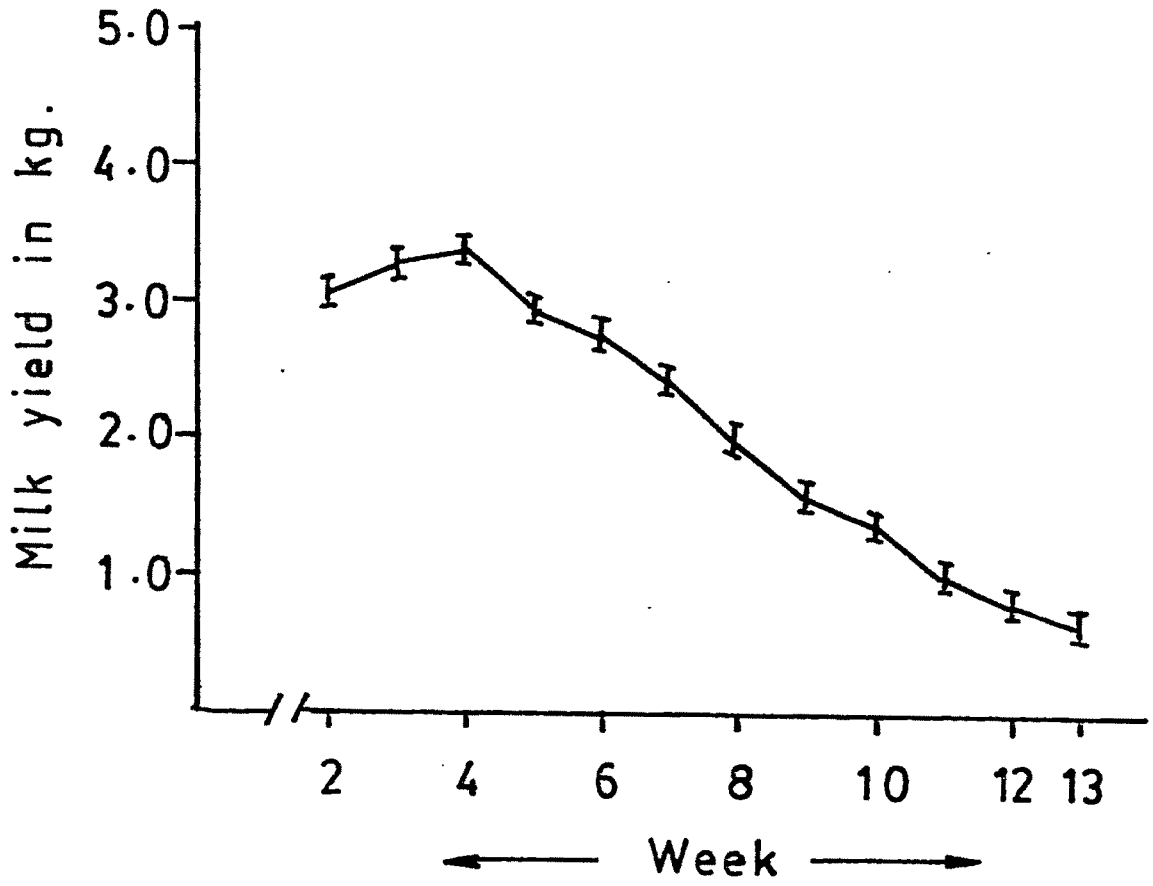


FIG. X MEAN WEEKLY MILK YIELD DURING THE EXP. PERIOD.

FIG. XI SHOWING TREND OF MEAN Hb%, PCV%, TOTAL PROTEIN ALBUMIN & GLOBULIN IN LACTATING GOAT

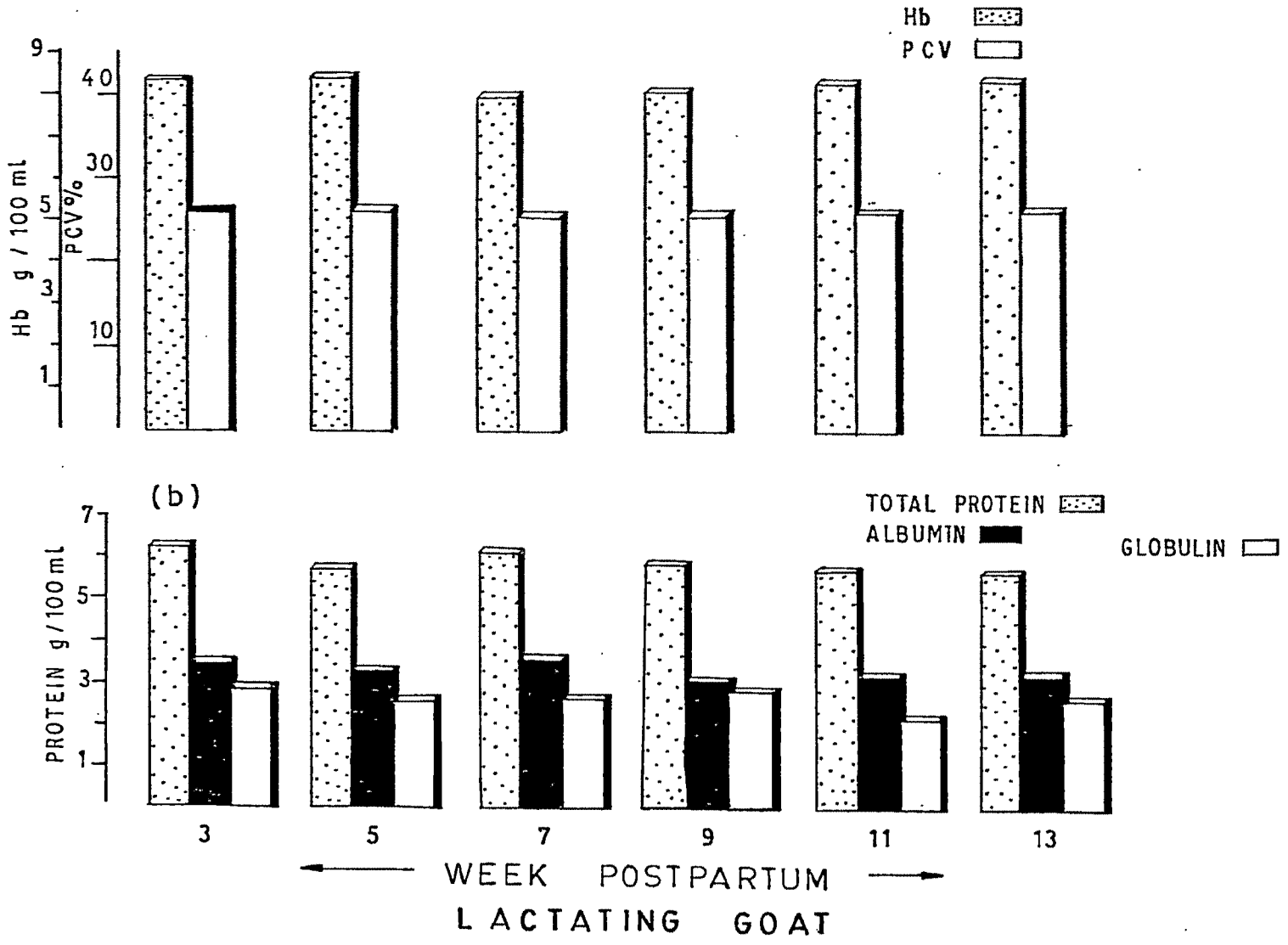


Table 48

Milk yield (kg) value (Mean ±SE) in grazing Black Bengal goat from 2nd week to 13th week post partum alongwith the result of Duncan's multiple range test milk yield (kg).

Days postpartum in week	Average milk yield (kg)/week (Mean ±SE) n=12	Average milk yield of individual animal for 12 weeks (Mean ±SE)
2nd week	3.06 ± 0.070	2.12 ± 0.287^{bcd}
3rd wk	3.28 ± 0.075^{a}	2.19 ± 0.299^{b}
4th wk	3.38 ± 0.072^{a}	2.07 ± 0.279^{cd}
5th wk	2.99 ± 0.073^{b}	2.18 ± 0.288^{bc}
6th wk	2.78 ± 0.055^{c}	2.22 ± 0.306^{b}
7th wk	2.48 ± 0.063^{d}	2.01 ± 0.290^{de}
8th wk	2.01 ± 0.036^{e}	1.90 ± 0.257^{e}
9th wk	1.64 ± 0.034^{f}	2.22 ± 0.324^{b}
10th wk	1.41 ± 0.229^{g}	2.36 ± 0.335^{a}
11th wk	1.04 ± 0.019^{h}	2.11 ± 0.259^{bcd}
12th wk	0.80 ± 0.018^{l}	1.95 ± 0.229^{e}
13th wk	$0.65+0.013^{j}$	$2.21+0.307^{b}$

$P < 0.05$

Means with atleast one superscript in common are not significantly different

Table 49

Analysis of variance of milk yield (kg) in lactating Black Bengal goat (2nd week to 13 week)

Source of variation	d.f.	Mean square
		Milk yield
Bet weeks	11	11.9333**
Bet animals	11	0.1999**
Error	121	0.0172

** P $<$ 0.01

The results presented in this sectionc cover haematological as well as some selective biochemical parameters. The values are presented at fortnightly interval from 3rd week to 13th week of postpartal period of lactating Black Bengal goats. The avérage weekly milk yield from second week to 13th week of lactation in these animals are also presented. The haematological values including haemoglobin and PCV did not show a significant difference between different post partal periods under study. The values were a little lower as compared to the reported values for this species. These values are however comparable to the values presented for the other groups of goat in the previous section. It has been indicated that the animals of this group and most other groups in this present investigation were maintained exclusively on grazing management system without provision of any concentrate. It is well known that the grazing goats are alwasy exposed to recurrent infection of gastro intestinal parasites. The climatic environment including significant rainfall during rainy season, might have favourned the recurrant parasitic infestation. Moreover a competition for a common pool of nutrients by the host and parasite, resultant possible intestinal ulcerion due to parasitic toxins deranged absorption of nutrients including minerals might have resulted into a lower haemoglobin values in grazing goats.

Similar observation has been recorded in sheep (Taylor, 1934, Sharma and Kidwai 1971 and Biswas et al.,1986)

The value of glucose observed in this study showed that thedifference between week was nonsignificant (Table 37). Individual variation was however found to be significant ($P < 0.05$). The values of glucose observed in this group was a little higher that the values observed in case of pregnant group and lower than the suckling kids. The values were however comparable to the values recorded for postweaned maturing goats reported in the preceding section. The recorded value in this group was within the normal range for this species as reposed elsewhere (Swenson, 1977, Vidan and Rai,1983; Verma, 1967). A significant ($P < 0.05$) variation between individual animals in this group might be related to superiority in competitive ability of some individual animals tod derive nutrients from the grazing field in the face of high metabolic requirements. But since the overall mean values during the entire experimental period were within the normal range it can be said that the grazing animals in the face of high metabolic requirements were able to maintain an output balance.

