EFFECT OF WEANING AGE ON PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS

Thesis

Submitted to the Guru Angad Dev Veterinary and Animal Sciences University in partial fulfillment of the requirements for the degree of

MASTER OF VETERINARY SCIENCE
in
LIVESTOCK PRODUCTION MANAGEMENT
(Minor Subject: Animal Nutrition)

By

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CERTIFICATE – I

This is to certify that the thesis entitled **“EFFECT OF WEANING AGE ON PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS”** submitted for the degree of **M.V.Sc.** in the subject of **LIVESTOCK PRODUCTION MANAGEMENT** (Minor subject: **ANIMAL NUTRITION**) of the Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana is a bonafide research work carried out by **Amarinder Jit Singh Brar (L-2012-V-11-M)** under my supervision and that no part of this thesis has been submitted for any other degree.

The assistance and help received during the course of investigation have been fully acknowledged.

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CERTIFICATE – II

This is to certify that the thesis entitled, **"EFFECT OF WEANING AGE ON PERFORMANCE OF BEETAL KIDS UNDER STALL-FED CONDITIONS"** submitted by **Amarinder Jit Singh Brar (L-2012-V-11-M)** to the Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, in partial fulfillment of the requirements for the degree of **M.V.Sc.** in the subject of **Livestock Production Management** (Minor subject: **Animal Nutrition**) has been approved by the Student's Advisory Committee along with the Head of the Department after an oral examination on the same, in collaboration with an external examiner.

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ABSTRACT

The present study with the objective to compare three different ages of weaning and their effects on the growth performance of Beetal goat kids was carried out under the climatic region of Ludhiana, Punjab. Total 24, 5-day old kids were divided into two treatment groups one weaned at 60 days of age (T_{60}) and other at 75 days of age (T_{75}) along with one control group following routine practice of weaning at 90 days of age (T_{90}). The animals considered under the present study were subsequently observed for various parameters such as meteorological, daily milk, feed and fodder intake, morpho-metric measurements, hematological responses, biochemical indicators and various enzymatic activity indicators in serum. The results indicated that kids of T_{60} group had achieved numerically highest body weight and daily weight gain followed closely by those of T_{90} group and lowest by those under T_{75} group. Moreover, there was no significant difference for the values of all the above mentioned parameters due to treatment effect. The cost of production of unit body weight gain was minimum at 60 days (Rs.76/kg gain) followed by 75 days (Rs.88/kg gain) and maximum at 90 days (Rs.96/kg gain) of weaning. Weaning at 60 days and 75 days were also able to spare 22.29 kg and 12.05 kg milk, respectively, for human consumption. It is concluded that early weaning among Beetal goat kids at the age of 60 days could be adopted without compromising growth, overall health and cost of production per unit weight gain.

Keywords: Beetal goat kids, Weaning, Growth

Signature of Major Advisor

Signature of Student

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS USED

µg	:	microgram
µl	:	microlitre
ADF	:	Acid Detergent Fibre
ADG	:	Average Daily Gain
ADL	:	Acid Detergent Lignin
AIA	:	Acid insoluble ash
ANOVA	:	Analysis of Variance
BAHS	:	Basic Animal Husbandry Statistics
BUN	:	Blood urea nitrogen
CLIA	:	Chemiluminiscence Immuno Assay
CP	:	Crude Protein
CRSC	:	Creatinine
DLC	:	Differential Leucocyte Count
DM	:	Dry Matter
DMI	:	Dry Matter Intake
EDTA	:	Ethylene diamine – tetra acetic acid
EE	:	Ether Extract
et al	:	Et alia (and others)
FCR	:	Feed Conversion Ratio
Fig.	:	Figure
GADVASU	:	Guru Angad Dev Veterinary and Animal Sciences University
gm	:	gram
Hb	:	Haemoglobin
kg	:	kilogram
ml	:	millilitre
mmol/L	:	millimole per liter
N	:	Nitrogen
NaOH	:	Sodium hydroxide
NDF	:	Neutral Detergent Fibre
ºC	:	Degree Celsius

OM	:	Organic Matter
PCV	:	Packed cell volume
RH	:	Relative Humidity
rpm	:	Revolutions per minute
SPSS	:	Software Package for Social Sciences
TA	:	Total Ash
TDN	:	Total Digestible Nutrient
TLC	:	Total Leukocyte Count
Wt.	:	Weight

CHAPTER I

INTRODUCTION

Worldwide, goat is considered as important specie for its contribution to the development of both rural and urban people. Importance of goats lies in the fact that human population is increasing very rapidly leading to increased demand for animal protein on one hand, however, feed resources are very meager on the other for animals. Since the demand for feed resources is comparatively less for goats as compared to large animals therefore, there is ample scope for increase in goat population.

In India, goat has been designated as the national meat animal as it does not have any religious or cultural taboos. As per Livestock Census of Department of Animal Husbandry Dairying and Fisheries, Government of India, the world's goat population during 2007 was around 868.00 million, out of which India possessed 140.54 million (16.19%), which was second largest after China (149.38 million), (BAHS, 2012). However, as per FAOSTAT-2012, the current goat population of India is around 160.00 million and stands first in the world. This is indicative of progressive goat industry in India. Goat meat production in the country has increased from 4.7 lakh tons to 5.96 lakh tons during the last decade (2002 to 2011) with an annual growth rate of 2.4%. Similarly, goat milk production in the country has also increased from 36.4 to 45.9 lakh tons during the same period with an annual growth rate of 2.6 %. The country stands first in goat milk production and the second largest in goat meat in the world by sharing 29% & 12% production, respectively. Punjab has approximately 0.29 million goats, representing 0.21 per cent of Indian goat population. In Punjab, there was decline in goat population by about 33 per cent during 2003 over 1997 (GOI, 2003).

Despite having important position in the Indian livestock, still goat production is in the hands of poor farmers. Moreover, the poverty, lack of education, unawareness towards scientific management and rearing practices affect the economic viability of goat farming. Perhaps high kid mortality is the major hindrance for not starting many large-scale goat farms. Kid mortality may be very high when weaning is not practiced on scientific lines. The moment of weaning is a critical phase for rearing kids, which is accompanied by a decreased or complete stagnation of weight gain and other problems like stress, impaired immunity and in turn overall health of the weaned kids.

The level or degree of weaning shock primarily depends on age and weight of the kids at the time of weaning. Other factors contributing to weaning shock include feeding program before weaning, sex and health status of kids. However, age alone is not a sufficient criterion for weaning. In fact, in many instances weight is a better indicator than age. As a thumb rule, weaning can take place when birth weight is tripled. Weaning can be a time of great stress, and blood glucose levels have been shown to fall from 1.2g/litre to 0.68g/litre, mainly as a result of the energy deficit (Bas *et al* 1992). Many systems of rearing kids can be used, depending upon management capabilities and facilities. The objective should be to raise kids, without increasing the likelihood of disease, mortality or to reduce economical cost on optimum growth rates.

Keeping this perspective in mind, as well as to overcome the problem of shrinkage of grazing lands due to urbanization and industrialization, intensive system (stall-feeding) is now a days adopted by most of the farmers of state and country. Under this system, early weaning is generally adopted to enhance the productive and reproductive efficiency of dam. Early weaning eases the lactation stress of both high-producing and highly stressed (due to age or any physical condition) females. Moreover, early weaning enables females to return to breeding condition earlier.

Secondly, goat milk is a valuable product as it is easily digestible due to smaller size of fat globules and serves as a ready source of family nutrition preferably to infants, aged and sick persons. Since ancient times goat milk has traditionally been known for its medicinal properties and has recently gained more importance in human health due to its proximity to human milk for easy digestibility and its all-round health promoting traits. Demand for goat milk and milk products for internal consumption and export is expected to rise further in coming years due to scientific validation. Moreover, from an economic standpoint, it is said that it is less expensive to feed kids than to feed dams and their offspring. It has also been reported in many studies that young animals convert feed very efficiently into weight gain and physiological growth of various organs especially rumen.

Keeping in view the aforementioned facts and challenges, there is immediate need to explore a midway weaning practice so that goat kids can be weaned successfully without adverse effects on their growth and health of kids, reproduction efficiency of dam as well as we can support ever increasing demand of goat milk by public. Therefore, the present study was planned with following objectives:

1) To study the effect of weaning age on performance of goat kids.
2) To study the relationship between weaning age, severity and duration of weaning stress in Beetal kids.
3) To workout economic viability of kids weaned at different ages.

CHAPTER II

REVIEW OF LITERATURE

Weaning can be a multi-factorial stressor, in which nutritional, social, physical and psychological stress are combined. During the weaning process, the lambs like piglets (Campbell *et al* 2013) and calves (Enriquez *et al* 2011) experience changes in their physical and social environments. Physical and nutritional stressors are often present through the introduction and adaptation to a new diet and new environment, whereas, psychological stress is present in the form of maternal separation and social disruption (Earley and McGee 2011).

Body weight and body measurements

Fehr (1991) and Ugur *et al* (2004) investigated the effect of early weaning of lambs based on body weight and growth performance of lambs and reported negative correlation between higher body weight and halt of growth due to weaning shock.

Nagpal *et al* (1995) weaned 82 kids of Sirohi, Marwari and Kutchi breeds at either on 60 or 90 days of age, randomly alloted to intensive or semi-intensive feeding systems to study post-weaning performance until 180 days of age. Weaning at 3 months of age and feeding intensively was more expensive compared with weaning at 2 months of age and rearing under a semi-intensive system. The latter system also resulted in surplus milk for human consumption.

Palma and Galina (1995) tested two weaning ages: one with an abrupt early weaning at 10 Kg; the other with late partial weaning until body weight reached 15 Kg. They concluded that faster growth could be obtained if milk was supplied for a longer period than the usual abrupt weaning at 10 Kg. However, in both the systems, animals could be available for breeding at 8-9 months of age and to kid at 13-14 months of age. Late-weaned kids performed significantly better reaching the goal 1 month before the early-weaned kids, which was a strong recommendation for the investment.

Kugonza *et al* (2001) conducted the study to estimate the contribution of parental phenotype to body weight gain at different ages in indigenous goats and during the pre-weaning period of kids. The results indicated that males had a significant faster growth rate averaging 39.1g/day over the females which might be due to male hormones which positively influence the growth.

The Scientific Committee on Animal Health and Animal Welfare (SCAHAW, 2001) recommends a more careful management of the early weaned calves than the late weaned calves. From various studies, it was reported that age at weaning affects the subsequent growth, feed intake and efficiency of calves (Myers *et al* 1999)

Ferreira and Thornton (2004) studied the feed intake and growth of Saanen kids weaned at 42 and 70 days of age and reported that final body weight, average daily gain and feed conversion efficiency did not differ significantly between weaning age. They concluded that weaning at 42 days of age proved to be effective. Kids underwent no post-weaning shock and had the same final weight as the 70 day weaning treatment at 140 days of age.

Villarroel *et al* (2008) conducted a research trial to study the effect of weaning age as well as weaning weight on post-growing rate, to estimate the optimal weaning age and weaning weight of Morada Nova–white variety breed lambs raised under extensive system. Lambs weaned with at 60, 75 and 90 days of age showed non-significant differences on post weaning growth. However, weaning weight had a significant influence on lamb weight. The group weaned at 9-10.4 Kg body weight had smaller live weight than those weaned with 10.5-12.4 Kg or above 12.5 Kg. It was concluded that body weight at weaning is more important than age at weaning on post-weaning growing of lambs and should be considered on weaning decision. It was recommended that the minimum body weaning weight for white Morada Nova lambs reared in extensive conditions should be over 10.5 Kg.

Ward *et al* (2008) conducted an experiment on twenty four Ossimi male lambs (body weight 3.75Kg of one week age) assigned two feeding groups (natural vs early rearing). In natural rearing the lambs were left to suckle their dam's until 12 weeks of age and served as a control group, while in other groups lambs were early weaned at 8 weeks. Early weaned lambs recorded significantly higher final live body weight due to their higher daily gain during their later life in comparison with the natural weaned group lambs.

Aksakal *et al* (2009) studied the effects of weaning at different ages on growth characteristics and body measurements of Awassi lambs. The lambs were weaned at different ages such as 45, 60 and 75 days. There were significant differences for live weights and daily weight gains in 46 and 61 days at the end of the grazing period. Lambs weaned at age of 75 days had higher values in terms of body measurements on day 60 and 120 compared to those weaned at the age of 45 as well as 60 days, respectively. Based on the research findings, the best time of weaning for the Morkaraman lambs was concluded to be 60 days of age. However, if ewes are to be milked, weaning age could be shorten to 45 days.

Memisi *et al* (2009) investigated the effect of time of weaning on body mass and gain of kids. They reported that the lowest body weight at the end of the experiment was recoded for kids weaned at 20 days of age. Highest body weight at age of 180 days was found in kids weaned at 60 days. From the established results it was concluded that kids can successfully be weaned as early as 35 days of age, and that weaning at an earlier age should not be done due to lack of economical validation and huge mortality encountered along with poor growth rate of kids.

Abbas *et al* (2010) studied the growth performance of Rahmani and Chios Lambs weaned at different ages viz., weaning at 8 weeks of age (early weaning), at 12 weeks of age (normal weaning) and at 16 weeks of age (late weaning) and reported that early and normal weaned lambs were heavier than the late weaned lambs with non- significant difference between the breeds of lambs. Weaning system had a significant effect on body weight at 3 and 4 months of age. After four months of age, the weaning systems did not differ significantly in terms of weight up to one year of age. Weaning system had a significant effect on average daily gain.