Sauvant and Bass (1979) studied the biochemical profiles of milch goats in relation to their nutritional status. It was concluded that plasma glucose estimation was more informative in late pregnancy than early lactation. Chaiyabtr et al.(1982) studied the metabolism of glucose during pregnancy and lactation in goat. It was observed that glucose synthesis and utilization increased during pregnancy and lactation in fed but not

starved goats. Thus it can be said that animals maintained per fect balance in energy metabolism. The values of total serum proteins albumin, globulin,A/G ratio and also blood urea concentration during the entire postpartal period under study did not show any significant difference between the weeks, The concentration of total serum protein and globulin, however, showed a significant ($P < 0.05$) variation between individual within week. Thev values of serum protein observed during different weeks in this group were a little lower than the values of total serum protein recorded in post weaned maturing goats and pregnant group of goats presented in the previous chapter.

The concentration of blood urea was consistently higher during different weeks in this group compared to the values obtained in other groups of goats as showed in preceeding section. The high concentration of blood urea at any time in ruminant animals may be the result of various factors like increased consumption of proteins, NPN (Pollan, 1970) high ammonia level in the rumen, increased catabolism and dehydration (Khan et al. 1979). The lactation period is marked by a considerable strain on the metabolism ofthe animal as a whole. The lactating udder of goat utilizes 60-85% ofg glucose largely produced by neoglucogenesis and 14-41% acetate and a significant portion of aminoacids available to the animal as a whole (Linzell,1968) Thus low protein value coupled with comparatively higher urea level might be the resultant effect of any one or combination

off factors discussed above. It is however more likely that grazing alone possibly failed to meet the nutritional requirement of the goats at point of higher metabolic demand and resulted some catabolic reaction in the body and utilization of body protein source for neoglucogenesis.

This is further substantiated by the observation that there was a significant ($P < 0.05$) drop in serum calcium values as the lactation period progressed. Apart from this the weekly milk yield of the experimental goats was considerably reduced compared to the reported milk yield of this sepcies under grazing and concentrate supplementation (Agarwal and Bhattacharyya, 1978, Ghosh et al.1982) The result of the serum inorganic phosphorus, sodium and potassium showed that whereas inorganic phosphorus and potassium did not show any significant difference between the weeks under study serum sodium concentration exhibited a significantly ($P < 0.05$) higher values than the values obtained during rest of the weeks studied.

The concentration of sodium was found to be comparatively higher in the post weaned maturing goat but no such appreciable difference was observed in case of inorganic phosphours and potassium level. Bogin et al. (1981) reported that there was small difference in the level of serum minerals like calcium, magnesium sodium and potassium between young and adult Israeli goats. But there was no distinct difference in the level of inorganic phosphorus.

Baruah et al.(1984) on the other hand observed that animals under free grazing system showed a decreasing trend of concentration of serum calcium and inorganic phosphorus with advancement of age. The availability of nutrients by the grazing animals depends upon host complex factors like soil fertility, type of field cover, stage of maturity, season, etc.

However, the concentration of inorganic phosphorus, sodium and potassium in this study were within the normal range.

The alkaline phosphatase activity observed in this study did not show any significant difference between the weeks under study. This concentration was however lower than the concentration recorded for preweaned suckling kids and postweaned maturing kids discussed in the previous sections.

The gradual decreasing trend of this enzyme with advancement ofage has also been reported earlier by other workers also (Baruah et al., 1984)

The SGOT activity showed a highly significant variation ($P < 0.01$) between individual but variation between week was nonsignificant. The values of SGOT activity during lactation period did not exhibit a definite trend and were low compared to the values observed in case postweaned maturing goats. The result was however comparable with the result of preweaned suckling kids and also pregnant goat. Thus under physiological

condition SGOT activity might have some role particularly during growth phase. Bhattacharyya et al(1084), observed a significant change in body weight SGOT and SGPT activity between 9 to 23 weeks in Black Bengal kids and SGOT activity showed a significant positive correlation with body weight (r = 0.60) during the period under study. A significant individual variation of SGOT activity in lactating goats, as has been observed in this present study was also reported by Bas et al. (1980) . The SGPT activity showed a significant variation between weeks under study. The values of SGPT activity were comparable with the values of SGOT observed during suckling period and also during pregnancy.

During postweaned maturing period the values were much higher. The higher values during growth stage has also been observed earlier (Bhattacharyya, et al.,1984a). The overall trend of SGPT activity observed in this study was found to be comparatively higher during 3rd week to 7th week of lactation period.

The trend of average weekly milk yield also showed that prior to 9th week the milk production was comparatively higher but from 9 week onwards the average weekly milk yield declined which indicate possible involvement of this enzyme under normal physiological condition in synthetic activity of milk constituents during peak lactation.

The result of study on milk yield during second to 13th week of lactation period in the experimental goats showed a significant ($P < 0.05$) variation in the average weekly milk yield. The average milk yield of individual animals during 12 week os lactation period under report also showed a significant individual variation. The variation between week is a physiological trend related with functional efficiency of secretory cells in the gland alveoli and is intimately linked up with nutritional and hormonal factors involved in lactogenesis and galactopoesis.

Individual variation of milk yield observed is with biological and is partly linked up with individuals ability to procure and assimilate available nutrients under free range condition and synthesize milk constituents. In the present study thepeak milk yield/week was attained by fourth week of lactation period with an weekly average value of 3.38 ± 0.072 kg. Theg gradual but consistent fall ($P < 0.01$) in milk yield with yield advancing lactation after peak yield between 4th to 5th week ppstpartum in Black Bengal goat was also observed earlier (Agarwal and Bhattacharyya 1978). Ghosh et al.1982 reported lactation length and milk yield in Black Bengal goat grazed on para pasture 6 hour/day and supplemented with 250 gms concentrate/doe/day. The average milk yield in 119 days lactation was 19.25 ± 0.37 kg with an mean weekly yield of 2.3+0.39/doe. In the present experiment observation was recorded from 2nd week to

13th week of lactation for which exact comparison is not possible. But milk yield reported by them was higher than the yield recorded in this experiment. The addition of concentrate might have improved the weekly milk yield in the earlier reports.

Dry matter intake (DM) under grazing condition :

The details of digestibility and DM intake trial by chromic oxide and acid insoluble ash methods in three groups of grazing goats eg maturing, pregnant and lactating are presented in the table 50. The protein content of pooled feed sample was also analysed but the result is not shown in the form of table. But the value of pooled feed sample was 7.45±0.234.

The least square mean of body weight (kg) digestibility and DM intake 100 kg body weight in maturing pregnant and lactating group of goat are presented in the table-51. The overall mean of body weight kg total digestibility % and DM intake kg/100 kg recorded in this study in respective of the group of the animals was respectively 17.01±1.860,64.82±0.767 and 2.86±0.073. The least square mean body weight (kg) in maturing, pregnant and lactating group of goat was 9.42±1.140, 21.89±2.850 and 19.78±1.500 respectively.

The DM intake kg/100 kg body weight varied from 2.36 kg to 3.2 kg in case of maturing goat 2.24 kg to 3.53 kg in case of pregnant and 2.55 kg to 3.41 kg in case of lactating goat.

The least square mean of total digestibility in maturing pregnant and lactating group of goats were 67.10±0.194, 63.95± 1.475 and 63.41+1.337. Thema maturing group of goat though showed a little higher mean value of total digestibility of nutrients but it was not statistically significant when compared with the rest of the two groups.

The least square mean value of dry matter intake kg/100 kg body weight in maturing, pregnant and lactating group of goats recorded respectively was 2.86±0.186,2.75±0.141 and 2.98±0.128.

The results of analysis of variance of digestibility of nutrients and dry matter intake (DM) is presented in the table 52.

The body weight of the maturing group of goat included in this study varied from 5-5 kg to 12.5 kg. In pregnant group of body weight varied from 14.7 to 34 kg and in lactating the body weight varied from 13.7 to 25.5 kg. The amount of chromic oxide fed/animal/day was 1 gm. The calculated digestibility of nutrients in maturing group of animals ranged from 69.38 to 60.00%. In case of pregnant group it was 60.00 to 71.25% and in case of lactating group it ranged from 61.19 to 67.50%.

The result of analysis of variance of digestibility and DM intake in maturing pregnant and lactating groups of goat maintained exclusively under grazing condition showed that there was a significant ($P < 0.01$) variation of body weight of different groups of animals included in this digestibility and

DM intake trial. The result also showed that the digestibility in three experimental groups of goat did not differ significantly but the calculated DM intake kg/100 kg body weight differed highly significantly ($P < 0.01$) among themselves.

The regression of body weight was significantl in case of digestibility ($P < 0.05$) and DM intake/100 kg body weight(P 0.01).

The Duncan's multiple range test table 51 indicated that there was significant ($P < 0.05$) variation of body weight between groups under study. The least square mean body weight of pregnant and lactating group of goat had significantly higher body weight than the maturing group of goats. The pregnant and lactating group of goat failed to show any significant difference in body weight among themselves.

The Duncan's multiple range test further indicated that there was a significant ($P < 0.05$) variation of DM intake between the groups under study. The lactating group of goat showed a significantly higher ($P < 0.05$) values compared with the values obtained in case of maturing and pregnant groups of goats. Similarly maturing group of goats had significantly ($P < 0.05$) higher value compared to pregnant group of goats.

Meteoriological data :

The meteoriological data collected (shown in table 53 and Fig. XI) were partitioned into three distinct season of the year, hot humid (June to October 15th), cold (October 16th to February 15th) and hot dry (February 16th to May) prevalnent

Table - 50

Showing digestibility and dry matter intake(DM) in three different groups of goat under grazing condition (Chromic oxide and internal indicator method).