Shi-Gang *et al* (2010) planned and conducted an experiment to study the effect of early weaning time (early weaning at either 40 days or 60 day) on biochemical indicators in serum of lambs of Xinjiang breed which were compared and analyzed with those of Kazak and Bayinbulbuk lambs i.e. local sheep breeds in China. It was concluded that early weaned Bayinbulbuk lambs had better growth performance as compared to those of other two breeds when weaned early.

Knights *et al* (2012) conducted two experiments to assess the effect of time of weaning on lamb growth, in which lambs were weaned either early (EW; 76 or 108 days of age for Experiments 1 and 2, respectively) or late (LW; 186 and 159 days of age for Experiments 1 and 2, respectively). The effect of time of weaning on average daily gain showed a significant quadratic period × treatment interaction ($P < 0.001$). The average daily gain of the EW-lambs declined after weaning for approximately 2 months, followed by an increase in average daily gain. In contrast the average daily gain in the LW-lambs did not change significantly or declined slowly prior to weaning, but showed a sharp decline following weaning. The overall average daily gain and total live weight gain tended to be or was higher ($P < 0.01$) in EW lambs as compared to sharp decline in average daily gain following weaning in LW-lambs. It was concluded that management systems in which ewes are re-bred 2.5–3.5 months after lambing and lambs are reared continuously with ewes until market at 6.5–7.5 months of age may offer producers an opportunity to maximize the productivity of the ewes in terms of the Kg of lamb marketed annually.

Abdel-Fattah *et al* (2013) studied the effect of weaning age (either early weaning at 60 days or late weaning at 120 days of age) on productive performance of Barki lambs. They concluded that productive performance was better for lambs weaned earlier than those weaned at late age. The effect of weaning age on lamb growth the results indicated that, early-weaned lambs had better body weight gain than those late-weaned between the 5th and the 8th month (fattening period) by about 2.64 and 0.98 Kg for male and female lambs, respectively. Late weaned lambs which had longer suckling period (4 months) did not show better post-weaning performance than those weaned earlier. Sex had significant effect ($P<0.01$) on live body weight and average daily gain at both the weaning ages. The final weight in males was heavier than that in females.

Abdel-Fattah *et al* (2013) conducted a trial to compare two systems of weaning viz., weaning at 60 days of age or at 120 days of age in Barki lambs. The results indicated that live body weight of males tended to be significantly greater than females in both early and late-weaned groups throughout the experimental period. However, early weaning system had improved growth performance of lambs compared to those weaned at age of 120 days i.e. late weaning.

Hashem *et al* (2013) carried out a study to determine the effects of weaning age on growth performance of male Barki lambs. The lambs were divided into two equal groups and weaned either at 60 (early weaning group) or at 120 days of age (late weaning served as control group). The results indicated that early weaned lambs had a highly ($P<0.01$) significant effect on live body weight and had higher values of average daily gain at the beginning of the 6 month up to the end the of experimental period compared with late weaned lambs.

Ramakrishnappa *et al* (2013) studied the influence of weaning age on post-weaning growth performance in Mandya lambs. Lambs were randomly allocated to one of the three groups (Gr-I: lambs weaned at the age of eighth week; Gr-II: lambs weaned at tenth week of age and Gr-III: lambs weaned at twelth week of age) and reported that there was no significant difference in post-weaning growth either in terms of live body weight or average daily gain, between the groups. The overall growth in male lambs during post-weaning was significantly higher than that of female lambs. They concluded that young Mandya lambs could be successfully weaned as early as two months of age.

Dry matter, feed and fodder intake

Nagpal *et al* (1995) studied the effect of weaning age and feeding system on growth performance and carcass traits of male kids in three breeds. It was reported from the experimental trial that weaning at 3 months of age resulted in higher ($P < 0.01$) body weights at 3 and 6 months of age because of the higher intake of milk.

Palma and Galina (1995) made an attempt to develop a feeding system that would produce female kids to start breeding early, at 7-8 months, with average body weight of 30 Kg. Two weaning ages were tested: one with an abrupt early weaning at 10 Kg; the other with late partial weaning until BW reached 15 Kg. It was concluded that faster growth could be obtained if milk was supplied for a longer period than the usual abrupt weaning at 10 Kg. However, in both systems, animals could be available for breeding at 8-9 months of age, to kid at 13-14 months of age. Nutritional management with alfalfa hay and commercial concentrates was feasible in cost and for early reproduction. Therefore, nutritional and management systems to obtain early reproduction in kids are recommended to use high-quality forages.

Sevi *et al (*2003) suggested that the lambs subjected to a gradual separation from their dams exhibited a lower growth rate than dam-suckled lambs ($P<0.01$) and artificially reared lambs ($P<0.05$, $P<0.001$). The hay and concentrate consumption was not enough to bridge the gap in growth rate between the lambs gradually separated and other lambs. They concluded that provision of *ad libitum* of a milk substitute having a nutritional value comparable to ewe milk may minimize the stress associated to artificial rearing.

Ferreira and Thornton (2004) investigated the effect of weaning age (42 *vs.* 70 days) on the feed intake and growth performance from seven to 140 days of age, using 58 male Saanen kids. Only feed intake, cumulative feed intake, dry matter (DM) intake and cumulative DM intake differed significantly in the creep (days 7-80) period. The creep intake (days 7-80) of the 42 day weaning treatment was 48%, which was significantly higher than the 70 day treatment due to creep feed replacing milk intake thus establishing weaning at 42 days of age to be effective.

Abou Ward *et al* (2008) reported that two important factors viz., speed with which the rumen develop in lambs and partly the level of milk production of the dams, determine the success of early weaning.

Memisi *et al* (2009) investigated the effect of time of weaning on body mass and gain of kids. Kids were weaned at 2, 20, 35 and 60 days, respectively and after weaning (either at 2 or 20 days), kids were fed milk replacer containing 22% protein up to 35 days of age while late weaned (either at 35 or 60 days) and fed concentrates and hay. The lowest body weight and highest mortality was faced by kids weaned either at 2 or 20 days. They concluded that kids can successfully be weaned as early as 35 days of age, and that weaning at an earlier age should not be done under our conditions, since it is not economically justified due to separation from their mothers and initiation of feeding with milk replacers.

Abdel-Fattah *et al (*2013) reported that weaning of lambs at 60 days of age had a strong influence on the ability of weaned lambs to earlier adaptation on solid foods as they can digest and utilize feed better resulting in promotion of lamb growth.

Hashem *et al* (2013) carried out a study to determine the effects of weaning age (weaned either at 60 or at 120 days of age) on growth performance, feed intake and carcass characteristics. The results indicated that, Barki lambs had physiological capability to use solid diets at 60 days of age and can be successfully to weaned at early age (60 days).

Carcass Characteristics

Nagpal *et al* (1995) while studying the effect of weaning age and feeding system on growth performance and carcass traits of male kids in three breeds reported highly significant (P<0.01) changes in pre-slaughter weight, hot carcass weight, enhanced dressing percentage, loin eye area and decreased bone percentage.

Hashem *et al* (2013) randomly selected and slaughtered eight rams of each weaning age (60 or 120 days) to assess carcass characteristics after 4 months fattening period. The results revealed that early weaned lambs had superior (P<0.01) carcass weight (7.44%) and tailed hot carcass weight (20.04%). All internal organs (liver, kidneys, heart, spleen, lung with trachea and testis) weights were approximately similar in early and late weaned lambs. Results obtained showed that tail and intestinal fats were significantly (P<0.01) affected by weaning age, where as early weaned lambs tended to deposit greater amounts of fat into the tail but, late weaned lambs tended to deposit greater amounts of fat into the intestinal region.

Health and survivability

The first, activation of the hypothalamus-pituitary-adrenal axis, results in a significant release of the steroid hormone, cortisol, from the cortex of the adrenal glands. Systemic cortisol concentrations increase several minutes after a perceived threat and can last for a number of hours. The immunosuppressive effects of cortisol, which is a potent glucocorticoid, may serve as physiological down regulators of initiated immune responses during recovery from infection or tissue damage (O'Connor *et al* 2000).

Ferreira and Thornton (2004) reported no problem associated with health and mortality in reared kids while studying the effect of weaning age on feed intake and growth of Saanen kids weaned at 42 and 70 days of age.

Memisi *et al* (2009) investigated the effect of time of weaning on body mass and gain of kids. It was concluded from the study that kids weaned at the age of either 2 days or at the age of 20 days encountered huge mortality especially at the time of separation from their dams and initiation of feeding with milk replacers as compared to their late weaned counterparts.

Physiology and Blood profile

Physiology

Abdel-Fattah *et al (*2013) studied the effect of weaning age on thermoregulatory traits and concluded that weaning age had no significant effects on thermoregulatory traits (Rectal Temperature, Surface Temperature, Respiration Rate and Heart Rate) which were more associated with the change in climatic conditions throughout the experimental period.

Hematology

Health and welfare of animal can easily be identified by its reference value as given in following table:

Parameter	**Jain, 1986**	**Cynthia, 2010**
PCV (%)	22.0-38.0(28.0)	22.0-38.0
Hb (g/dl)	8.0-12.0(10.0)	8.0-12.0
TLC (10^3/µl)	4.0-13.0 (9.0)	4.0-13.0
Lymphocyte (%)	2.0-9.0(5.0)	2.0-9.0
Neutrophil (%)	1.2-7.2 (3.2)	1.2-7.2
Eosinophil (%)	0.5-6.5 (4.5)	1.0-8.0
Monocyte (%)	0.0-5.5(2.5)	0.0-4.0

Hickey *et al* (2003) studied the effect of abrupt weaning of male and female calves on the leukocyte concentration and concluded that there was no effect of weaning on leukocyte concentration. The neutrophil:lymphocyte ratio increased ($P < 0.01$) after weaning.

Fozia Shah *et al* (2010) conducted a study with an objective to establish normal haematological values in male Beetal goats at various physiological stages of life. The haemoglobin, total erythrocyte count, total leucocyte count and packed cell volume were maximum in pre weaning stage as compared to post weaning, pre pubertal and post pubertal stages of the study. The values of haemoglobin, total leucocyte count and packed cell volume did not exhibit any significant change at any of stage except pre-weaning period in the study.

Antunović *et al* (2012) studied the influence of age on changes of some blood parameters of lambs and concluded that with increasing age of the lamb, number of WBC (leucocytes) and RBC (red blood cell) as well as the content of haemoglobin in blood, significantly increased in the blood of older lambs in comparison with the younger lambs. With increasing age of lamb, the number of WBC and RBC as well as the blood content of haemoglobin and haematocrit significantly increased. Higher number of platelet content and mean corpuscular volume and lower content of Mean corpuscular haemoglobin (MCH) and Mean corpuscular haemoglobin concentration (MCHC) were found in the blood of the older lamb in comparison with the youngest lamb. They also concluded that in lamb production the age must be taken as a very important factor in determining metabolic profile of blood.

Abdel-Fattah *et al* (2013) studied the effect of weaning age on changes in hematological parameters of Barki lamb and reported significant (P<0.01) decline in hematological parameters (RBC's, Hb, PCV, MCV, MCH and MCHC) with the advancement of animal age. Female lambs had slightly higher (P<0.01) values in RBC's, Hb and PCV than males under both the two weaning ages, results indicated that weaning age has no significant effect on total circulating leukocyte count and subset percentages.

Plasma metabolites

Reference value of serum biochemical attributes of kids is as under through which welfare of the animals can be assessed:

Parameter	**Kaneko, 2008**	**Cynthia, 2010**
Glucose (mg/dl)	50.0-75.0	48.0-76.0
Cholesterol (mg/dl)	80.0-130.0	65.0-136.0
Creatinine/CRSC (mg/dl)	1.0-18.0	0.7-1.5
Blood Urea Nitrogen /BUN (mg/dl)	10.0-20.0	13.26
ALT/SGPT (μ/l)	6.0-9.0	15.0-52.0
AST/SGOT (μ/l)	167.0-513.0	66.0-230.0
GGT (μ/l)	20-56	20-50

Shi-Gang *et al* (2010) studied the effect of early weaning on biochemical indicator in serum of Xinjiang local sheep breeds in China and reported that early weaned lambs had decreased activity of various enzymes reflected from the level of alanine aminotransferase (ALT) and aspartate aminotransferase (AST) and Lactate dehydrogenase (LDH) in serum. Low level of these enzymes in serum had the positive effect on the liver function and had strong anti-stress ability after weaning.

Abdel-Fattah *et al (*2013) reported that level of urea in plasma in lambs dropped at weaning and slowly increased with the ingestion of feed and development of the rumen which may be attributed to the effect of the separation between lambs and their dams and sudden shift from liquid to solid feeding which influenced the appetite of lambs.

Antunović *et al* (2012) studied some blood parameters within the blood serum of lambs either during suckling i.e., 30th day or during fattening period i.e.,70th day. The results of some blood metabolites in the lamb production indicated that the age must be taken as a very important factor in determining metabolic profile of blood. With increasing age of lamb, body mass increase as a consequence of and intensified the metabolic activity resulting in increase in ALT enzyme activity in serum of lambs. Similar observations for the activity of ALT and GGT have been obtained by Mohri *et al* (2007).

Bas *et al* (1992) studied the changes in lipid content, fatty acid composition and lipoprotein lipase activity in dry goat adipose tissue in omentum according to tissue site and reported that weaning can be a time of great stress and blood glucose levels have been shown to fall from 1.2g/litre to 0.68g/litre, mainly as a result of the energy deficit.

Serum hormonal profile

Demir (1995) investigated the growth pattern of Kivircik lambs weaned at different times and reported that time of weaning accompanied by stress caused drop in feed consumption thus decreasing the growth rate and modifying the body composition.

Hickey *et al* (2003) conducted a study with the objective to examine the effect of abrupt weaning (inclusive of social group disruption and maternal separation) on the physiological mediators of stress and measures of immune function. It was reported that abrupt weaned suckler calves were sensitive to the social stress associated with group disruption and weaning. Abrupt weaning increased plasma cortisol and nor-adrenaline concentrations which may be attributed to differences in age at separation, breed, or animal management in particular since the animals in this study were subjected to continued rather than intermittent separation from the dam. Since the alterations in immune function and hormonal mediators of stress were still evident, 7th day post-weaning, farm management practices at weaning should aim to minimize the social distress of calves during this time and allow calves a period of adaptation before other management stresses are imposed.

Shi-Gang *et al* (2010) studied the effect of early weaning on growth and reproductive hormones in serum of Bayinbulbuk ewe and reported that early weaned lambs can increase the stress resistance of the body.

Redondo *et al* (2010) evaluated the changes in concentrations of some histo-physiological parameters of the pineal gland of goat kids in situations of stress due to early weaning. It was reported that concentrations of cortisol in plasma were significantly higher in weaned than in non-weaned goat kid that could increase susceptibility to disease.

Magistrelli *et al* (2013) analysed the weaning-induced stress in Saanen goat kids. One group was weaned at 48 days and other was un-weaned and reported that after weaning fasting plasma cortisol level was significantly lower, whereas plasma activity of both ALT and AST was significantly higher in weaned kids, in relation to the un-weaned ones. Therefore, differences observed in cortisol, ALT and AST could be the consequence of the metabolic changes that occur during the transition from pre-ruminant to ruminant state. The gradual weaning at 48 days of age did not result in any stressful condition. Moreover, stress indicators such as cortisol or aminotransferase activity can vary in relation to the physiological status of the animals thus could not give true interpretation of stress.

Weaning and Economics

Palma and Galina (1995) studied the effect of early and late weaning on the growth of female kids and reported that profit from goat meat under early weaned group was more as compared to their counterparts under late weaned group. However, kids in later group had greater physiological growth as compared to gain in profit. It was further concluded that 33% higher cost per goat was incurred to achieve 30 kg under late weaning compared to those under early weaning group.

Chandrahas (2011) analyzed that cost-benefit ratio for Beetal kids under stall-fed conditions remains in the range of 1:1.69 to 1:1.92. Similarly, Mann (2013) had reported a cost- benefit ratio 1:1.66 for Beetal kids reared after feeding of natural colostrums under stall-fed conditions.

Nagpal *et al* (1995) studied the effect of weaning age and feeding system on growth performance and carcass traits of male kids in three breeds. Kids were weaned at 60 and 90 days of age, and concluded that weaning at 3 months of age and feeding under intensive system was the more expensive compared with weaning at 2 months of age and rearing under a semi- intensive system. The latter system also resulted in surplus milk of 12.7 to 22.5 kg for human consumption.

Reproductive performance of dam

Early weaning of lambs was adopted as one of the efficient system to increase the frequency of lambing in order to enhance ewe productivity in both temperate and tropical hair sheep breeds. Early weaning might had allowed the ewes to bypass the inhibitory effects of the suckling stimulus on fertility or to reduce nutritional anestrous, associated with the high metabolic demand of lactation (Knights *et al* 2012). It was further reported that weaning after day-70 post partum, before or after introduction of the rams, did not improve any of the key reproductive performances indices.

CHAPTER- III

MATERIALS AND METHODS

EXPERIMENTAL DETAILS

Various methodologies used during the present study had been explained herewith under different sections given below.

3.1 LOCATION OF THE WORK

The present experiment was conducted at Goat Research Farm, Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana (Latitude: 30°54'North Longitude : 75°48' East), Punjab, India.

3.2 EXPERIMENTAL DESIGN

A total of 24 Beetal kids born at Goat Research Farm, Department of Livestock Production Management, College of Veterinary Science, GADVASU, Ludhiana were used in the present study. The kids spent 3 days with their dams following parturition (colostrum feeding period). The kids were allocated to one of the three treatment groups having 8 kids (4 male + 4 female) in each 5 days after birth.

Treatment	Weaning age (days)	No. of kids
T_{60}	60	8
T_{75}	75	8
T_{90}	90	8
The kids (both male and female) were reared under identical conditions of rearing except weaning age treatment. After weaning, early weaned kids were reared on creep feed		

3.3 HOUSING AND GENERAL MANAGEMENT:

Kids were kept in groups in an enclosure made up of wire meshed iron panels having an effective area of 1.44m^2. Feeders having dimensions (Length x Width x

Depth) of 1” x 8” x 5.5” (smaller) and 18” x 12” x 6” (Larger) were fixed in each enclosure, for concentrate feed and roughages, respectively, where height of feeder could be adjusted as per height of kid. These panels were fixed in two sheds having covered area of 9.4 m x 5.1 m and open area of 11.3 m x 9.5 m. Open area of shed was used for providing at least 4-5 hours exercise to kids. Additionally, there were at least two watering points in open area for free access of clean potable drinking water.

Five-day old kids were milk-fed @ 10% of their body weight up to weaning by baby feeder. Creep feed (CP 23.18 %) and green fodder (CP 8.12%) were introduced from 15th days onwards to all kids on *ad libitum* basis. Grower ration (CP 20.04%) was offered after weaning at 3-months of age on *ad libitum* basis. Creep or concentrate feed was offered in morning (10 A.M.) and fodder in evening (3.00 P.M.) hours (Table 3.1).

Table 3.1: Ingredient comparison and chemical composition (% DM) of the creep and growth diet

Composition	**Creep feed**	**Growth feed**
Physical composition		
Maize	37.00	40.00
Soybean flakes	33.00	27.00
Wheat bran	15.00	18.00
De-oiled rice bran	12.00	12.00
Mineral mixture	2.00	2.00
Salt	1.00	1.00
Crude Protein	22.56	20.24
Vitamin premix	25g/100kg	25g/100kg
Chemical composition		
Dry matter	91.30	89.94
Organic Matter	80.46	78.94
Crude Protein	23.18	20.04
Ether Extract	6.40	1.92
NDF	30.05	24.95
Ash	10.84	10.60

3.4 OBSERVATIONS RECORDED

3.4.1 Micro- and Macro-climate

Ambient temperature (AT ^{0}C) and relative humidity (RH%) were recorded daily at 7:30 A.M. in morning and 2:30 P.M. in evening. Similarly, outdoor temperature and relative humidity were recorded at same duration at Meteorological Observatory of Punjab Agricultural University, Ludhiana, was utilized for comparison between micro-and macro-climate for assessing the effect of climate on animals. The mean temperature-humidity index (THI) was calculated using the following equation.

THI=0.8 * AT ^{0}C + (RH%) * (AT ^{0}C - 14.4)/100 + 46.4 (Amundsan *et al* 2006)

Temperature-humidity index is commonly used as an indicator of the degree of climate stress on animals, where a THI of 72 and below is considered as no heat stress, 73-77 as mild heat stress, 78-79 as moderate and >80 as severe (Fuquay,1981).

3.4.2 Daily milk, feed and fodder intake

Daily milk, feed and fodder intake were measured by offering weighed amount of milk, concentrate and roughages to each animal and taking records of daily residue in case of concentrate and roughages.

3.4.3 Body weight

The kids were weighed at fortnightly intervals up to 180-days. Weight of animals was taken in the morning hours before feeding and watering on a 200-kg capacity digital platform weight bridge having 50g least count (Essae DS-45). **Average daily gain:** it is simply the rate of weight gain per day over a specified period of time

$$\text{ADG (g)} = \frac{\text{Body weight gain (g)}}{\text{Interval between two BW recordings (days)}}$$

PIC. 1: FEEDING TO THE GOAT KIDS DURING EXPERIMENTAL PERIOD

Milk feeding of goat kid with baby bottle

Green fodder feeding to the goat kids

Concentrate feeding to the goat kids

Feed Conversion Ratio (FCR): Feed conversion efficiency is expressed as feed conversion ratio (F.C.R.) and was calculated as gram of feed consumed per gram of body weight gain.

$$FCR = \frac{\text{Daily DM intake (g)*}}{\text{ADG (g)}}$$

Protein Efficiency Ratio (PER): The efficiency of protein utilization is expressed as protein efficiency ratio (P.E. R.) and was calculated as grams of body weight gain per gram of protein consumed.

$$PER\ (g) = \frac{\text{ADG (g) **}}{\text{Daily protein consumption (g)}}$$

* In calculation of FCR, milk DM (g) was included in total DM after multiplying milk intake (ml) by a factor 0.13, the total DM of goat milk, as per ICAR Handbook of Animal Husbandry (2002).

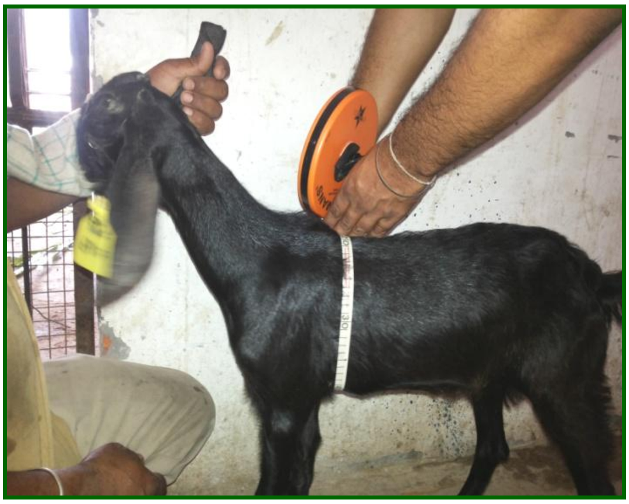
** In calculation of PER, milk protein was added to other protein, where total milk intake was multiplied by a factor 0.0352, value of goat milk protein, given by ICAR Handbook of Animal Husbandry (2002).

3.4.4 Body Measurements:

A flexible tape rule was used to measure the parameters *viz*. Body length (BL) distance from point of shoulder to the pin bone, height at withers (HAW) distance from the base of hoof to the highest point of withers; heart girth (HG) body circumference around the chest just behind the withers on top and just behind the elbows on the bottom, Paunch Girth (PG) body circumference around the paunch, height at rump (RH), measured as the distance from the ground to the rump, Hip bone width (HBW) was taken as the distance between the two pelvic bones and distance between hip and pin bone is also measured (Akcapinar 2000).

PIC. 2: BODY WEIGHT AND MORPHOMETRIC MEASUREMENTS OF GOAT KIDS

Weighing of kid



Measurement of heart girth

Measurement of body length

Height at wither measurement

3.4.5 Proximate Analysis of Feed and Fodder:

3.4.5.1 Preparation of samples

The samples of experimental diets were taken and finely ground in an electric grinder. The ground samples of the experimental diets were stored in plastic bags for analysis of proximate principles. The details of analytical procedure followed are as under AOAC (1997).

3.4.5.2 Dry matter:

A known quantity of the sample was taken in a pre-weighed dry silica crucible and dried in oven at $100^{o}C$ for overnight. The dried sample with crucible was weighed after being cooled in desiccator and dry matter was calculated as follows:

$$DM(\%) = \frac{\text{Wt. of crucible with oven dried sample} - \text{Wt. of empty crucible}}{\text{Wt. of the sample before drying}} \times 1000$$

3.4.5.3 Crude protein

Macro-Kjeldahl method was used for determination of nitrogen. A suitable quantity of finely ground material (0.2 g) was weighed and transferred into KEL PLUS® automatic extraction tube. The samples were digested with 10 ml conc. H_2SO_4 in presence of 5 g digestion mixture ($CuSO_4$:K_2SO_4:: 1:9) till appearance of light blue colour. After completion of the digestion, the tube was cooled and then transferred into steam distillation tube. Then 20 ml of 40% NaOH solution was added slowly into distillation flask and ammonia was trapped in 25 ml of 4% boric acid solution with mixed indicator (10 ml/litre) in a conical flask. The ammonia borate was titrated later with 0.1 N H_2SO_4. The crude protein percentage of the sample was calculated as follows:

$$N(\%) = \frac{(\text{ml } H_2SO_4 \text{ for sample} - \text{ml } H_2SO_4 \text{ for blank}) \times \text{Strength} \times 0.014}{\text{Wt. of sample}}$$

The crude protein of feed samples was calculated with the following formula

$$CP(\%)=N(\%) \times 6.25$$

3.4.5.4 Ether extract

About 2 g of the ground sample was weighed and quantitatively transferred into a thimble which is made of Whatman filter paper no.1. The sample with thimble was transferred to the extraction beaker of SOCS PLUS® six place automatic solvent extraction system. The extraction was carried out for 2 hours with 80 ml petroleum ether (b.p 60-80°C). After completion of the extraction process, the beaker was dried in the hot air oven at 100°C. The ether extract was calculated as follows:

$$EE(\%)= \frac{\text{Wt. of beaker with ether extract} - \text{Wt. of empty beaker}}{\text{Wt. of the sample}} \times 100$$