Sl. No.	Goat No	Body wt(kg)	Chromic fed g	Chromix oxide in faeces (g)	Faecal output of DM (g)	Indicator in feed %	Indicator in faeces	DM in faeces %	DM in feed %	Digestibility %	DM intake (g)	DM intake/ 100 kg body weight
							MATURED					
1	11	12.5	1 g	0.005	200.00	0.151	0.30	27	18	67.50	400	3.2
2	31	10.3	"	0.006	166.00	"	0.30	27	20	60.00	332	3.11
3	14	9.8	"	0.00714	140.00	"	0.30	25	20	62.50	280	2.86
4	36	9.0	"	0.0066	151.51	"	0.25	40	20	60.00	250	2.78
5	25	5.5	"	0.0072	139.29	"	0.14	37	20	69.38	130	2.36
							PREGNANT GOAT					
1	45	34.0	"	0.0022	450.55	"	0.40	38	20	71.25	1200	3.53
2	146	25.9	"	0.0028	355.83	"	0.38	27	"	67.50	900	3.47
3	48	20.4	"	0.004	250.00	"	0.28	35	"	65.56	460	2.55
4	163	19.0	"	0.0037	270.27	"	0.25	25	"	62.50	450	2.37
5	130	17.0	"	0.0046	217.39	"	0.25	27	"	67.50	360	2.24
6	12	14.7	"	0.0076	131.58	"	0.40	32	"	60.00	350	2.38
							LACTATING GOAT					
1	177	20.2	"	0.0041	243.90	"	0.40	33	20	61.88	650	3.22
2	B28	18.4	"	0.0052	192.30	"	0.50	26	"	65.00	600	3.26
3	32	13.7	"	0.0062	161.29	"	0.40	33	"	61.19	400	2.92
4	48	20.4	"	0.0040	250.00	"	0.28	35	"	65.56	460	2.55
5	146	25.5	"	0.0028	355.84	"	0.38	27	"	67.50	900	3.41
6	48	20.5	"	0.0040	250.00	"	0.28	20	"	65.00	460	2.55

Table - 51

Least square mean +SE of body weight (kg), digestibility % and dry matter intake kg/100 kg body weight in maturing (12 to 36 wk age), pregnant and lactating group of Black Bengal goat under grazing condition alongwith the result of Duncan's multiple range test.

	Body weight	Total digestibility	Dry matter intake kg/100 kg body weight
Overall mean	17.01±1.860	64.82±0.767	2.86±0.073
Groups :			
Maturing (12 to 36 wk of age) group	9.42±1.140^{b}	67.10±0.194	2.86±0.186^{a}
Pregnant group	21.89±2.880^{a}	63.95±1.475	2.75±0.141^{b}
Lactating group	19.78±1.560^{a}	63.41±1.337	2.98±0.128^{c}
Partial regression	-	0.4025±0.1679	0.0706±0.0161

* $P < 0.05$

Means with ateleast one superscript in common are not significantly different.

Table - 52

Analysis of variance of digestibility and dry matter (DM) intake of maturing (12 to 36 wk), pregnant and lactating group of grazing goat.

Source of variation	d.f.	Mean square		
		Body wt (kg)	Digestibility	DM intake/100 kg body weight
Bet group	2	235.178**	10.0889NS	0.61148**
Regression on body weight	1	-	56.2940*	1.7329**
Error	-	24.8221 (14)	9.8016 (13)	0.090304 (13)

Figures in the parenthesis indicate number of error degree of freedom

** P $<$ 0.01, * P $<$ 0.05

NS = Nonsignificant

in this area. The mean maximum and minimum temperature in celcius during hot humid, cold and hot dry period were respectively 32.68±0.270 and 25.46±0.109, 27.81±0.346 and 15.26 ± 0.333 and 34.56±0.302 and 21.53±0.400.

The mean maximum and minimum relative humidity (%) during the above three seasons were 88.35±0.401 and 68.01±0.987, 84.40±0.625 and 44.02±0.831 and 78.64±1.080 and 42.42±1.203 respectively. The mean recorded rainfall in mm was 9.80±2.02 1.87±1.30 and 2.45±0.75 respectively.

The above climatological information had definite bearing on field cover, nutrient content in the forage sample and also on feed intake by the grazing animals in different groups in different seasons.

Table - 53

Showing temperature and humidity complex during the experimental period 1985 & 86.

Season	Temperature Mean ±SE		Relative humidity (%) Mean ±SE		Rainfall min. Mean ±SE
	Max °C	Min °C	Max	Min	
Hot Humid June to Oct.15	32.68±0.270 n = 136	25.46±0.109 n=136	88.35±0.401 n=136	68.01±0.987 n=136	9.80± 2.02
Cold Oct.16th to Feb.15th	27.81+0.346 n=122	15.26+0.338 n=122	84.40+0.635 n=122	44.02+0.831 n=122	1.87± 1.30
Hot dry Feb 16th to May	34.56±0.302 n=104	21.53±0.400 n=104	78.64±1.080 n=104	42.42±1.203 n=104	2.43± 0.75

The digestibility trial conducted during the month of July (Experimental year 1986-87) by use of chromic oxide as external marker and acid insoluble ash as an external marker to asses the feed intake under grazing condition and trial on digestibility of the nutrients was found to give certain useful information. As already indicated it was a combined trial using reasonable number of animals from each of the three experimental grazing group e.g. post weaned maturing, pregnant and lactating groups. The result thus gives the scope for comparative evaluation of the nutritional status of the three groups of animals under different physiological state. A single trial though hardly reflects the nutritional status for the entire length of experimental period but the results are quite informative for evaluation of overall nutritional status of the three different experimental groups. It is seen from the results (table 50 and 51) that total digestibility of three groups of grazing goats was not significantly different. But DM intake kg/100 kg body weight showed a significant difference ($P < 0.05$). The overall mean values of three groups was 2.86 ± 0.073.

The highest DM intake kg/100 kg body weight was recorded in case of post parturient lactating group of goats then followed the post weaned maturing group and lowest value was observed in case of pregnant group of animals. Physiologically the lactating group of animals are expected to have enhanced metabolic activity for the synthesis of essential milk components.Thus observed highest DM intake kg/100 kg body weight in lactating

group of animalsin the present experiment appears in conformity to our expectation. The post weaned goats showing positive growth response equally have high nutritional requirement since these animals require nutrients for maintenance as well as far anabolic effect in the form of cellular proliferation,deposition of protein fat, and osteoblastic activity.

In the present trial lowest DM intake (kg/100 kg body weight in pregnant group of animals apparently appears very confusing and misleading too. It is well known that the pregnancy period is mot crucial physiological period in life. During this period the animals derive nutrients for the maintenance requirements of their own as well as to meet the persistent growing demand of the developing faetus in the utero. As pregnancy progresses this demand for more nutrients is also increased. It was further observed that most of the animals included in this group were in the advanced stage of pregnancy. The only possible explanantion in this case might be that animmls in their advanced stage of their pregnancy were physically handicapped to ıpam about in search of nutrients in the grazing field. This failure in adequate nutrient intake during this advance stage of pregnancy might have been reflected in number of biochemical parameters like, glucose, serum calcium, phosphorus studied in this group.

A number of reports are available in the literature indicating digestibility of nutrients and DM intake both under grazing and stall fed condition in different species of livestock and

goat in particular (Prosad, 1964, Joshi and Ludhri 1970, Sexana and Maheswari, 1971, Hamada et al.,1973,Devendra 1967).

Arnald (1962) recorded a distinct seasonal changes in the pattern of grazing. Ghosh (1981) observed that DM intake (kg/100 kg body weight) did not significantly differ between stall fed and grazing group of Black Bengal goat. It was further observed that season, sex had no significant influences on dry matter intake. The average range of DM intake varied from 2.0 to 3.5 kg/100 body weight in different seasons. Thus the present observed value except in pregnant group appears in conformity with the reported values in the literature.

The analysis of forage sample as already pointed out was only restricted to analyses of protein in pooled forage sample. It was not possible to analyse all the different proximate principles and mineral content of the samples. This could have been much more informative in the assessment of nutritional status of the animal.

The assessment of nutritional status of the animals exclusively reared under grazing management system having a mixed variety of field cover is extremely difficult. The nutrient content of the forates vary from season to season. The variability are also seen in the different parts of the same forage. The animals under free grqzing system are very much choosy in nature. Thus collection of representative sample of forage for analysis is extremely difficult. In the present analysisof protein content

of the forage sample, collection was made as the animals grazed for a near representative sample. The crude protein content of grass samples are reported to vary considerably.

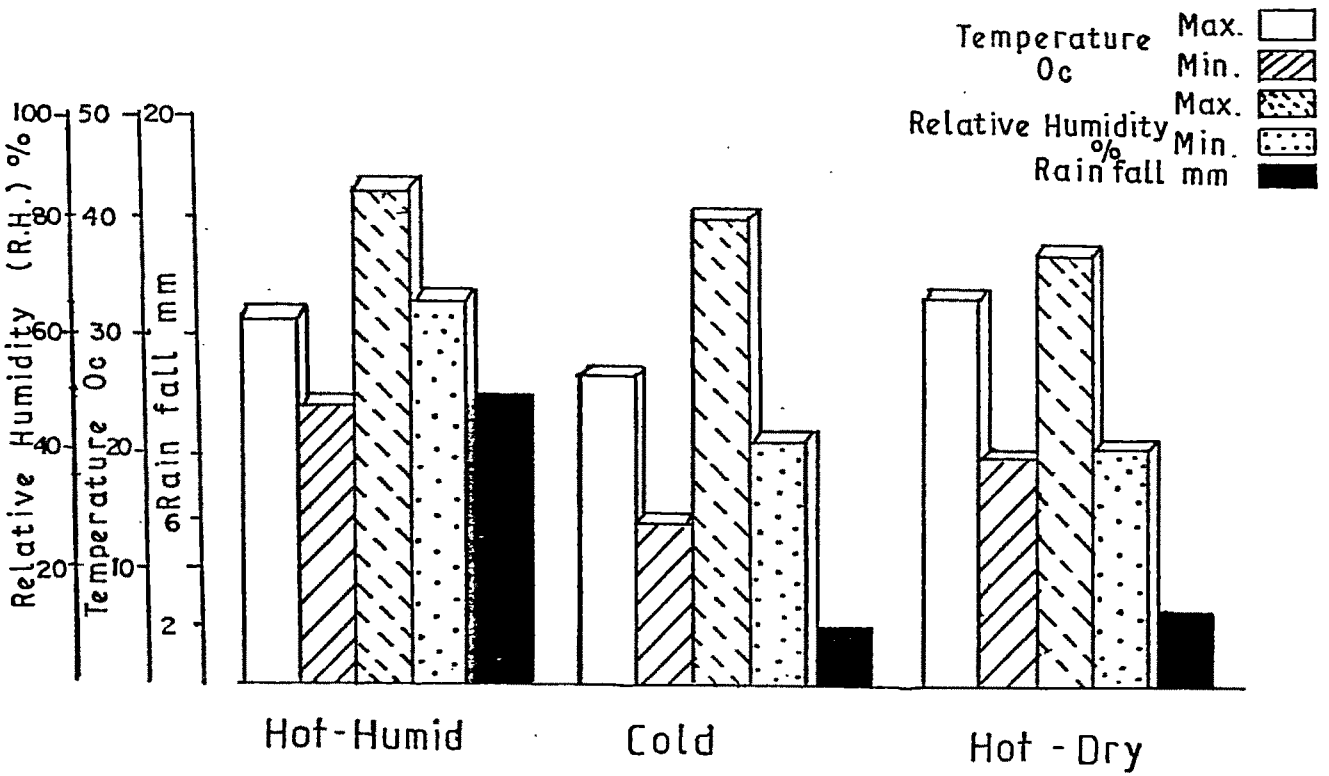
Singh and Jain (1981) observed that crude protein content of grass pasture varied from 5.34% to 9.22% during different moth of experimental sample analysis. The corresponding values for mixed pasture was reported to vary from 5.81 to 12.46%. The nutritive value particularly crude protein (CP) content of different varieties of grasses like Dinanath grass, 3.03% (Banerjee and Mondal, 1974) Dhubgrass 2.65%(Panchauri 1970) have been reported from time to time. The present result on protein content of mixed grass samples is within acceptable limit and assures rough estimate of the prude protein nutritional status of the grazing. A protein deficiency can be manifested in a variety of ways because of diverse functions it has in the living organisms. In animals it most often occurs simultaneously with the deficiency of energy and is interrelated with energy as to the lesions manifested. The clinical signs are loss of weight in adult or retarded growth in young, weekness,anaemia and poor hair cont (Cannon 1948). In the presant experiment in all the groups such clinical manifestations were not observable. Thus a clear cut deficiency of dietary protein energy could hardly be predicted.