3.4.5.5 Crude fibre

The ether extracted sample of about 1 g was taken into the glass crucible. The sample was digested with 100 ml 1.25 of N H_2SO_4 for 45 minutes in FIBRA PLUS automatic fibre estimation system and washed with hot distilled water till it was acid free. It was again digested with 100 ml 1.25 of N NaOH for another 45 minutes and washed to make it free from alkali. The residue in glass crucible was dried for overnight in hot air oven at 100°C and weighed. Then the sample was ignited in muffle furnace at 500°C. The ash with crucible was cooled in desiccator and weighed. The loss of weight on ignition gave the crude fibre content of the material.

$$CF(\%)= \frac{\text{Wt. of crucible after oven drying} - \text{Wt. of crucible with ash after ignition}}{\text{Wt. of the sample}} \times 100$$

Charred over heater to make the sample smoke less. Ashing was done in muffle furnace at 700°C for 6 hours. The crucible with ash was cooled in a desiccator and weighed. The percentage of ash was calculated by using the formula given below:

$$TA(\%) = \frac{\text{Wt. of crucible with ash} - \text{Wt. of empty crucible}}{\text{Wt. of the sample}} \times 100$$

Organic matter = DM(%) – TA(%)

3.4.5.6 Acid insoluble ash

The ash was transferred into 100 ml beaker with about 25 ml of (1+1) HCl and heated over hot plate to reduce the volume to half. Again 5 ml of conc. HCl was added to the beaker and heated to complete dryness. Then added another 10 ml of (1+1) HCl was added into the beaker and heated for few minutes. The content of the beaker was filtered through Whatman filter paper no.1. The residue was quantitatively transferred from beaker to the filter paper and washed with distilled water till it is acid free. The residue along with the filter paper was kept in previously used silica crucible for ash estimation. Then it was charred over heater to make smoke less. Ashing was completed in muffle furnace at 700^{o}C for 6 hours. Then it was cooled at desiccator and weighed. The percent of acid insoluble ash was calculated as follows:

$$AIA\ (\%) = \frac{\text{Wt. of crucible with insoluble ash} - \text{Wt. of empty crucible}}{\text{Wt. of the sample}} \times 100$$

3.4.5 Haematological Attributes

3.4.5.1 Hematological parameters

Blood samples (5ml) were collected aseptically from jugular vein in the morning at 9:00 AM from day zero to the fifth months, at monthly interval, including pre and post weaning collection in EDTA coated vials (Accuvete Disposables) .The whole blood, immediately after collection, was used for determination of following parameters as described by Jain (1986).

a) Haemoglobin (Hb; g/dL) concentration was estimated using Sahili’s method.

b) Packed cell volume (PCV; %) was estimated by haematocrit centrifugation technique using capillary tubes.

c) Total leukocyte count (TLC; $x10^3/\mu l$) was determined using Neubar's counting chamber method (Benjamin 1985).

d) Differential leukocyte count (DLC; %) was performed manually under oil immersion of light microscope in blood smear stained by Wright Giemsa stain or/and Leishman stain (Jain 1986). For differential leucocyte count (DLC), a drop of blood was placed on a clean glass slide and a thin smear was prepared. These were air dried, fixed in methanol for 2 minutes and stained with Wright Giemsa stain (composition: Wright powder 300 mg, Giemsa powder 30 mg and methanol 100 ml) after diluting in ratio 1 : 10 with phosphate buffer (pH 6.8) for 30 minutes. Slides were washed under a jet of buffer from the wash bottle to remove the extra stain. Stained slides were air dried and examined under oil immersion to count 100 WBCs per slide.

3.4.5.2 Serum / plasma biochemical parameter

For serum samples, blood was collected, at monthly interval including pre- and post-weaning collection in fluoride and gel tubes for glucose and other biochemical parameters, respectively. Samples were centrifuged at 3000 RPM for 10 minutes and serum was separated in MCT (micro centrifuge tubes) tubes. The collected serum samples were kept at $-20\,^{o}C$ till it was further used for estimation of different biochemical parameters. Samples were thawed properly before estimation of biochemical parameters.

3.4.5.3 Blood biochemical analysis

VITROS DT-II Chemistry system (Ortho-Clinical Diagnostics, Johnson and Johnson Company) was used for estimation of following parameters.

a) Glucose	d) BUN	g) GGT
b) Cholesterol	e) Creatinine	
c) AST	f) ALT	

The principle of the procedure of each parameter is written below.

The VITROS DT Slide method was performed using the VITROS DT Slides and the VITROS Chemistry Products DT Calibrator Kit on VITROS DT60/DT60 II Chemistry Systems. The VITROS DT Slide is a multilayered, analytical element coated on a polyester support. A drop of patient sample is deposited on the slide and is evenly distributed by the spreading layer to the underlying layers.

3.4.5.3.1 Glucose (GLU; mg/dL)

The VITROS GLU DT Slide was used. The oxidation of sample glucose is catalyzed by glucose oxidase to form hydrogen peroxide and gluconate. This reaction is followed by an oxidative coupling catalyzed by peroxidase in the presence of dye precursors to produce a dye. The intensity of the dye is measured by reflected light.

3.4.5.3.2 Cholestrol (mg/dL)

The VITROS CHOL DT Slide is a multilayered, analytical element coated on a polyester support. The Triton x-100 surfactant in the spreadid layer aids in dissociating the cholesterol and cholesterol esters from lipoprotein complexes present in the sample. Hydrolysis of the cholesterol esters to cholesterol is catalysed by cholesterol ester hydrolase. Free cholesterol is oxidized to form cholestenone and hydrogen peroxide. Finally hydrogen peroxide oxidizes a leuco dye in the presence of peroxide to generate a colored dye. The density is measured by reflectance spectophotometry

3.4.5.3.3 Aspartate Aminotransferase (AST; IU/L)

The VITROS AST DT Slide was used. The spreading layer contains the AST substrates aspartate and α-ketoglutarate. In the assay for aspartate aminotransferase, the amino group of L-aspartate is transferred to α-ketoglutarate in the presence of pyridoxal-5-phosphate (P-5-P) to produce glutamate and oxaloacetate. Malate dehydrogenase (MDH) then catalyzes the conversion of oxaloacetate and NADH to malate and NAD^+. The rate of oxidation of NADH is monitored by reflectance spectrophotometry. The rate of change in reflection density is proportional to enzyme activity in the sample.

3.4.5.3.4 Blood Urea Nitrogen (BUN; mg/dl)

The VITROS BUN DT Slide was used. Water and non-proteinaceous components travel to the underlying reagent layer, where the urease reaction generates ammonia. The semi-permeable membrane allows only ammonia to pass through to the color-forming layer, where it reacts with the indicator to form a dye. The reflection density of the dye is measured and is proportional to the concentration of urea in the sample.

3.4.5.3.5 Creatinine (CRSC; mg/dl)

The VITROS CRSC DT Slide was used. Creatinine diffuses to the reagent layer, where it is hydrolyzed to creatine in the rate-determining step. The creatine is converted to sarcosine and urea by creatineamidinohydrolase. The sarcosine, in the presence of sarcosine oxidase, is oxidized to glycine, formaldehyde, and hydrogen peroxide. The final reaction involves the peroxidase-catalyzed oxidation of a leuco dye to produce a colored product. Following addition of the sample, the slide is incubated. During the initial reaction phase, endogenous creatine in the sample is oxidized. The rate of change in reflection density is proportional to the concentration of creatinine present in the sample.

3.4.5.3.6 Alanine Amino Transferase (U/L)

The VITROUS ALT DT slide is multilayered, analytical element coated on polyester support. A drop of sample is deposited on the slide and is evenly distributed by the spreading layer to the underlying layers. The spreading layer contains alt substrates L-alanine and sodium α-ketoglutarate. Aminotransferase catalyze the transfer of amino group of L-alanine to α-ketoglutarate to produce pyurate and glutamate. Lactate dehydrogenase then catlyses the conversion of pyurate and NADH to lactate and NAD^+. The rate of oxidation of NADH is monitored by reflectance spectrophotography. The rate of change in reflection density is proportional to enzyme activity.

3.4.5.3.7 Gamma Glutamyl Transferase (U/L)

The VITROUS GGT DT slide was used. GGT catalyzes the transfer of the Γ-glutamyl transfer portion of L-γ-glutamyl-p-nitroanilide to glycylglycine, simultaneously producing p-nitroaniline. The rate of change in reflection denisity is measured and is used to calculate the enzyme activity of GGT.

3.4.5.4 Serum hormonal attributes

The serum hormone Cortisol was estimated at monthly intervals from stored (-20^{o}C) serum samples after proper thawing, it is analyzed using Lumax™ Model 4101 ChemiluminiscenceImmuno Assay (CLIA) Strip Reader (Monobind, Inc. USA) using Acculite CLIA microwells (Monobind, Inc. USA) as per the protocol given in the Table 3.2.

Table 3.2: Chemiluminiscence Immuno Assay Protocol for Cortisol

Assay Steps	**Cortisol**
Standard/ Samples	13 µl
Working Tracer Reagent	25 µl
Mix	Plate was swirled for 1 min.
Biotin Reagent	25µl
Mix	Plate was swirled for 1 min.
Incubation	45 min (22-26^{0}C)
Wash	Decant and washed 5 times with 350 µl of wash buffer
Signal Reagent	50 µl
Incubation	5 min Room Temp.
Reading	Relative Light Unit (RLU) were read in each well in a microplate luminometer for at least 0.2 seconds/well

3.4.6 Health status

Prompt observations were made to individual diarrhoea status in the morning hours daily before cleaning of enclosures.

Morbidity, if any, was recorded daily and treated accordingly. In case of any mortality, dead animals were immediately sent for post-mortem examination to know cause of death.

3.4.7 Thermoregulatory Parameters

Rectal temperature (RT, °C) was measured by using a clinical thermometer which was inserted about 6-7 cm, into the animal's rectum for one minute. Respiration rate (RR, r.p.m) was measured as respirations per minute, by counting flank movements per minute. Heart rate (HR, b.p.m) was measured as beats per minute by using a clinical stethoscope from the joint point of left-front leg and body. All thermoregulatory parameters were measured at 7:00 AM on monthly basis.

3.4.8 Input-output records

The economics of production was calculated on the basis of cost of inputs like milk, feed, fodder, medicine, supplements etc. and the value of output from sale of live animals at the end of experiment. The cost of inputs and value of outputs were based on current prevailing price. Medicine cost was calculated @ Rs. 5.00/day for general ailments like diarrhoea, fever, common cold etc.

3.4.9 Statistical analysis

The collected data of different experiments was subjected to statistical analysis using Software Package for Social Sciences (SPSS version 16.0) available in the Library, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana. The recorded data were subjected to one way ANOVA (Snedecor and Cochran, 1980) to test the difference between various treatments. The significant means between different treatments were compared by Duncan Multiple Range Test (Duncan, 1955).

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CHAPTER- IV

RESULTS AND DISCUSSION

The result for present experiment for the completion of this study have been presented and discussed as per the observations enlisted in chapter III. The data for ambient temperature, relative humidity, average body weight, feed intake, FCR, PER, biochemical and hormonal parameters was recorded in this experiment have been represented in Tables 4.1 to 4.14.

4.1 Meteorological Parameters

Mean ±SE of monthly ambient temperature (AT^{o} C), relative humidity (RH, %) depicting the micro-climate and macro-climate during the study period (July, 2013 to February, 2014) is presented in Table 4.1.

Within shed, the difference between maximum and minimum temperature was between 1-6^{o}C, whereas, corresponding range for temperature in the outer surrounding was 6-12^{o}C. The relative humidity (RH) within the shed was higher in the morning than the evening hours. It was also observed that relative humidity during study period was above 70% in the period of July to October and December to February. The macro-RH was always higher in morning hours as compared to the micro-RH, which was indicative of better climate management within the shed.

It was also observed that minimum temperature was always higher during different months within the shed as compared to outer climate. Which may have created either stressful or comfortable environment depending upon the prevailing seasons throughout the study period which is evident from the THI values as presented in Table 4.2. The THI value (80 to 82) as an index of thermal comfort indicated that animals were under severe heat stress in first three months from July to September.

Table 4.1: Monthly micro- and macro-climate during the experimental period

Month	Temperature (^oC)						Relative Humidity (%)					
	Micro-climate			Macro-climate			Micro-climate			Macro-climate		
	Min.	Max.	Mean	Min.	Max.	Mean	Mor.	Even.	Mean	Mor.	Even.	Mean
July	28.21	32.06	30.13	27.7	34.81	31.26	77.31	73.18	74.41	82.25	64.39	73.32
Aug	27.78	30.93	29.35	26.42	32.94	29.68	84.9	74.35	79.63	89.1	69.77	79.44
Sept	25.52	31.88	28.70	24.14	33.75	28.95	82.0	69.5	75.75	84.9	61.4	73.15
Oct	25.37	28.29	26.83	20.02	31.04	25.08	74.80	66.00	70.40	90.70	49.40	70.00
Nov	22.96	23.25	23.10	10.20	25.90	18.00	61.36	62.03	61.69	91.7	37.2	64.50
Dec	15.36	15.80	15.58	7.40	20.00	13.7	67.45	66.09	36.77	93.5	54.8	74.1
Jan	15.33	15.69	15.51	7.00	17.50	12.20	72.58	72.87	72.72	95.60	62.30	79.00
Feb	15.12	16.37	15.74	10.07	18.30	14.18	70.12	71.62	70.87	95.93	71.85	83.89

Table 4.2: Mean ± SE of monthly climatic data throughout the experiment (July 2013 to February 2014)

Month	AT(^oC)	RH (%)	THI
July	31.20±0.40	70.50±1.33	82.33±0.55
August	28.75±0.34	74.00±0.95	81.75±0.43
September	28.25±0.32	73.00±1.14	80.19±0.45
October	23.50±0.36	69.50±1.51	76.71±0.59
November	23.50±0.35	62.50±0.92	70.11±0.52
December	11.00±0.56	71.50±1.16	59.51±0.78
January	15.50±0.20	71.50±0.62	59.63±0.29
February	15.00±0.19	70.50±0.44	59.95±0.24

AT=Ambient Temperature, RH=Relative humidity, THI=Temperature Humidity Index

However, THI value of 77 in the month of October showed mild stress on the kids. The kids were in thermal comfort zone as evidenced from THI value which ranged from 59-70 in the rest of period.