Hameotherms increase feed intake in cold and decrease it in heat. The set point of temperature at which this occurs shows variability from one species to another and even within the same species. The differences have also been observed between younger and older animals and nonlactating and lactating animals. Brobeck (1960) suggested thermostatic theory which received special consideration in ruminants. Artificial induced temperature changes in the hypothalamns of goats altered feeding pattern (Balch and Campling 1962) Although there remains scope for arguing as regards precise relationship between metabolic heat production and feed intake regulation there is no doubt that body temperature regulation and feed intake regulations are interrelated.

Temperature, humidity and rainfall all have direct impact on the nutrient content on the forage samples and indirectly on the nutritional status of the experimental animals. The temperature and humidity, in addition, dictate the feed intake of the animals.

C H A P T E R - V

SUMMARY AND CONCLUSION



FigXII Mean Ambient Temperature - Humidity - Rainfall during the Experimental period (1985-86)

SUMMARY AND CONCLUSION

In poor country like India the increases in human population is accompanied by increase in livestock population because later represents family wealth. The present population of sheep and goat alone is around 41.75 million. These are mostly owned by small and marginal farmers of our country in small numbers. In recent past research work has been intensified on different aspects nutrition, breeding and management of our livestock in order to improve their production potential. But the main constrain lies with the supply of balanced nutrition because of common competition for ingredients of concentrate ration for our livestock. Thus scientific recommendations like intensive and semi intensive husbandry practice though apparently appear sound failed to produce desired impact amongst the economically nonvible small animals owners. Further there has not been any organised survey conducted about the extent and nature of grass land, permanent pasture, village grazing ground and forest grazing land including their productivity in different agricultural zones in India. Thus there is a growing demand to gather information on different aspects of pasture based nutritional resources and their productivity in different species of livestock. Keeping in view the above consideration, the present work has been taken up to assess the growth reproductive and productive performance of Black Bengal goat reared exclusive on grazing

management system on uncultivated pasture.

In the first section of this thesis an attempt has been made to asses the growth performance of preweaned suckling kids. The early growth is considered to be economically most acceptable trait since it quickens the slaughter weight. The kids of this breed received milk from the respective dam up to 11 weeks of their age. The dams' nutritional source was grazing alone. The body weight, absolute gain in wt, percentage gain in wt. and feed efficiency studies all indicated that kids were in positive nutritional balance. The haematological and biochemical parameters studied at selective period of their life (4th weeks and 8th week) failed to indicate apparently any adverse nutritional stress at the cellular level.

In the second section of this study the growth performance of postweaned Black Bengal kids from 12 week to 36 week of their life has been studied. The animals in this group were reared exclusively on grazing management system on uncultivated pasture on rotational basis for 8 hours a day. The field cover consisted mostly paragrass, dhub grass and different other varieties of uncultivated grasses types of them have not been typed. The growth performance measured in terms of body weight, absolute body weight gain and percentage body weight gain at fortnightly interval indicated positive growth response and was suggestive of anabolic effect. The haematological parameters like Hb and PCV and biochemical study like blood glucose, protein, urea,

minerals (calcium, phosphorus, sodium and potassium) and enzymes (alkaline phosphatase and transaminases) did not indicate any adverse effect at the cellular level; rather results depicted physiologically normal functioning of thecells. The lower haematological values were however suggestive of recurrent parasitic infection in grazing animals and host parasite competition for a common nutritional pool.

The performance record of both preweaned and postweaned kids upto age of 36 weeks indicated positive nutritional balance. But whether available level of nutrition was sufficient for optimum expression of genetic potentiality in the breed under study remains to be ascertained.

In the third section of this thesis performance of the pregnant goat has been assessed in terms of birth of viable featus and supporting haematological and biochemical study. The pregnant animals throughout the length of gestation period were reared on grazing management system, and gave birth to viable faetus. For haematological and biochemical study the entire pregnancy period was partitioned into early, mid and end term pregnancy birth of viable featus at the end of terms indicated nutritional sufficiently to the pregnant dams. But the result of haematological and biochemical study indicated certain nutritional stress particularly at the later half of pregnancy. The haematological values were lower throughout the entire length of gestation period

period which might be the result of recurrent parasitic infection as in previous case. The biochemical profiles like blood sugar level, serum calcium and phosphorus concentration particularly in later half of pregnancy are suggestive of nutritional stress at the cellular level may be at a subclinical level.

Thus it can be concluded that grazing alone on uncultivated pasture even for 8 hours/day was just sufficient to meet the growing demand of the pregnant doe and therefore same extra nutritional provision at the later part of pregnancy should be made. In fourth section of this thesis an attempt has been made to assess the productive performance of post parturient lactating does from second week to 13th week of lactation period only. The Black Bengal goat is potentially low milk yielder so lactational performance was studied for a prime lactation period only. The highest milk yield was recorded between 3rd to 4th week of lactation period and on subsequent weeks, and on subsequent weeks the yield gradually end consistently decreased. The trend of lactation curve was more or less identical when compared with trend exhibited by well nutished does. The yield when compared quantitatively with the published record showed some reduction thus suggesting nutritional stress on biosynthetic mechanism at the cellular level.The haematological and biochemical results further confirmed this. The haematological value was low. The biochemical values like low serum protein calcium and phosphorus concentration and high blood urea level. Thusn it can be concluded that nutrition available

through grazing only was not sufficient during lactation period though milk production potential of this breed was very low.This low milk production purely under grazing, likely to affect adversely the growth rate of the suckling kids. Some extra allowance, during lactation period is considered beneficial. In the last portion of this thesis information incorporated include (1)result of digestibility trial and dry matter intake under grazing condition involving animals of different experimental group (2) result of analysis of pooled feed samples and (3) climatological data during the entire experimental period. The results of total digestibility and calculated DM intake in pregnant group has been explained in terms of physical barrier for continuous grazing during advanced stage of pregnancy.

The highest dry matter (DM) intake in lactating group of animals suggested enhanced nutritional demand for biosynthesis of milk constituents. The analysis of crude protein (CP) in the pooled feed sample gave a rough estimate about the status of protein nutrients in the grazing animals. The estimated value was within the normal range. The climatological data throughout the experimental period has not been correlated with any of the parameters studied. The data have been partitioned depending upon into three major season of the year in this locality. The climatic environment has influenced the overall performance of the different groups both directly through feed intake, and acting on thermoregulatory mechanism and indirectly through the growth and nutrient content of the field cover.

Thus result presented in this thesis on the performance of Black Bengal goat under different physiological condition reared purely on grazing system normally practised by marginal farmers suggest the availability of nutrients from grazing alone on rotational basis which was even above maintenance level favouring reproductive and production as well but for optimum expression of genetic potentiality some extra nutritional allowance in the form of concentrate particularly during growth phase, later half of pregnancy and lactation might be much more beneficial and remunerative. It is suggested that study of this nature should beintensified in different agroclimatic zones in India. The future study should also ascertain available grass land in the area under study and admissible animal load/hectre of grazing land without any adverse effect on land/field cover. An utmost emphasis should be laid on the identification and nutritional evaluation of unconventional plant/fodder resources covering different seasons of the year in different geoclimatic regions. Development of field cover in non agricultural area of village side with nutritionally improved variety of plants/fodders, if possible with fertilizers particularly in the deficient areas will encourage villagers for self employment and assure better return.

C H A P T E R - VI

FUTURE SCOPE OF RESEARCH

FUTURE SCOPE OF RESEARCH

About two-third of the world population of sheep and goat is in Asia. These animals are ever neglected and inspite of the neglect they had not only sustained but also thrived. About 19% of the animal are slaughtered in the India and inspite of any special effort they population is also exhibiting with increasing trend.

The farmers' system of goat in India is very unorganised. Till now the animals are kept by nomad's, following a migratory rules and mostly kept on thec crop residues, uncultivated pastures, herbage and other vegetations along high ways, railway-tract, hills and forest areas.

Black Bengal goat is a very popular meat breed and its habitat is a high rainfall and humid area of eastern India. They are highly profilic breed and their mature body weight is not very high. Their consumption as one of theb best meat type breed of the world and it has high potentialities provided judicius management is practised.

In the National Planning for economic development of marginal farmers and landless agriculture labour, constant attention has been given in area ofl livestock raising. The popular species that has been envisazed in this programme are cattle, pig and poultry. Sheep and goat have also been considered but the area

of operation is limited.

It is unfortunate, amongst livestock, sheep and goat have been considered to play a major role in soil erosion. It is true that they have role but not the only species who is to be blamed for it. In case of overgrazing even by cattle, such eventuality may take place.

The present investigation has indicated that a population of goat can maintain, grow and reproduce without being supplemented by any nutrient, neither by any concentrate nor by any shown fodder.

The norms of nutrients has indiated that goat required about 3 to 4% dry matter and the present experimental evidence has indicated that such requirements are made available by the animals. It may be investigation was undertaken in highly agriculturally advanced areas. The soil type is very fartile and the areas is agriculturally advanced. Hardly a plot is keft uncultivated. It means that under such intensive cultivated area the animals have to depend only on grazing on natural pasture.

It needs to be investigated further on the reproductive behaviour, litter size and other physiological parameters and a well planned comparison needs to be made in different soil types.

C H A P T E R - VII

BIBLIOGRAPHY

BIBLIOGRAPHY

Adaval, S.C., Morris, D.I. and Khare, S.G.(1969). Serum Alkaline Phosphatase activity and inorganic phosphate in goat. Indian Vet. J. 46:485.

Adomosum, A.A.(1970) Nutritive valuation of Nigerian forages 1. Digestibility of Pennisetum Pusisum by sheep and goats Nigerian Agri. J. 1:19-26.