4.2 Daily milk, feed and fodder intake

The data pertaining to milk, feed and fodder fed during the experimental period have been presented in Table 4.3. All kids were offered measured quantity of dam's milk up to their respective weaning age. While comparing milk intake of all the groups up to weaning of T_{60} group (First weaning group), there was no difference in milk intake between different treatments. Concentrate feed intake was numerically higher (P>0.05) in T_{75} followed closely by T_{60} than T_{90} group. The difference between overall concentrate feed intake during entire study period was non-significant among all the treatment groups.

Table 4.3: Milk (ml/day) and daily dry matter consumption (g/day) by the kids under different treatments

Groups	Age(days)	Milk(ml/day)	Concentrate(gm/day)	Fodder(gm/day)
T_{60}	0-60	419.00 ± 0.77	19.89 ± 0.05	16.37 ± 0.39
	60-180	-	301.87 ± 0.02	175.51 ± 3.83
	Overall	**139.63 ± 0.29**	**207.84 ± 0.02**	**122.43 ±1.97**
	Total DMI	18.15 ± 0.04	187.06 ± 0.02	24.49 ± 0.39
T_{75}	0-75	448 ± 0.56	45.21 ± 1.40	23.42 ± 0.70
	75-180	-	325.00 ± 1.40	187.76 ± 0.59
	Overall	**186.52 ± 0.22**	**208.60 ± 0.50**	**119.37 ± 0.81**
	Total DMI	24.25 ± 0.03	187.74 ± 0.45	23.87 ± 0.16
T_{90}	0-90	528.83 ± 0.82	66.56 ± 1.65	27.80 ± 1.07
	90-180	-	330.71 ± 0.73	204.70 ± 1.03
	Overall	**264.40± 0.78**	**198.30 ± 1.13**	**116.19 ± 0.55**
	Total DMI	34.37 ± 0.10	178.47 ± 1.02	23.24 ± 0.11

NS= Non-significant (p>0.05)

The green fodder intake, which comprised of maize, Jowar, bajra (Sept, Oct and Nov) and oats (Dec and Jan), during study period was (P>0.05) was higher in T_{60} followed closely by T_{75} than T_{90} group. Total Dry matter intake (DMI) for milk, concentrate and fodder consumption ranged from 18.15- 34.37 ml/day, 198.30-208.6g/day and 116.19- 122.43 g/day among all the groups. The difference for DMI values was non-significant (p>0.05) in all the treatment groups.

4.3 Growth performance

Comparative productive performance in terms of live body weight (LBW), average daily gain (ADG), monthly growth rate (GR), dry matter intake (DMI) of

Beetal goat kids under different weaning groups has been statistically evaluated during the study period. The data on the average body weight (Kg) ± SE of male and female kids at birth, average daily gain (ADG) and monthly growth rate (GR) under different weaning treatments are presented in Table 4.4. At birth, kids weighed about 3.15 Kg in all the treatment groups. The results indicated that kids grouped in T_{90} achieved numerically lower body weight as compared to those under T_{60} and T_{75} groups up to one month. However, kids in T_{75} group slightly lagged behind with respect to live body weight immediately after weaning at 75 days of age than those in T_{60} and T_{90} groups. The graphical presentation of the data for average live body weight of kids under various treatment groups recorded at fortnightly interval has been given in Fig. 4.1. Overall, kids of T_{60} group which were subjected to early weaning at 60 days of age had achieved numerically highest body weight followed closely by those of T_{90} group and lowest by those under T_{75} group weaned at 75 days of age. Though, there was no significant difference in the body weight of kids at pre-weaning and post weaning periods under all the treatment groups.

The average daily gain (ADG) as depicted in Table 4.4 indicates trend of higher growth rate in both T_{60} and T_{90} treatment groups over T_{75}, though difference was non-significant. The average daily gain was 6.45% higher in T_{60} and T_{90} kids than those in T_{75} group. There was no difference in average daily gain among the kids of both T_{60} and T_{90} groups.

This equality in ADG is indicative of the successful response of early weaned kids to improve their performance compared with their late weaned counterparts (Fig 4.2). During the entire study period, the ADG of male kids was numerically higher (Fig. 4.3) though statistically non-significant than that of female kids irrespective of weaning at different age. The ADG values among male kids varied from 59 to 68 g $^{-1}$ d while range of ADG in female kids was 55 to 56g $^{-1}$ d under all the treatment groups. The male kids grew more by 6.7% and 7.4 %, respectively in T_{90} and T_{60} over T_{75} group. However, female kids of T_{90} group gained about 2.5% higher body weight than their counterparts in T_{75} and T_{60} groups during entire study period (Fig. 4.3).

Table 4.4: Average live body weight and daily weight gain of Beetal kids under various weaning treatments

Parameter	Days	T_{60}	T_{75}	T_{90}
Live body weight, Kg	0	3.20±0.11	3.21±0.11	3.19±0.18
	30	4.43±0.18	4.41±0.16	4.37±0.26
	60	6.83±0.29	6.83±0.31	6.58±0.35
	90	9.03±0.44	8.28±0.48	8.91±0.48
	120	10.23±0.56	9.75±0.53	10.11±0.49
	150	11.51±0.38	11.40±0.85	11.61±0.60
	180	14.28±0.62	13.59±0.87	14.19±0.80
Average daily weight gain, g/day	30	45.33±9.08	44.66±6.03	51.08±0.40
	60	89.58±14.52	93.75±14.48	74.16±11.58
	90	66.25±12.60	50.83±12.38	60.83±13.59
	120	51.66±9.32	47.00±31.90	47.33±10.34
	150	45.41±12.42	66.66±13.59	62.91±20.14
	180	125.00±11.63	88.58±9.02	108.91±23.12
	Over all	61.65±3.95	57.63±4.73	61.08±4.35

NS= Non-significant (p>0.05)

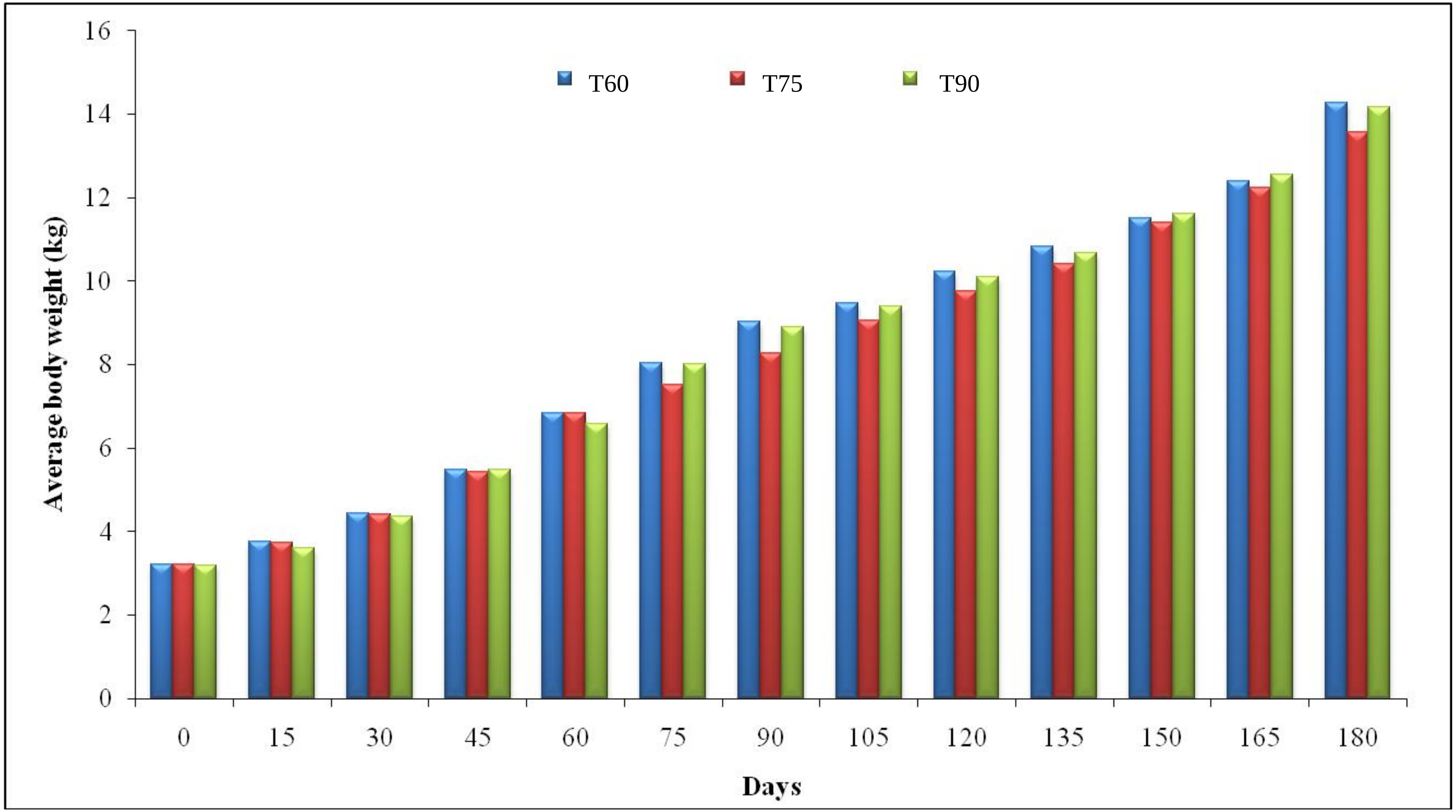

Fig. 4.1: Average body weight (kg) of kids at fortnightly interval in different treatments

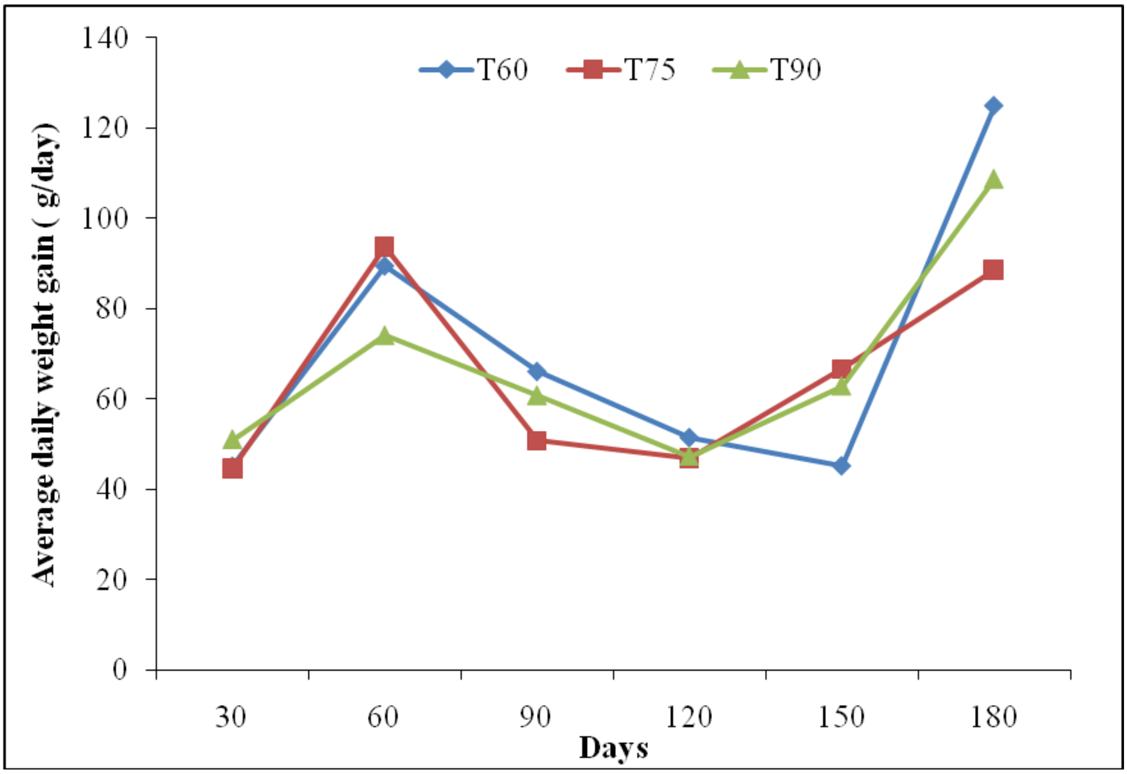

Fig. 4.2: Average daily gain of Beetal kids under various treatments

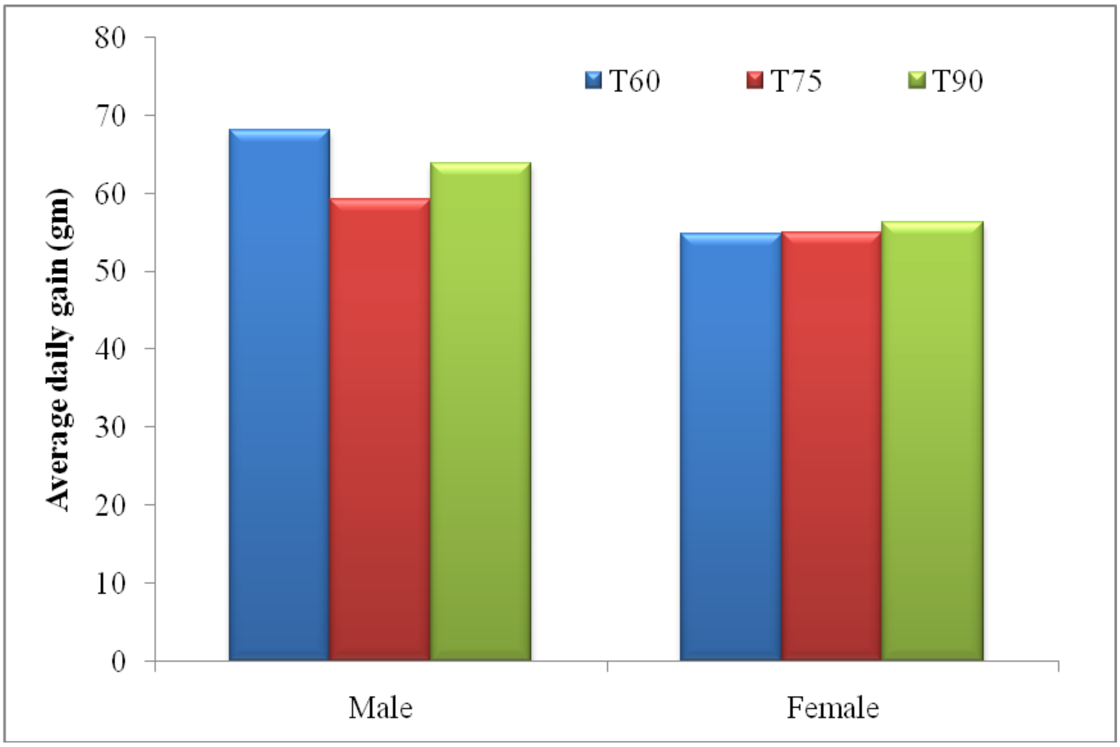

Fig. 4.3: Average daily gain (gm) of male and female kids under various treatments

Monthly data for growth rate (GR) among kids under various weaning groups, presented in Table 4.5 indicated that percent growth rate among kids weaned at 60 days of age decreased drastically from 54 % to 32% which continued upto 5 months of age. However, kids of 75- day weaning group had variable growth rate with slight increase at 5 months of age as compared to other two groups. Kids of 90- day weaning group followed almost the same trend with the sharp growth upto 1 month and gradual decline afterwards. Overall, T_{60} group had highest growth rate (29.70%) followed closely by T_{90} group (29.17%) and had lowest by T_{75} group (28.15%). However, growth rate of kids under different weaning groups showed no statistical difference (Fig. 4.4).

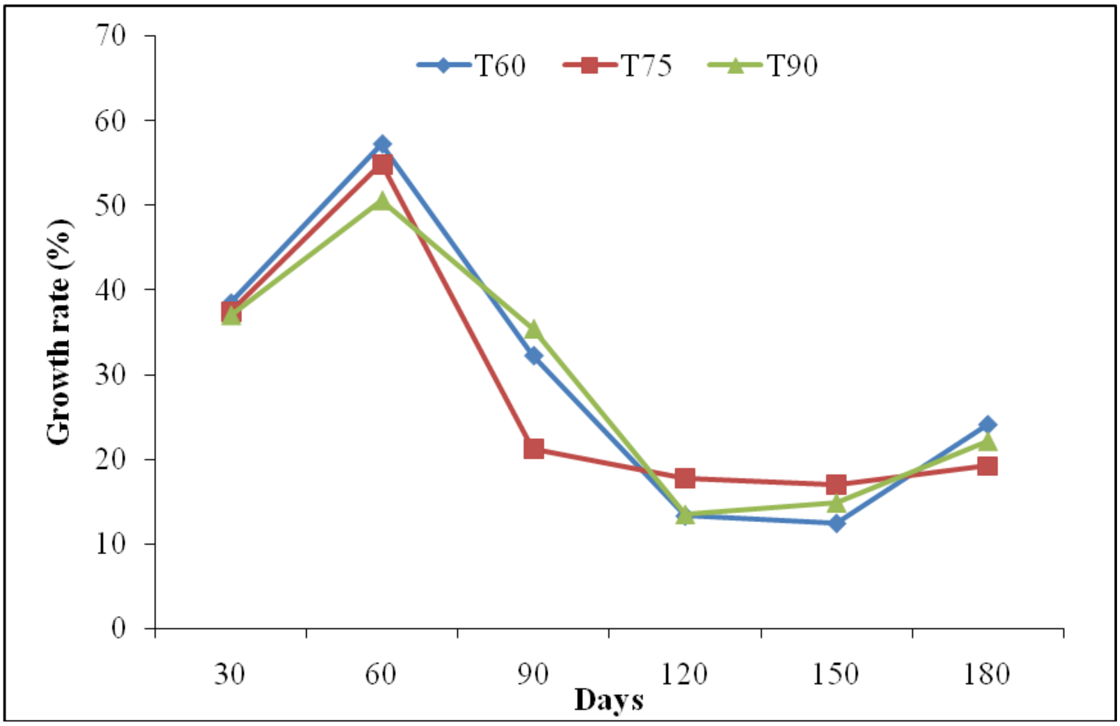

Fig. 4.4: Percentage growth rate of Beetal kids under various treatments

The results indicated that kids weaned at 60 days of age had a higher LBW and higher values ADG and GR at the beginning up to the end of experimental period compared with those weaned at 75 and 90 days of age. After weaning it was expected that kids weaning with lower weights would have less growth rate due to weaning stress and may have less developed digestive system. However, such observations were not noticed in the present study and kids had a similar ADG between groups with values ranging from 62 g^{-1} d (T_{60}), 58 g^{-1} d (T_{75}) and 61 g^{-1} d (T_{90}) showing that at weaning the digestive system of all kids was developed. Moreover, difference in body weight of kids under different weaning groups was maintained up to six months of age, showing that weaning at 60 days or 75 days may not cause any adverse effect on growth of kids compared to those under conventional weaning age group. Similar results were obtained by Schichowski *et al* (2008). In accordance, Memisis *et al* (2009) found that the highest body weight of kids weaned at 60 days compared with those weaned at 120 days. Presence of heavier male kids in the present study also confirms the findings of Abdel-Fattah *et al* (2013) and Saddiqi *et al* (2011). Continuous drop in ADG among kids of 75- days weaning group confirms the finding of Ekiz *et al* (2012) who also observed significant decrease in ADG in lambs after weaning at 75 days indicative of stress due to weaning. Inhibition of growth rate in kids at 75 days might be due to slow adaption to solid food consumption as a consequence of the physiological delay in ruminal development. Thus, in the weeks following weaning at 75 days, weight gain could drop due to a low consumption of grass and concentrate. In contrast, Napolitano *et al* (2008) reported less marked effect of weaning on growth of lambs separated from their dams at 65 days of age. Vecihiaksakal *et al* (2009) also recommended 60 days period as the best time of weaning in lambs.

4.4 Dry matter intake, FCR and PER

The data for total dry matter intake (DMI) by the kids and their efficiency to utilize feed and protein in to daily weight gain in terms of FCR and PER are presented in Table 4.5. The dry matter consumption by young kids increased with the advancement of age in all the groups. The kids under different treatment groups consumed similar amount of total dry matter irrespective of change in feed viz., shift

Table 4.5: Overall growth performance (Mean ± SE) of beetal kids from 0 to 180 days of age

Measurements	T_{60}	T_{75}	T_{90}
0-90 days			
Initial body weight (kg)	3.20±0.11	3.21±0.11	3.19±0.18
Final body weight (kg)	9.03±0.44	8.28±0.48	8.91±0.48
Cumulative dry matter intake (kg)	11.31±0.05	9.48±0.03	10.04±0.04
Dry matter intake (gm/day)	125.66±0.02	105.33±0.04	111.55±0.03
Average daily gain (g/day)	64.77±0.54	56.33±0.46	63.55±0.49
Feed Conversion Ratio (Kg feed/ Kg weight)	2.06±0.19	2.00±0.20	1.87±0.25
90-180 days			
Initial body weight(kg)	9.03±0.44	8.28±0.48	8.91±0.48
Final body weight(kg)	14.28±0.62	13.58±0.87	14.18±0.80
Cumulative dry matter intake(kg)	30.15±0.04	33.08±0.03	33.75±0.04
Dry matter intake (gm/day)	335.00±0.12	367.55±0.05	363.88±0.02
Average daily gain(g/day)	58.33±0.36	59.00±0.53	58.55±0.80
Feed Conversion Ratio(Kg feed/ Kg weight)	5.92±0.38	6.72±0.73	7.39±1.22
Total period			
Initial body weight(kg)	3.20±0.11	3.21±0.11	3.19±0.18
Final body weight(kg)	14.28±0.62	13.58±0.87	14.18±0.80
Cumulative dry matter intake(kg)	41.47±0.06	42.56±0.04	42.79±0.03
Dry matter intake (gm/day)	230.38±0.03	236.44±0.02	237.72±0.05
Average daily gain(g/day)	61.55±0.71	57.66±0.85	61.05±0.70
Feed Conversion Ratio (Kg feed/ Kg weight)	3.86±0.26	4.32±0.40	4.02±.26

NS= Non-significant (p>0.05)

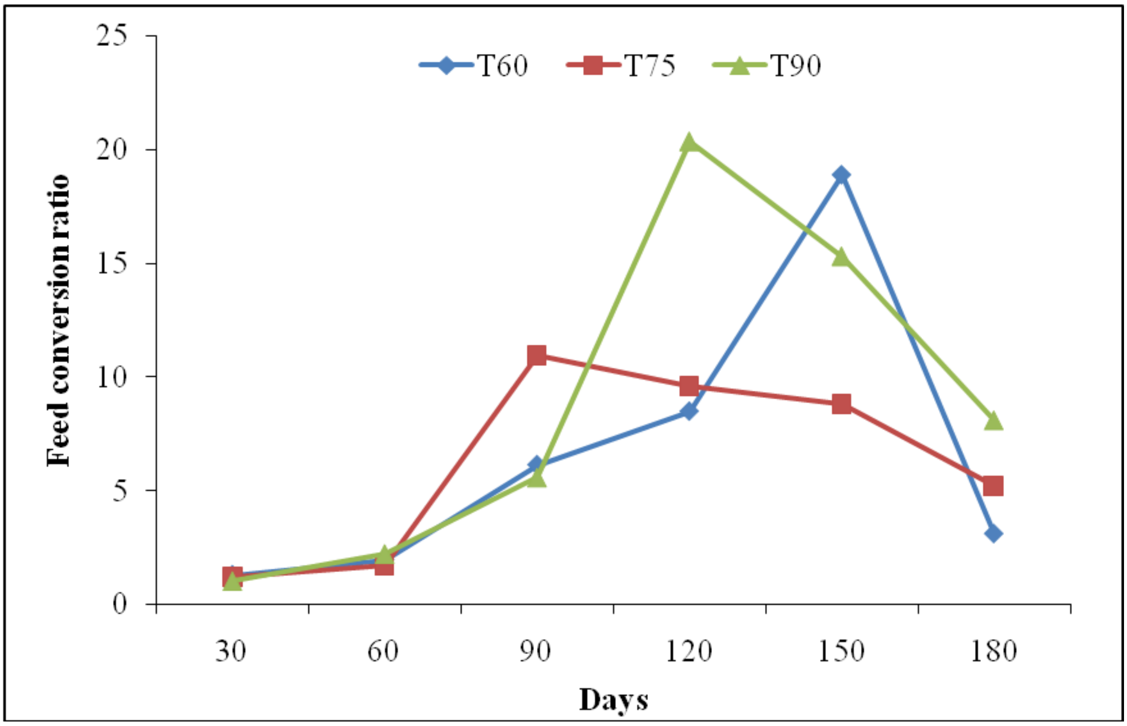

Fig. 4.5: Feed conversion ratio of kids at monthly intervals under different treatments