Agarwal, K.P. and Bhattacharyya, N.K.(1978) Yield and composition of milk in Black Bengal, Barbari and Black Bengal x Barbariannies. Ind. J. Anim. Sci. 48:882-886.

Agarwala, O.N. and Pachauri, V.C.(1974). Studies on sheep nutritive (1) Effect of supplementation of concentrate mixture or lucern hay on efficiency of feed utilization and performance of sheep fed basal rationn doob(Cynodon dectylon) hay. Ind. J. Anima. Sci. 44(11), 856-860.

Agarwala, B.L. and Talapatra, S.K.(1970) Biological availability of calcium in feed stuff (a) Introduction of low calcium diet. Ind. J. Anim. Sci. 40:414-417. (b) Availability of calcium from leguminus roughages Ind. J. Anim.Sci. 40:610-613.

(c) Availability of calcium from mineral salts. Ind.J. Anim. Sci. 41:11-19.

Agarwal, B.L. and Talapatra, S.K.(1971) Biological availability of feed stuff availability of calcium from mineral salts. Indian J. Animal Sci. 41:11-19.

Ahuja, A.K., Poonia, R.S. Bhatia, S.K. and Rao, A.R.(1972) Faical excretion pattern of chromic oxide administered as component of high conc. ration in Hariana and cross-bred cattle. Ind. Vet. J. 49;1040.

Ahuja, S.P. and Talapatra, S.K.(1973) Effect of different plane of nutrition on Hariana cows grazing natural pasture of yield and composition of milk. Ind. J. Anim. Sci. 43(7) : 604-608.

Ali, S.Z.(1979). A study of the growth pattern of Black Bengal goat Indi. J. Anim. Sci. 49(12), 1048-1052.

Altman and Diffner (1961). Blood and other body fluids fed. Am.Soc. Exp. Biol Washington of Sweusou M.J.(1977) Dukes' physiology of domestic animals 9th Ed.pp.29 Cornel Uni. Press.

Amble, V.N., Khaudekar, N.L. and Grag, J.N.(1964). Statistical studies on breeding data of beetal goats Res. Ser 38 Indian Coun. Agri. Res. New Delhi. pp.70.

Amos, R.L. Cheissman, G.J., Keefar, R.F. and Horvath, D.J.(1975) Serum magnesium levels of ewes grazing orchard grass top dressed with docomite or calcite. Ind. J.Anim. Sci. 41:198-207.

Arlond, G.W.(1962). Influence of seasonal factors in determining grazing behaviour of Border heister x merino sheep. J. Brit. Grassland Soc. 17:41-51.

Banerjee, G.C. and Mondal, L.N.(1974). Nutritive valueof pennisetum pedicellatum grass for adult sheep. Indian Vet. J. 51(9+10). 620.

Bas, P; Rourean, A. and Morand-Fehr. P.(1980) Diurnal and weekly variation in concentration of certain metabolites in the blood of lactating goats. Annales de Recherches Veterinaries. 11(4):409-420. c.f. Vet. Bull. (1982) 52(6) 3515.

Bath, I.H. and Rook, J.A.F.(1965) The evaluation of cattle feed and diet in terms of ruminal concentration of V.E.A. 2. Roughages and snuuleuts. J. Agri.Sci. 64:67.

Baruah, R.N.; Saikia, M.J.; Goswami, J. and Talukdar,S.C.(1984) Studies on serum calcium inorganic phosphorus and alkaline phosphatase activity on non-descript goats of Assam. J. of Vet. Physiol. and Allied Sci.3(1):1-3.

Bergeim, O.(1924) J. Biol Chem. 62:45. c.f. Das. B.N. (1981) Studies on theefficiency of utilization of certain nutrients in Black Bengal goats under free and confined condition Ph.D. thesis, BCKVV.

Berland, J.E. and Demavin, L.S.(1975) Certain characteristics of cool season annual forages and their Relationship to performance by growing beef colts. Indi. J.Anim. Sci. 41:1206-1211.

Bhattacharyya, B. Chatterjee, M. and Chatterjee, S.(1977). A study on calcium, phosphorus and magnesium in the serum of pregnant goat with a history of early abortion. Ind. J. Anim. of Health XVI(2) 177-178.

Bhattacharyya, B. and Chakraborty, A.K.(1979). Serum amino-transferase activity in normal and experimentally infected Jamunapari goat with riderpest virus. Indian.Vet. J. 96:435-436.

Bhattacharyya, B. and Dattagupta, R.(1987). Some biochemical constituents of blood serum in growing kids. Indian Vet. J. 64, 618-619.

Bhattacharyya, B., Ghosh, T.K., Duttagupta, R. and Moitra, D.N. (1984a). Effect of age and body weight on serum amino-transferase activity in Black Bengal kids. Indian J. Dairy Sci. 37(3) : 267-268.

Bhattacharyya, B., Senapati, P.K. and Duttagupta, R.(1984b). Some blood constituents in crossbred cattle. Indian J. Anim. Sci. 367-69.

Bhandari, D.S. and Gupta, M.L. (1972). Studies on digestibility and nutritive value of Ardu (Ailanthus excelsa, Royb.) Ind. Vet. J. 49:512-516.

Bhatia, D.R., Modan, M. Patnayak,,B.C.(1978). A note on plane of nutrition on malpura rams grazing on available pasture in semi arid areas of Rajasthan Indian J. Anim. Sci. 48 759-760.

Bhimaya, C.P., Chakraborty, A.K.; Das, R.R. and Bhutia, G.N. (1969) Grazing studies in the arid and semiarid zones of Rajasthan. III. Growth and different kinds of live-stock in pasture and pali. Indian J. Anim. Sci. 39 : 416-428.

Biswas, S.S., Moitra, D.N., Sasmal, N.K.; Bhattacharyya, B. Roy, S.K. and Mazumder, S.C.(1986) Seasonal variation of parasitic load on performance of grazingsheep. Indian. Vet. J. 63:996-999.

Blach, C.C. and Campling, R.C.(1962). Regulation of voluntary feed intake in ruminants. Nutr. Abst. Rev. 32:669-686.

Bogin, E., Shimshony, A., Avidar, Y. and Esraeli, B.(1981). Ensymes, metabolites and electrolytes levels in boood of local Israeli goats. Zentralblatt fur veterinarmedizin A. 28(2):135-140. c.f. Veterinary Bull. (1981) 51(11):7133.

Boila, R.J. Devliu, T.T.; DrysDale, R.A. and Lillio, L.E.(1984) Supplementary copper for grazing beef cows infectable copper glycouate,copper sulphate, in free cheric mineral supplement. Ind. J. Anim. Sci. 64(3):675-696.

Boss, P.H. and Wanner, M.(1979) Clinical chemical values in serum of sannen goats. Schweizer arehiv Fur Tierheikunde (1977) 199(7). 293-300. c.f. Nut. Abst.Rev.Series B.(1978) 48(4):1316.

Botkin, V.P. and Lang, R.L.(1978). Influence of severe dietary restriction during dry period on subseqnent ewe productivity. J. Anim. Sci. 46:1147-1150.

Bowling, R.A.; Riggs, J.K., Smith, G.C.; Carpenter, Z.L.; Reddish, R.Z. and Butlen, O.D.(1978). Production carca and palatability characteristics of steeds produced by different management system. J. Anim. Sci. 46(2):333-340.

Brobeck, J.R.(1960). Food and temperature Recent progress in hormone research 16:489-466.

Brochart(1965). Nutr. Abst. Rev. 35:257. c.f. Church D.C.(1979) Digestive physiology and nutrition of ruminants.Vol.2 Nutrition 2nd edn. Book Inc. 125 N.W. Klive place Corvalis Oregon 97330 USA.

Cambell, J.R. and Wqlts, C.(1970) Blood urea in bovine animals Vet. Record 87:127-132.

Cannon, P.R. (1948). Some pathologic consequences protein and amino acids deficiency spring field III.C.C. Thomas c.f. Hafer ESE and Dyer, I.A.(1969).Animal growth nutrition Fibger Philadelphia.Vet.Record.87:127-132.

Castle, M.E.; Drysdalo, A.D. and Watsou, J.N.(1964). Feeding of supplementary concentrate to dairy cows grazing good pasture J. Brit. Grassland Soc. 19:381.

Catarsini,O. Chilofalo, L. Pugliese, A. Domina,F. and Magistri C. (1984). Metabolic profiles of goat (1) serum content of some electrolytes phosphorus calcium, potassiummagnesium sodium. Amali Dilla Facatta demidicine Veterinari Meg gime 19:201-209. c.f. Vet Bull(1985) 55(2).

Chaiyabtr, A.; Faulkner,A. and Peaken, M. (1982). Glucose metabolism in vivo in fed and 48 hrs. starved goats during pregnancy and lactation. Brit. Jr. Nutr. 47(1):87-94.

Chakaraborty, A.K. and Bhatia, G.N.(1971). Grazing studies in arid and semi arid zones of Rajasthan. VIII performance of wether in whewn and natural pasture at pali with supplementary feeding. Indian J. Anim. Sci. 41(9):888 - 894.

Chakraborty, A.K. and Subbuyan, R.(1969). Grazing studies in arid and semi arid zones of Rajasthan. Role of reserve pasture for summer grazing. Indian. J. Anim. Sci. 39:519-523.

Chanost, W.(1972). Seasonal variations in amount of feed eaten by goats in humid tropical environment. Ann. Zootechns. 21:108-111. c.f. Ghosh, T.K.(1981). Ph.D.thesis,B.C.K.V.

Chandra, R. Clapham, H.M. McNaught, M.L. and Owen, E.C.(1951) Use of chromium sesquioxide to measure the digestibility of carotine by goat and cows.J.Agri.Sci41(112):179.

Chaudhury, H.P.S. and Majumder, B.N.(1962) Comparative usefulness of the ∅ indicator technique in digestibilities in d7fferent species of animals. Ann. Biochem. Explt.Med. 22(12):297.

Chaturvedi, M.L.(1971). Determination of pasture consumption.A new regression method for determination of pasture consumption by lambs. Indian Vet. J.48(5):489.

Clark, J.L.; Hembry, F.G.; Thomson, G.B. and Preston,R.L.(1972). Ration effect on polythelene glycol as a rumen marker J.Dairy Sci. 55:1160.

Cook, C.W. and Harris, L.E.(1951). A comparison of the lignin ratio technique and chromogen method of determining digestibility and forage consumption of desert range plants by sheep J. Anim. Sci. 10:565.

Coleman, S.W.; Neri Flores, O; Allem, A.J.Jr. and Moore, J.E. (1986) Effect of pelleting and maturity on quality of two subtropical forages. Indian. J. Anim. Sci.42:259.

Coleman, S.W.; Pate, F.M. and Beardsby(1976). Effect of level of supplemental energy fed growing steer on performance during pasture and subsequent dry lot period. J.Anim. Sci. 42:27-35.