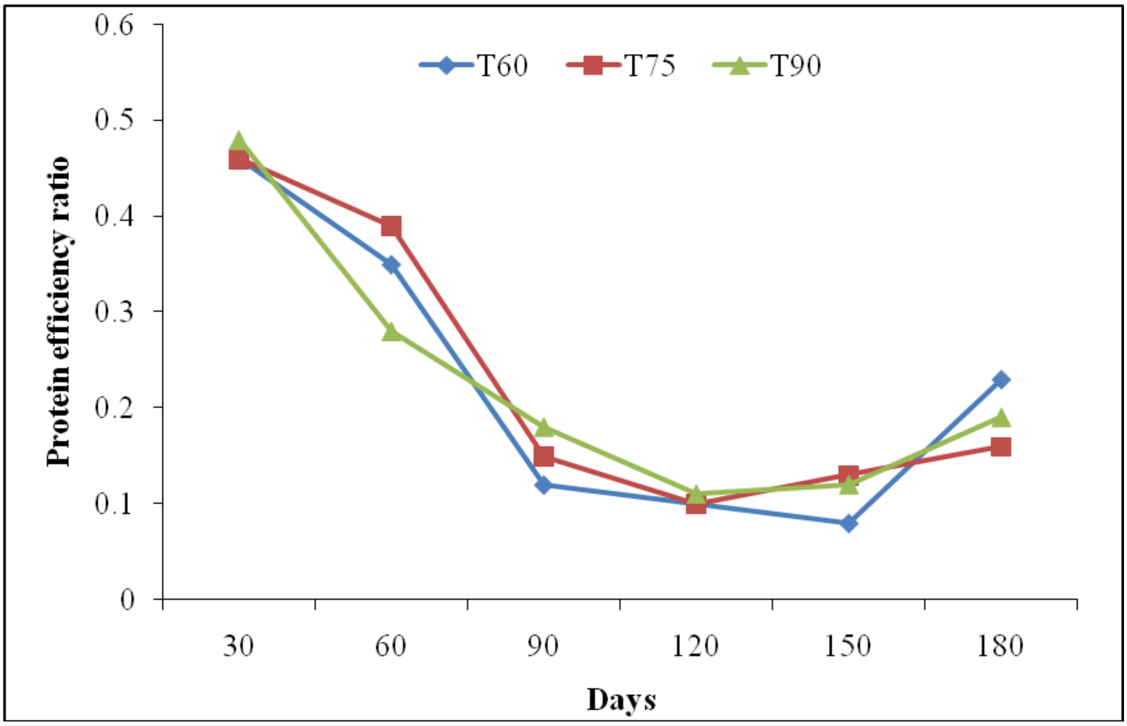

Fig. 4.6: Protein efficiency ratio of kids at monthly intervals under different treatments

from milk to solid feed at different weaning ages probably to satisfy their hunger. However, the numerical variation in the DMI values under different treatment groups had no statistical difference during entire study period. The data for FCR and PER indicated that kids had better growth rate after consuming feed in the start of experiment. However, the shift in the values of FCR and PER indicated poor efficiency of kids to achieve desired weight gain in proportion to feed and its protein content, respectively in the later stages of growth period which might be due to weaning and climatic stress under different treatments. However, the difference in FCR and PER values under different weaning treatments had no statistical difference. The data for FCR and PER values depicted graphically in Figs. 4.5 & 4.6 which showed that kids weaned at either 60 or 75 days performed equally to those weaned at 90 days of age. These results clearly indicated that increasing solid feed consumption by early weaning stimulates rumen morphological development. Another important component in successful newborn rearing programs is an early transition to starter grain. Due to increase in solid feed consumption by kids of early weaned groups, volatile fatty acids production might have enhanced which could have activated the papillary development of these groups biologically and functionally and this might have increased the utilization from ingredients of the diet which is reflected from kids gain and efficiency as explained by Abou ward *et al* (2008) while studying the effect of weaning age on lamb's performance.

4.5 Morpho-metric Measurements

The graphical representation of data for body weight against various body measurements viz., in relation to body length, heart girth, height at wither recorded with standard procedures as mentioned in materials and methods is given in Table 4.6

and Figs. 4.7 to 4.10. All the important body measurements increased ($P>0.05$) with the advancement of age in all the groups. At the age of 60 days, slight decrease in the values for body length, heart girth and height at wither in the kids weaned at 60 days, was noticed as compared to the other two groups (Fig. 4.7). Similarly, kids weaned at 90 days of age also showed similar pattern of decrease in morphometric values in relation to growth pattern (Fig. 4.9). However, group weaned at 75 days of age had little less variation in these body measurements when compared with their counterparts of other two groups (Fig. 4.8). The reason behind such pattern among kids of 75 days weaning group seems to be less intensity of weaning shock as kids in this group might have more developed rumen than those in kids of 60-days weaning as well as slightly lower behavioural instinct with dams thus inflicting less shock than those in 90-days weaning group. Overall, the kids weaned earlier than those weaned at 90-days of age had slightly higher values for all the body measurements which were, however, statistically non-significant ($P>0.05$) among different treatments indicating that weaning at different ages had no effect on various body measurements traits of kids against the expectations as heart girth, body length and height at wither strongly and positively correlated with body weight (Table 4.6 and Fig. 4.10). This might be due to almost similar live body weight of kids in all the groups.

Male kids had 1-2 cm higher value for height at wither as compared to those of female kids irrespective of treatments. However, the height at wither of kids under all the weaning treatments did not differ significantly. Same pattern was followed by males for all the other measurements as compared to their female counterparts irrespective of age and treatments.

Table 4.6: Body measurements (cm) of Beetal kids weaned under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
Height at wither (cm)	60	43.68±1.18	46.50±0.89	46.21±0.67	45.38±0.60
	75	48.00±0.69	48.85±0.54	46.68±0.35	47.79±0.57
	90	49.83±0.60	51.28±0.96	49.00±1.47	50.00±0.67
	180	58.35±1.68	58.92±0.66	56.25±1.14	57.77±0.72
Body Length (cm)	60	37.25±0.71	39.57±0.71	38.85±0.62	38.50±0.47
	75	41.64±.7296	41.71±.3595	39.00±.8452	40.70±.47
	90	44.41±1.12	43.57±0.52	40.50±0.84	42.64±0.60
	180	49.86±1.4	48.71±0.68	48.75±1.03	48.90±0.59
Paunch Girth (cm)	60	37.06±1.05	38.85±0.98	38.85±1.10	38.20±0.60
	75	41.571±0.89	42.28±6.60	41.125±1.10	41.63±6.51
	90	44.50±1.11	46.57±0.97	44.00±1.14	45.00±0.65
	180	51.71±1.20	53.71±1.61	52.25±1.30	52.54±0.78
Heart Girth (cm)	60	36.93±0.58	39.57±0.61	39.92±1.11	38.72±0.52
	75	41.71±0.64	42.42±0.52	40.00±0.88	41.31±0.45
	90	43.66±0.95	44.71±1.06	42.81±1.13	43.69±0.61
	180	51.42±1.49	52.57±1.06	51.62±1.32	51.86±0.72
Height at Hip (cm)	60	45.18±1.10	48.42±0.91	48.21±0.54	47.18±0.59
	75	49.85±0.76	51.00±0.62	48.25±1.19	49.63±0.56
	90	52.00±0.82	53.35±1.10	50.43±1.38	51.85±0.70
	180	60.42±1.69	60.78±0.70	58.12±1.19	59.70±0.73
Pin bone to Hip bone distance (cm)	60	5.5±0.13	6.00±0.07	5.78±0.10	5.75±0.07
	75	6.21±0.10	6.00±0.08	5.81±0.16	6.00±0.07
	90	6.41±0.08	6.42±0.13	6.25±0.18	6.35±0.08
	180	8.92±0.20	9.07±0.20	8.56±0.27	8.84±0.13
Hip to Hip bone distance (cm)	60	8.68±0.13	9.21±0.10	9.42±0.17	9.09±0.11
	75	9.50±0.11	9.57±0.13	9.00±0.18	9.34±0.09
	90	9.58±0.08	9.85±0.09	9.50±0.21	9.64±0.09
	180	11.65±0.25	11.71±0.10	11.25±0.38	11.52±0.16

NS= Non-significant ($p>0.05$)

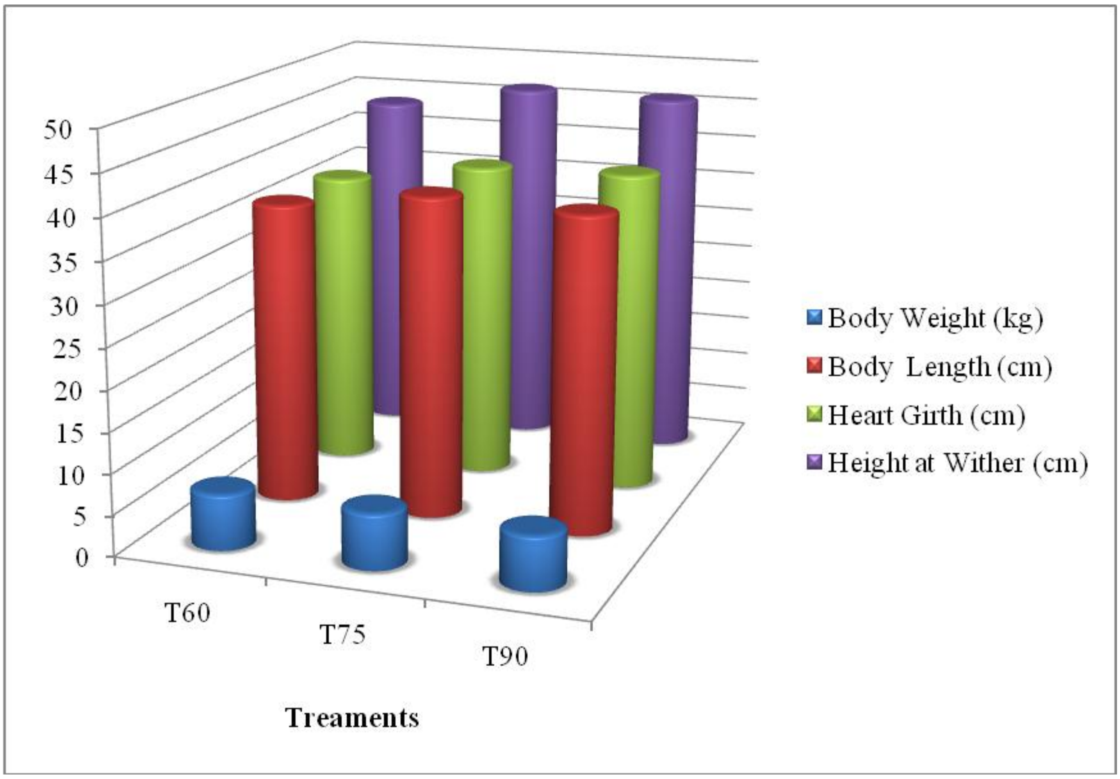

Fig. 4.7: Body weight vs. body measurements at 60 days of age under different treatments

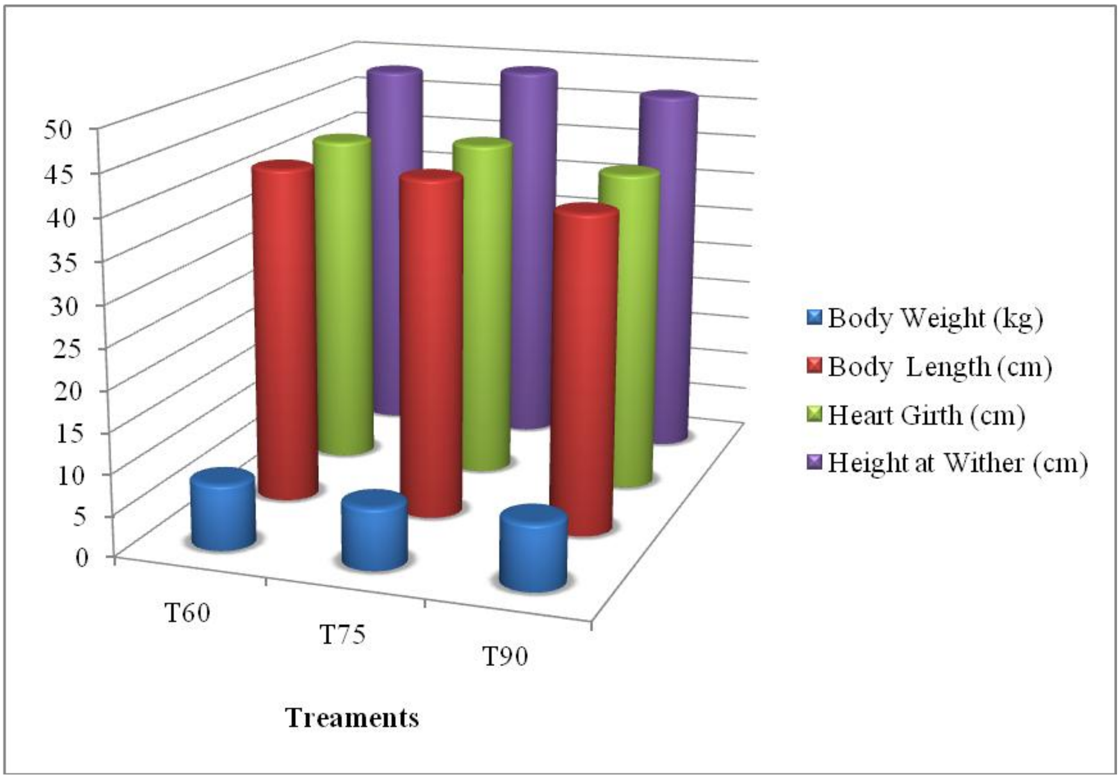

Fig. 4.8: Body weight vs. body measurements at 75 days of age under different treatments