Cornelius, C.E. and Bishop, J. (1969). Serum Transaminase activity in domestic animals. Cornell Vet. 49:116.

Corbett, J.L. Greenhalgh, J.F.B. and McDonald, A.P.(1958) Paper as carrier of chromium sesquioxide. Nature Lond. 182:1014.

Cross, D.L.; Luduruk, R.L.; Boling, J.A. and Bradley,N.W.(1974) J.Anim. Sci. 38:404, c.f. D.C. Church Digestive physiology and nutrition of ruminants Vol. 2 of B books Inc.

Dabadghao, A.K.; Raj Das and Mudgal, V.D.(1971). Effect of feeding urea on haematological and chemical composition of blood growing heifers. Indian. J. Anim. Sci.41:906-909.

Dabadghao, A.K.; Upadhyayay, V.S.; and Rekib, A.(1976). Meat production form Barberi kids grazed on cenchrus siratra pasture with or without concentrate supplementation Indian Vet. J. 53:536-546.

Das, B.R.(1981). Studies on the efficiency of utilization of certain nutrients in Black Bengal goats under free and confined condition. Ph.D. thesis, B.C.K.V.

Dehman, J.J.; Hutlet, C.V.; Price, D.Am and Everson, D.O.(1976) Effect of dry lot and pasture management of ovulation rate and production in panama ewes. Indian J. Anim. Sci. 42:427-238.

Devendra, C.(1967). Animal production and improvement Malay. Outb. Agric. 5:167-171.c.f. Anim. Breed. Abst. 35:2157

Doker, J.D., Marten, G.C., Jordan, R.M. and Bhargava, P.K. (1976) Effect of drying on forage quality of alfalfa and Reed Cannary grass fed to lambs Indian J.Anim. Sci. 42:180-184.

Djafar, R.I. and Chanfook, Y.(1972). Nutritive value of four green grasses in Malayasia. Malayasiau Agri. Res 1(2) 110-117.

Edin, H.(1918). Cutral onstalt for soksvasendent Jodbruks. Medd. Nr. 105. c.f. Schurnch A.F.(1950) J. Nutr. 41:629.

Egan, A.R. and Kellaway R.C.(1971). Brit. J.Nutri. 26:335. c.f. D.C. Chmeh. Digestive physiology and nutrition of ruminants vol. 2 B. Inc.

Ellot, R.C. and Topps, J.H.(1963). Voluntary intake of low protein diet by the sheep. Anim. Prod. 5:269-276.

ElMog, G.A.(1976). A comparative study of desert goats and sheep in efficiency of food utilization world Review of Anim. Prod. 12 : 3-43.

Elseraphy, A.M. Refaat, 1; Khattab, H.M.; El-Ashry, M.A.; Soliman, M.A., Motany, W. and El-Serafy, A.M. (1982). Productive performance of local goats fed on ration with different roughage concentrate rationsl III. Milk Production and composition. Ind. J. Anm. Sci.52:866.

Faichney, G.J. (1972). J. Agric. Sci. 19:493(cited from Singh, R.B.(1974). M.Sc(Ag) thesis, West Bengal.

Faroda, A.S. and Patil, B.D.(1975). A note on micronutrient on cenchras grass. Ind. J. Anim. Sci. 45(5):299-300.

Fels, M.E. Moir, R.J. and Rossiter, R.C.(1959). Herbage intake of grazing sheep in south western Australia. Aust. J. Agric. Res. 10:237-247.

Frontenot, J.P., Miller, R.F. and Price, N.O.(1964). J. Anim.Sci. 23:875(abster). c.f. Church, D.C.(1979). Digestive physiology and nutrition of ruminants Vol. 2 Nutrition 2nd Edn. O+B Book Inc. 1215. N.W. Cline Place Corvalis Oregon 97330, USA.

Fiske, C.H. and Subbahow, Y. (1925). J. Biol. Chem. Colorimetric determination of phosphorus 66:375 c.f. Osser,B.L.(1965) Hawk's Physiological chemistry. 14th Ed.McGraw Hill Publ. Co. Ltd. New Delhi.

Gallagher, J.R. and Shalton, M.(1972). Efficiencies of conversion of feed tof fibre of Angora goats and Rambonillet sheep. J. Anim. Sci. 34:319-321.

Gallup, W.B. (1928). The digestibility of the proteins of some cotton seed products. J. Biol. Chem. 76:43.

Georgin, A.; Koustantineskin, O.; Vligaine,P.D.(1964).Effect of different green fodders on quality of milk . Mol. Mjas, ,Skot 645, c.f. Nutrition abst. Review 35:11516.

Ghosh, T.K.(1981). Studies on water turn over, water requirements and nutrient utilization of Black Bengal goats in different seasons both under stall fed and grazing conditions Ph.D. thesis, B.C.K.V.

Ghosh, T.K.; Bhattacharyya, B. and Moitra, D.N.(1981). A note on cellular and serum biochemical constituents of blood in Black Bengal kids. Ind. Vet. Med. J.5(2):95-97.

Ghosh, T.K.,Bhattacharyya, B., Sinha, R. and Moitra, D.N.(1982) Effect of lactation length of composition of milk in Black Bengal kids. Ind. J. Dairy Sci 35(4):433-35.

Ghosh T.K. and Moitra, D.N.(1986). Measurement of plane of nutrition in grazing and stall fed goats in different seasons Indian J. Anim. Nutr. 3(1):40-42.

Gohan,E.A.(1976). Intake, digestibility and nitrogen utilization of torpical natural grass hay by goats and sheep. J. Anim. Sci. 43:879-883.

Gupta, D.C. and Jackson, M-G.(1968). Effect of feeding lucern on milk yield and composition as compared to barseem feeding Indian J. Vet. Sci. 38:311.

Gupta, B.N. and Majumder, B.N.(1962). Studies on indirect method of determining feed digestibilities and herbage intakes of grazing animals. Part II Pattern of excretion of chromic oxide in the faeces of grazing animals vis-a-vis stall fed animals. Ann. Biochem. Expt. Med. 22:91.

Gupta, P.C. and Prodhan, K. (1975). A note on comparative nutritive value of legumes and non legumes forages. Indian J. Anim. Sci. 45(5):290-291.

Guyton, A.C.(1976). Text book of medical Physiology. 8th Ed. P. 1021. W.B. Stauder Co. Philadelphia PA.

Haenlien,G.F.W.(1980) Mineral nutrition of goats - a review J. Dairy Sci. 63(10) : 1729-1748.

Hafez, E.S.E.(1968). Adaptation of domestic animals. Lea and Febiger, Philadelphia.

Hagsten Perry, T.W. and Outhouse, J.B.(1976). Supplemental needs of pregnant ewes withered on fescure pasture. J. Anim. Sci. 43:369-372.

Hale, E.B.; Duncan, C.W. and Huffmen, C.F.(1939). Proc. Amer. Soc. Anim. Prod. 32:389.

Hamada, T.; Hayakawa, H. and Makaaka, K.(1973). Feed value, ruminald decomposition. Intake of affalfa hay cube and Italian ryegrass hay by goat. Bull.Natiohal Ins. Anim Husbandry, No. 28 : 11-15.

Hamilton, T.S.; Mitchell, H.H.; Kick, C.H. and Carman, G.G. (1927-28) 41st Annual Report Illinnis Agri. Expt. Station P. 119

Hardison, W.A., Reid, J.T., Martin, C.M., and Wool'folk,P.G. (1954). Degtee of herbage selection by grazingc cattle J. Dairy Sci. 37:89.

Harmeyer, J. ; Martens, H. 1980) ; Aspects of urea metabolism in ruminant with reference to thegoat review : J. of dairy Sci. : 63(10) : 1707-1728.

Hill, E.W. and Anderson, D.L.(1958). J. Nutrition 6A:687(c.f. R.B. Singh (1974) M.Sc(Ag) thesis, West Bengal.)

Hodges, E.M.; Peacock, F.M.; Chapman, H.L.Jr. and Martin,F.G. (1977). Grazing studies with penisula bahia grass and worm season annual legumes. Soil Crop Sci. Soc. Fla. Proc. 36:173-175, c.f. Biol. Abst. 1978 63(5):249-279.

Holescheck, J.L.; Vavra, M. and Piper, R.D.(1982). Methods for determining nutritive quality of range forage ruminant diet - a review. J. Anim. Sci. 54:363-373.

Holeschek, J.L.; Vavra, M.; Skovlin, J.(1981). Diet quality and performance of cattle on forest and grass land roughage. Indian J. Anim. Sci. 53:291-298.

Hossain, W.(1950). Nutrition of goats. Ar. Pakist. 10:299-307

Ischii, T.; Snsmi, M.; Masatoshi,,H.; Yoshimasa, K. and Horotoshi, T.(1979). Raoghage feeding system of dairy beef sturs II Raising Holstein sturs by continuous pasturing. Bull Fac. Agric. Taranagawa Univ. 18:89-92. c.f. Biol.Abst. (1980) 69(2) : 7069.

James, C.S.(1978). Studies on goat nutrition Kerala J. Vet. Sci. 2:192-195.

Jaynal, M.Ml and Johri, S.B.(1977). Nutritive value of sunhemp (cnotalaria Juncia) hay. Indian. Vet. J. 54:82-83.

Jindal, S.K. Maths, A.K. and Rao, M.V.N.(1979). Effect of high energy supplementation on nutrient utilization and energy balance during growth in goat. Indian. J. Anim. Sci. 49: 652-655.

Johari, C.B. and Talapatra, S.K.(1971). Growths studies with Jamnapuru goats, II Jamnapari kids under browsing and stall feeding condition. Indian Vet. J. 48:495-500.

Joshi, D.C. and Ludri, R.S.(1970). Studies on sheep nutrition 2, plane of nutrition of grazing sheep during different months. Indian Vet. J. 47:1089-1194.

Joshi, D.C.(1985). Makarakari grass as feed for sheep. J.Vety. Physiology and Allied Sci. 4(2):33-36.

Joshi, B.C.; Aravinda, M.K., Singh and Bhattacharyya, N.K. (1977). Effect of high environmental temperature stress on physiological response in bucks. Indian J. Anim. Sci. 47(4):200-208.

Kane, E.A., Jacobson, W.C. and Moore, L.A.(1952). Diurnal variation of chromic oxide and lignin. J. Nutr. 47:263.

Kakan, M.L.; Chakraborty, S.C. and Mishra, B.(1969). Serum enzymes in the Indian livestock phosphate in blood serum of Hariana cattle and Murrha buffaloes. J. Res. Ludhiana 6:394-399.

Kameoka, K.; Takaharhi, ,S. and Monimoto, H.(1956). Variation in the excretion of chromic oxide by ruminants. J. Dairy Sci. 39:462.

Khan, M.S.; Sasidharan, T.O. and Ghosh, P.K.(1979). Glomerular filtration rate. blood and urinary urea concentration in Barwer goats of Rajasthan Desert. J. Aggi.Sci. U.K. 93(1) : 247-248.

Khan, B.U. and Sahani, K.L.(1983). Nongenetic sources of variation on milk production traits in Jamnapari goats under semi arid farm conditions. Ind. J. Anim. Sci. 53(7):776-778.

Khan, M.S., Sasidharan, T.O and Ghosh, P.K.(1979). Glomerular filtration rate, bloodand urinary urea concentration in Barmer goats of Rajasthan Desert. J. Agri. Sci. U.K. (93(1):247-248.

Kiron, A.H.; Paterson, D.J. and Mackerth, V.(1977). Live weight of formed feral goats. (Capra hircus). Newzealand J. of Expl. Agriculture. 5(1):7-10.

Kumar, S.; Usha, R.M.; Singh, K.B.(1980). Effect of dietary protein fractions and plasma urea nitrogen. Indian J.Anim. Sci. 50(2):146-150.

Kundu, Hl; Panda, N.C. and Saha, B.K.(1983). Leaves of gyna dulcis (Malinatamarind) fodder for goats. Indian. J. Anim. Sci. 53(6) : 669-671.

Kwaitkowski,T. and Pres. J. (1975). Influence of high nitrogen fertilization of pasture on metabolism and changes of blood constituents of dairycows changes in the blood picture. Polskie Archewam Weterynaryjne 18(3):445-454. c.f. Nutr. Abst. Review Series B. 177 Vol. 47(2):7128.

Lambourne, L.J. (1957). Measurement of feed intake of grazing sheep. (1) rate of passage of inert reference materials through the ruminant digestive tract (2) the estimation of faecal output by using marker J. Agri. Sci. 48:273.

Landh, G.(1958). Acta Chirurgica Seaudinavica Suppl. 231:15 c.f. R.B.Singh (1974). M.Sc.(Ag) Thesis,W. Bengal.

Landland, J.P. and Donald, G.E. (1977). Efficacy of wool production of grazing sheep. Forage intake and its relationship to wool production. Aust. J. Exp. Agri. Husb. 17(85):247-250.

Langland, J.P.; Bowles, J.E.; Donald, G.E. and Smith, A.J.(1982) Nutrition in ruminants grazing native and improved pasture. V. Effect of stoking rate and soil injestion on copper and selinium status of grazing sheep. Aust. J. Agric. Res. 33:313-320.

Linzell, J.L.(1968). Magnitude and mechanisms of uptake of milk precursors by the mammary gland. Proc. Nutr. Soc. 27:44.

Lippke, H.(1980). Forage characteristics r lated to intake, digestibility and gain by ruminants. J. Anim. Sci. 50:952-961.

Lodge, G.A. and Pell, A.S.(1968). Use of hay as complete diet for lactating dairy cows. Proc. II. World confer as animal production. c.f. Rayden.

Lorrey, H.C., Macambell, H.C. and Calvirt, G.V. and Beaty. E. (1976) Effect of previous treatment and energy levels on finishing yearlings steers on winter pasture.Indian J. Anim. Sci. 42:260.

Louw, G.N., Steen Kamp E.I. and Steen Kamp C.W.P.(1966). South Afr. J. Agri. Sci. 19:749. c.f.

Machado,M.A. and FerreinaNeto, J.M.(1981). Total blood protein electrophoretic pattern and blood fibrinogen on confined and semi confined goats. Arquivos da Escola de veterinaria da Universidade Federal de Minas Gerais 33(2):247-254. c.f. Veterinary Bulletin(1982). 52(8):5165.

Mackenzie, D.(1980). Goat Husbandry PP 139 4th Edn. Oxford and IBH Publ. Co. New Delhi, Bombay,Calcutta.

Maheswari, M.L. and Talapatra, S.K.(1975a) Stall feeding Jamnapari goats with cowpea fodder. Indian Vet.J. 52(1): 30-33.

Maheswari, M.L., and Talapatra, S.K.(1975b). Barseem as fodder for milch goats. Indian Vet. J.52:113-114.

Manston, R.; Kitechenham, B.A. and Baldry, A.F.(1977). Influence of system of husbandry upon the blood compositions of bulls and steers reared for beef production Br.Vet.J. 133(1):37-45.

Marcos, E.P.(1980). Blood values related to liver function in Dairy cattle. Total cholesterol and asperate amino-transferase. Gaceta Veterinaria 42(353):537-545. c.f. veterianry Bulletin(1981) 51(7):4550.

Mathur, M.L., Ghosh, S.N. Sampath, S.R.(1963). Studies on para grass (Penicum labinode) Effect of replacing 25% production ration (concentrate) with para grass on milk and fat production in milch cows. Indian J. Dairy Sci. 16:9

McGregor, B.A.(1980). Growth and composition of wetner goat carcasses. Anim. Production 13:345 - 348.

McGurie; Bradly, N.W. and Tittle, C.O.(1966). J.Anim. Sci. 25: 185. c.f. Nutr. Abst. and Revies. 42(3)1972.c.f. Das, B.R. (1981). Ph.D. thesis, B.C.K.V.

Majumder, B.N.(1960). Studies on goat. Minimum protein requirement of goats for maintenance endogenons urinaryi introgen and metabolic faecal nitrogen excretion studies. J. Agri. Sci. 54:329-334.

Majumder, B.N., Gupta, B.N. and Kehar, N.D.(1962). Studies on indirect methods of determining feed digestibilities and herbage intakes of grazing animals. Part I use of chromic oxide as indicator for estimating faecal output of animals. Ann. Biochem. Expt. Med. 22:13.

Morand, Fehr, P. and Sauvant, D.(1980). Composition and yield of goat milk as affected by nutritional manipulation. Indian J. Dairy Sci. 63:1671-1680.

Morris, J.G.(1980). Assessment of sodium requirements of grazing beef cattle - a review. J.Anim. Sci. 50:145-152.

Mostaghni, K. (1979). A note on haemoglobin type and some blood mimerals of goat (Capra hircus) in Iran. Indian J.Anim. Sci. 49(10):857-858.

Mukundan, G.; Bhat, P.N. and Khan, B.V. (1982). Variation in body weight gain in malbari goats and their saanen halfbreeds in humid tropics. Indian J. Anim. Sci. 52(12): 1193-1197.

Munro, H.N. and Allison, J.B.(1964). Mammalian protein metabolism vol. 1 pp. 72. Academic Press, New York, Lond.

Murtuza, M.; Pandey, M.D. and Rowat, J.S.(1980). Studies on certain clinically inport serum enzymes. Indian J. Anim. Health 19(2) : 137-141.

Murty, V.N. and Kehar, N.D. (1951). Ind. J. Physioll Allied Sc. 5 71.

Nabi,S.G.(1980). Nutritional Studies on sheep under range condition Indian Vet. J. 57(8) : 648-653.

Nasks, A.S.; Malechek, J.C.(1981). Digestion and utilization of nutrients in oak browse by goats. J.Anim. Sci. 53:283-290.

Natelson, S.(1957). Microtechniques of clinical chemistry for routine laboratory. C.C. Thomas, Spingfield p. 381. c.f. Varley, H.(1976). Practical clinical Biochemistry 4th Edn. p. 161-162. Gulab Vazirani for Arnold Heinemann.

Nath, K. and Malik, N.S.(1970). Chemical composition and nutritive value of tibalus terrestris. L. Ind. J. Anim. Sci. 40:434-437.

Nelson, Nand, Somogyi, M.(1952). ~~Chemical composition and nutri~~- Practical clinical Biochemistry, 4th Ed.P. 89-90. The English Language Book Society and W. Hememann Medical Book Ltd. G.B.

Nelson, A.B. and Green G.R.(1969). Excretion of chromic oxide administered in paper to steers fed prairie hay Anim. Sci. 29:365.

Nooruddin, Roy, C.N. and Jha, G.D.(1975). Studies on digestibility and nutritive value of marvel (Dicanthium Annulatum)grass at the flowering stage. Ind. Vet. J. 52-350-353.

Oser, B.L. (1965). Hawk's Physiological chemistry, 14th Ed. Tata McGraw Hill Publishing Co. Bombay, New Delhi.

Osser, B.L.(1954). Hawk's Physiological chemistry 13th Ed. Tata McGraw Hill Publishing Co. Bombay, New Delhi.

Pachauri, V.C.; Agarwala, O. and Mahadovan, V.(1970). Nutritive value of Dhub (Cynodon dactylon) hay for adult sheep. Ind. Vet. J. 47:782-785.

Pal, R.N.; Pachauri, V.C. and Negi, S.S.(1975). Studies on yield composition and nutrive value of Pennisetum pedicellatum forage. Ind. J. Anim. Sci. 45(11):817-822.

Pandey, J.N.; Joshi, H.B. and Pal, A.K.(1971). Nutritive value of Akra for adult sheep Ind. J. Anim. Sci. 41:100-104.

Pandiya, S.C., Dwaraknath, P.K. and Rathor, S.S.(1975). Studies on serum calcium, inorganic phosphorus and alkaline phosphatase activity in cross breed dairy cattle. Indian Vet. J. 54:130-133.

Pant, H.C. and Roy, A.(1971). Effect of two levels of green barseem in the diet of rumen microbiol and biochemical activities of buffaloes. Ind. J. Anim. Sci.41:231-254.

Parontaud,C.(1979). Some constituents of blood plasma of dairy cows and their behaviour at the time of calving. These Ecole Natfonale Veterinarid, Alfor't pp. 33. c.f. Veterinary Bulletin (1971). 51(7):4560.

Parthasarathy, M.; Singh, D.; Rowal, P.S.(1983). Effect of supplementation performance of weaner kids Ind. J. Anim. Sci. 53(6):671-672.

Patnayak, B.C.; Mohan, M. and Bhatia, D.R.(1979). A note on nutritive value of cowpea, moth(dewgeram) and clusterber fodder fed as hay to sheep.

Peterson, L.G. and Waldern, D.E.(1981). Repeatability of serum constituents in Holstein-Friesians affected by feeding, age, lactation and prēgnancy. J. Dairy Sci. 64:822-831.

Pollan, C.E.; (1970). J. Dairy Sci. 53:607-1578. c.f. D.C.Church Digestive physiology and nutrition of ruminants Vol. 2,0 and B Benks Inc.

Prosad, D.(1964). Studies on the chemical composition, digestibility and nutritive value of Basul pods(Acaciaarubica) Ind. Vet. J.41:418-42.

Pyne, A.K. Duttagupta, R. and Moitra, D.N.(1982). Physiological studies on blood of Black Bengal goat. Ind.Vet. J. 59-597-599.

Pyne, W.J.A.(1966). Studies of ruminants in tropics. - revies. Nutr. Abst. Review 36:635-670.

Rai, G.S. and Pandey, M.D.(1979). Effect of three dietary regimes on nitrogen fractions in blood Indian Jr. Anim. Res. 13(1):53-55.

Rakeb, A.(1979). Effect of feeding natural grasses and barseem hay on the growth rate and nutrient utilization by barbari kids. Indian Vet. J. 56:784-788.

Raymond, W.F. and Minson, D.J.(1955). The use of chromic oxide for estimating the faecal production of grazing animals. J. Brit. Grassland. Soc. 10:282.

Razdan, M.N.(1972). Low concentration and high forage ration for dairy cattle-review article. Ind. J.Anim. Sci. 42(5): 321-333.

Razifard, R.(1972). Pattern of blood plasma magnesium and urine of magnesium underfed lactating goats . Indian. J. Anim. Sci. 42(11):935-37.

Reid, B.L.,Powell, K., Ballasco, J.A. and McCornick, C.C.(1978) Performance of lambs on perennial rye grass, smooth broom grass, orchard grass and tall fescue pasture 1. Live weight change. dogestono;otu amd intate of herbage J. Anim. Sci. 46:1493-1502.

Reid. J.T. Woolflok, P.G.Richards, C.R. Kangnan, R.W.Loosli, J.K. Turk, K.L., Miller, J.I. and Blaster, R.E.(1950) A new indicator method for determination of digestibility and consumption of forages by ruminants. J.Diary Sci. 33:60.

Reinhold, Steward and Gilman(1950). 117th Meeting of the American Chemical Society c.f. Osser, B.L.(1965). Hawk's Physiological chemistry pp. 210 14th Edn. Tata McGraw Hill Co. Bombay, New Delhi.

Rook, F.J.A. and P.C. Thomas(1983). Nutritional Physiology of Farm Animals Longman Lond. pp. 162.

Roe and Kahn (1929). J.Biol Chemistry 81:1. c.f. Osser B.L. (1954). Hawk's Physiological chemistry 13th Edn. Tata McGraw Hill Co. Bombay- New Delhi.

Saha, G. and Sadhu, D.P.(1971) A study on the urea content of the blood of goat on diet containing optimum level of dry matter and 13% crude protein. Proc. Indian. Sci. Congr. Association 58th Session P.III Abstr. 709.

Salo, M. L. (1958) Mataloust Aikokansk 30:97

Sanderson, I.D. Mcfanlane, J.D. and Mcranns, W.R.(1980).The growth rates of weaned lambs grazing three legume based pasture during summer. Aust. J.Of Expt. Agric. and Animal Husbandry. 20(102) : 9-14.

Sapargatiev, G.S. and Dzarikbaev, A.(1969). Doki Vses, Akad Setshohoz, Nank No. 8:33.

Sastry, V.B.S. and Mahajan, J.M.(1978). A note on growth rate of Gaddi and Crossbred weaners lams on white clover and rye grass mixtures with or without concentrate supplementation Indian. J.Anim. Sci. 48:546-547.

Sauvant, D. and Bas, P.(1979). Biochemical profiles of milch goats Applications and limitations. Dossiers de L & Levage 3(3):45-54, c.f. Vet. Bull (1980) 50(9): 6131.

Saxena, J.S. and Maheswari, M.L.(1971). Studies on Jamnapari Goat. Comperative untake of nutrients by ~~mm~~ browsing goats. Indian Vet. J.41:173-175.

Shaffer, H., Rouseel, J.D. and Koonee, K.L.(1981) Effect of age, temperature, season and breed on blood characteristics of dairy cattle. J.Diary Sci. 64:6270.

Sharma, A.K., Thakaria, K.Sarmah P.C. Borah, H.P., add Pant, K.P.(1981) A note on growth of local Assam Goats Indian. J.Anim. Sci. 51(6):669-672

Sharkarnaryan (Late) K.A. Dadahao, P.M., Upadhyaya, V.S. and P. Rai (1975) A note on Utilization of spear grass pasture. Monthly variation in yield, chemical composition and performance of withers. Indian. J. Anim. Sci. 45(2) : 92-95.

Sharma, K.M. and Kidwai, W.A-(1971) Effect of dirrerent levels of feeding on the mortality due to parastites, growth and maturing in cross breed combs Indian Vet. J. 48:349.

Sherry, M.P., Venm, T.L; Smidf, M.K. and Huetcheson, D.P. (1978) Dietary protein to carotry ration and fat sources for neonatal pigs reared antificially with subsequent performance II serum variable. J.Animal Sci. 46:1267-1275.

Sinha, K.N., Martz, F.A. Johnson, H.D. and Hahn, H.(1970) J.Anim. Sci. 30:467.

Singh, C.S.P. Singh, D.K. Singh, S. Nath, S.; Mishra H.P. (1983) Growth rate in Crossbred and pure bread Black Bengal goat. Tropical Vet. and Vet. and Animal Sci. Res. I: 63-68.

Singha, S.P.S. : Nazki, A.R.; Sodhi, S.P.S. and Pattan, P.J.S.(1986) Studies on the effect of seasonal environments on some of the plasma enzymes in ewes. J.Vety. Physiol. and Allied Sci. 5(1):39-41.

Singha, R., Gupta, P.C. Vidyasagar and Pradhan, K. (1975). Chemical composition of cell wall in vitro dry matter and cell wall digestibility of important grasses. Indian J.Anim.Sci. 45(6) :339-349.

Singh, R.A.; Prosad, L.K. Singh, D.K. and Verma S.K. (1986) Indian Vet. J. 63:74-75.

Singh, C. and Bakeb, A(1979) Effect of feeding natural grasses and Barseem hay on the growth rate and nutrient utilization by Barberi Kids. Indian. Vet. J. 56:786-788.

Singh, C. and Bakeb, A (1980). Nutritive value of berseem hay prepared by three different methods.Indian Vet. J.57(1) :1025-1031.

Singh, A.P. Upadhyaya, V.S. Verma, N.C. and Rakeb (1974) Nutritive value of M.P. Chari at different stages of maturity. Indian J.Anim Sci. 44(3): 153-56

Singh, Smith, A.M. and Reid. J.T.(1955) Use of chromic oxide as nonindicator for feacal output for purpose of pasture harbage by grazing goat. J.Diary Sci.38:467.

Smithson, L.J. : Essing, H.W.; Withers, F.T.Jr. (1976). Influence of initial weight of steers on rye grass pasture. J.Anim. Sci. 42:261.

Snedecor, C.W. and Cochrum, W.C. (1967). Statistical methods, 6th Edn.

Somogyi (1945). J.Biol. Chemistry 160:62.

Sood, D.R. and Chopra, A.C.(1973). Oxalate content of common grass. Indian J.Anim. Sci. 43(6):476-479.

Sperber, I., Hyden, S. and Ekman, U.(1953). Hogsk, Ann. 20:337

Spitzer, J.C., Niswender, G.D. Seidel, G.E.(1978). J.Anim. Sci. 46:1071-1077.

Srivastava, S.K. Rayan, S.K. and Patak, W.N. (1979). Effect of feeding all roughages ration during early life on growth and nutrient utilization and feed conversion effciency in crossbred calves(Bosin dicus x Bostaurus) Indian. J.Anim. Sci. 49(7):499-503.

Srivastava, J.P.(1972). Chemical composition and nutritive value of pasture. Indian Vet. J. 49:516-518.

Srivastava, V.S. and Talapatra, S.K. (1962). Pasture studies of Utter Pradesh, Use of some natural indicators to determine plane of nutrition of grazing animals. Indian J. Dairy Science 15:154-160.

Stillings, B.R., Bratzler, J.W., Marriott, L.F. and Miller, R.c. (1964). J. Anim. Sci. 23:1148. c.f. Church D.C. (1979) Digestive physiology and nutrition of ruminant vol. 2 Nutrition 2nd Edn. O+Book Inc. 1215 N.W. Klive/ place Corvalis Oregon 97330, USA.

Stonekar, H.K. (1985) Beef production in tropics I. Extensive production system on unfertile soil J.Anim. Sci. 41:1218-1227.

Sutoh, H. : Vchida, S. : Mojakos, K(1972). Studies on silage making. The relationship between the growth stage quality of the green goats, Scientific reports of the faculty of agriculture. Okayama University 10:25-33

Swenson, M.J.(1977). Dukes' Physiology of domestic animals. 9th Edn. 12:82.

Talapatra, P.M.: Purohit, L.P. (1978). Comperative studies on nutritive value of hybrid napier NB 21 fodder as green silage and hay. Indian. J.Animal Sci. 48(8) : 563-565.

Talapatra, S.K. and singh, C.P.(1961-62). Interview Report of Jamunapuri Goat Scheme ICAR New Delhi.

Taylor, EL.(1934)

J.Comp. Path. 47:235.

Thonny, M.L. : Duhaime, D.J.; Moe, P.W. and Reid, J.T. (1979) Acid insoluble ash and permanganate lignin as indicators to determine the digestibility of cattle rations. J. Anim. Sci. 49(4):1112.

Topsy, J.Teeluck, J.P. and Hulman, B.(1983). Effect of diet composed entirely of green feed on the growth of young male Anglo-Nabian goats.

Tropical Vet. J. 1:25-28.

Tumbleson, M.E., Barker, M.F. and Wiggfield, W.E.(1973) Serum protein concentration as function of age in female dairy cattle.

Cornell Vet. 63:65-67.

Verma, S.D.(1967). Biochemical studies of goat blood. Indian Vet. J. 44:759.

Vidan, V.S. and Rai, P.(1983). Metabolic profiles at different physiological stages in goat. Indian J.Vet. Med. 3(1): 1-8.

Walker, B.(1977). Productivity of macroptilium atroparpureum C.V. Siratro pasture. Trop. grassland. 11(1) : 79-86.

Wildt. E.(1874) J. Furland Wirtschaft 22: 137.

Wilkinson, J.M. and Presscott, J.H.D.(1970). The use of chromic oxide in the measurement of individual feed intake in cattle fed on silage and barley. Anima. Prod. 12:71.

Wilson, P.N. (1957). Studies on browsing and reproductive behaviour of east African dwarf goat. East. Agr.J.27:135-147.

Wilson, K.: Cook, R.M. and Riw, T.(1976). Use of high altitude grassland in equator for cattle production. Indian J.Anim. Sci. 43:338.

Wire-Austin, W.D.(1963). Napier grass for milk production in trans Nazoia E.Afri Agri Fer J. 28:223. c.f. Razadan, M.N. (1972). Indian J.Anim. Sci. 42(5):321-333.

Winter, W.H.L., Edye, A. and Williams, W.T.(1977) Aust. J. Exp. Agri. Anim. Husb. 17(85): 187-196

Wooton, I.D.P.(1982). Micromanalysis in medical biochemistry London, Churchill, Livengstone.

Yatzidis, H.(1960). Measurement of transaminases in serum Nature, Lond. 186: 79-80.

****