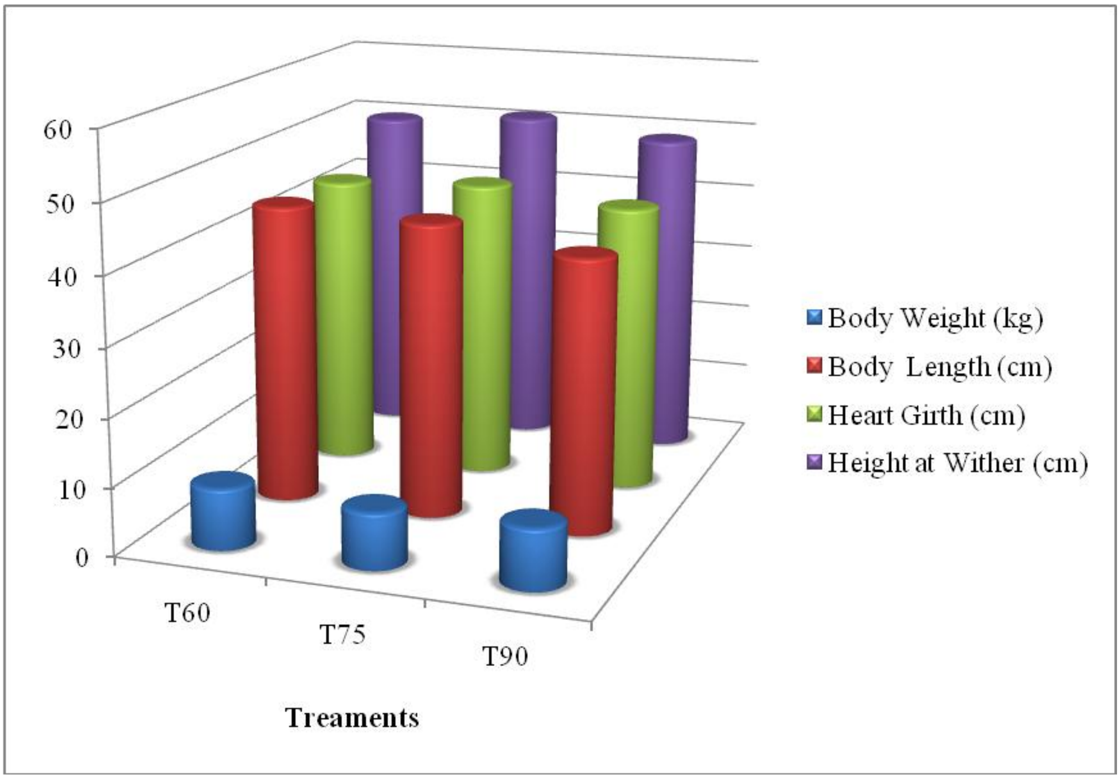

Fig. 4.9: Body weight vs. body measurements at 90 days of age under different treatments

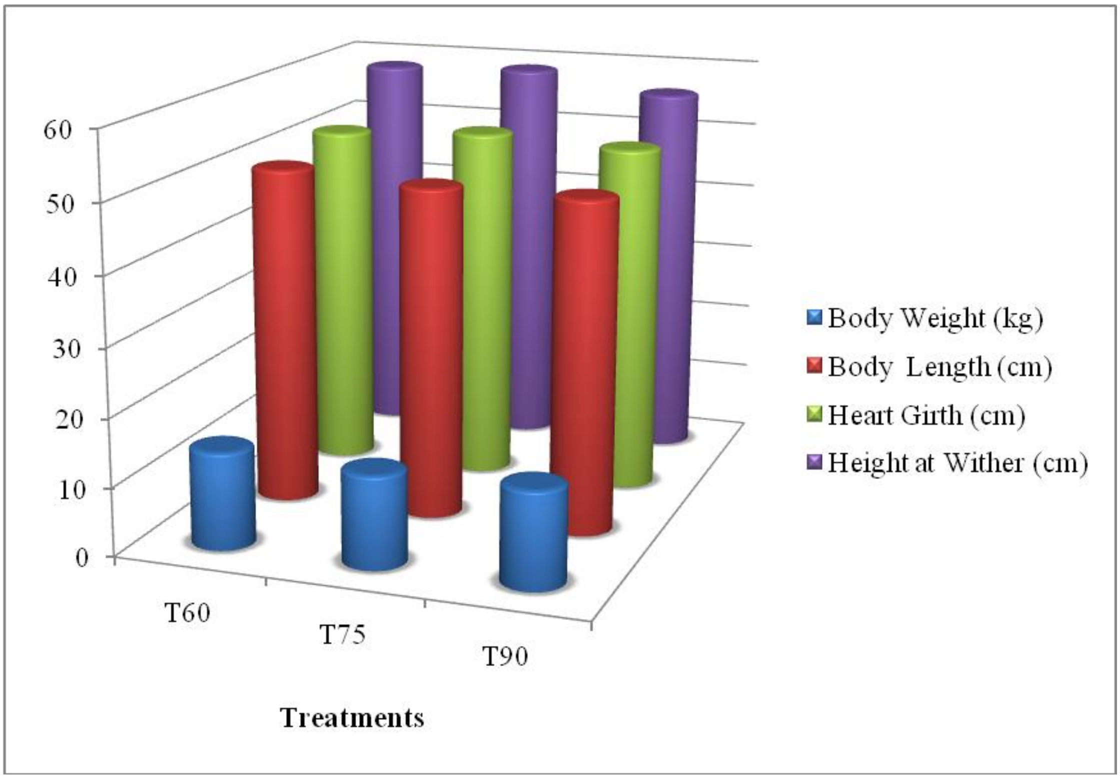

Fig. 4.10: Body weight vs. body measurements at 180 days of age under different treatments

4.6 Hematological responses, Total WBC's and differential counts

Mean values ± SE of Hemoglobin (Hb, g/dl), Packed cell volume (PCV, %), Total leucocyte count (TLC, $10^3/\mu l$) and per cent Lymphocytes and Neutrophils under various early and late weaned kids are presented in Tables 4.7 & 4.8. The percent Hb and PCV levels decreased up to 2 of months age and then started improving by the end of experimental period irrespective of weaning treatments. However, the overall haematological profile of kids indicated that Hb and PCV were not statistically different due to weaning under different treatment groups.

Table 4.7: Haematological profile of Beetal kids under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
Hb (g/dl)	0	10.31±0.21	9.42±0.53	10.00±0.36	9.91±0.23
	30	9.00±0.46	9.00±0.15	7.81±0.26	8.56±0.21
	60	9.07±0.31	9.2±1.39	8.43±0.27	8.88±0.19
	90	10.07±0.33	9.48±0.36	9.68±0.36	9.74±0.20
	120	9.21±0.54	9.35±0.43	9.31±0.18	9.29±0.21
	150	9.64±0.30	10.14±0.38	9.62±0.46	9.79±0.22
	180	9.92±0.20	10.01±0.21	9.75±0.28	10.20±0.17
PCV (%)	0	37.86±0.595	33.43±1.73	33.00±2.0	34.68±1.02
	30	31.71±1.358	31.14±0.705	27.88±0.12	30.14±0.71
	60	31.86±1.18	31.86±1.45	28.88±1.59	30.77±0.85
	90	34.43±1.11	32.14±1.18	32.38±1.43	32.95±0.73
	120	31.86±1.59	32.29±1.52	32.88±0.54	32.36±0.69
	150	33.71±0.91	35.43±1.37	33.25±1.50	34.09±0.75
	180	34.71±0.60	37.86±0.59	34.25±1.11	35.55±0.58

NS= Non-significant (p>0.05)

Table 4.8: Total leukocyte count and differential counts of Beetal kids under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
Total leukocyte count					
TLC (10^3/µl)	0	9.34±0.20	12.60±0.18	12.80±0.20	11.59±0.10
	30	11.30±0.17	12.20±0.09	11.30±0.13	10.40±0.11
	60	10.90±0.16	11.80±0.16	13.60±0.14	12.20±0.08
	90	12.60±0.21	16.20±0.13	17.40±0.23	15.50±0.11
	120	14.40±0.14	13.90±0.11	14.40±0.13	14.20±0.07
	150	12.00±0.13	16.30±0.15	13.80±0.20	14.10±0.10
	180	19.00±0.27	18.20±0.41	18.20±0.13	18.40±0.15
Differential counts					
Lymphocyte (%)	0	51.00±4.15	53.29±4.61	43.88±4.94	49.14±2.69
	30	47.17±2.3	54.00±2.22	41.25±2.63	47.68±1.76
	60	53.00±4.46	58.4±1.68	50.75±2.27	53.82±1.77
	90	62.57±1.85	55.00±3.38	51.25±3.65	56.05±2.00
	120	55.71±3.98	62.57±3.39	58.88±3.57	59.05±2.09
	150	57.14±3.54	63.29±3.30	61.38±1.67	60.64±1.66
	180	56.86±2.73	51.7±6.25	58.38±1.40	55.77±2.20
Neutrophil (%)	0	44.29±3.35	46.71±4.61	56.12±4.94	49.36±2.68
	30	51.29±2.31	45.71±.40	58.50±2.55	52.14±1.77
	60	47.00±4.46	41.57±1.64	49.25±2.27	46.09±1.78
	90	37.43±1.85	45.00±3.38	50.00±4.78	44.41±2.32
	120	44.29±3.98	37.43±3.39	41.12±3.57	40.95±2.09
	150	42.86±3.54	36.71±3.30	38.62±1.67	39.36±1.66
	180	43.14±2.73	48.29±6.25	41.62±1.40	44.23±2.20

NS= Non-significant (p>0.05)

The data for total leukocyte count and their differential percentages of Beetal kids indicated that total WBC's, percent neutrophils and lymphocytes decreased up to the age of 2 months and started increasing at weaning indicative of weaning stress evidenced by the increase in total WBC's count due to increase in proportions of neutrophils and lymphocytes after weaning at their respective ages under various treatment groups. Kids in both the early weaned groups and conventionally weaned at 90 days did not differ significantly with respect to total circulating leukocyte count and the subsets percentages.

Overall data for the values of hematological parameters fell within the normal range indicated by Cynthia (2010). Bornez *et al* (2009) and Antunović *et al* (2012) also reported similar findings about the values of Hb, PCV and WBC's, with increasing age of lambs. Blanco *et al* (2009) and Abdel-Fattah *et al* (2013) reported a similar response to weaning in young calves and lambs, respectively. Knowles *et al* (2000) also found increased values of haematocrite, haemoglobin and RBC that can be associated with the increase in WBC's. Mann (2013) also observed increasing trend of WBC count among all the kids during post-weaning period in all different treatments and higher values than the earlier reports.

4.7 Biochemical indicators in serum

The data for glucose, cholesterol, blood urea nitrogen and creatinine level in the serum of young kids are presented in the Table 4.9. The values for glucose level in the serum of kids varied from 54.50 to 68.88, 48.86 to 77.14 and 59.43 to 73.57 mg/dl, respectively in T_{60}, T_{75} and T_{90} groups. Kids at their respective age of weaning under different treatment groups had declined level of glucose in the blood serum followed by improved glucose level during post-weaning period indicated that weaning time imposed stress thus affecting the metabolism of glucose level which stands for insufficient energy or lower digestion rate just after weaning. Similar trend in glucose level in serum of lambs was observed by Wang *et al* (2007).

Table 4.9: Biochemical indicators in serum of Beetal kids under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
Glucose (mg/dl)	0	54.50±7.77	77.14±12.02	67.86±5.85	65.95±5.27
	30	68.00±5.07	62.71±9.27	73.57±4.88	68.09±3.84
	60	70.00±3.56	58.86±7.45	67.43±8.94	65.64±3.86
	90	59.38±3.67	48.86±5.64	59.43±5.84	56.05±2.97
	120	62.25±4.48	64.00±5.91	68.57±4.20	64.82±2.70
	150	63.38±5.99	69.00±2.69	70.14±3.38	67.32±2.94
	180	68.88±3.61	60.86±3.05	62.43±2.95	64.27±1.95
Blood Urea Nutrition (mg/dl)	0	14.57±9.81	13.71±2.58	14.25±1.91	17.27±3.03
	30	14.86±3.93	14.86±4.14	20.75±17.02	17.00±10.69
	60	22.25±1.58	24.14±3.45	23.88±1.49	23.55±1.26
	90	21.71±2.33	25.43±2.05	22.12±1.73	23.05±1.17
	120	29.00±3.64	35.43±4.34	24.25±2.46	29.32±2.16
	150	23.43±1.71	29.14±2.66	23.38±2.22	25.23±1.36
	180	32.43±3.05	31.29±2.34	27.62±3.22	30.32±1.67
Cholesterol (mg/dl)	0	112.57±12.87	126.29±24.67	114.25±4.13	117.55±8.61
	30	115.43±17.32	175.00±25.64	173.62±19.71	155.55±13.03
	60	123.57±18.84	140.86±25.44	83.25±4.72	114.41±11.06
	90	59.43±5.04	65.29±3.85	89.25±6.21	72.14±4.07
	120	58.43±2.22	59.29±3.44	56.00±3.66	57.82±1.80
	150	69.00±6.90	71.86±7.37	73.62±8.15	71.59±4.18
	180	77.14±6.94	76.86±6.82	79.88±11.07	78.05±4.85
Creatinine/ CRSC (mg/dl)	0	0.70±0.08	0.60±0.07	0.51±0.02	0.60±0.04
	30	0.67±0.06	0.61±0.04	0.61±0.07	0.63±0.03
	60	0.51±0.06	0.47±0.07	0.36±0.04	0.44±0.03
	90	0.31±0.05	0.40±0.05	0.32±0.05	0.34±0.03
	120	0.65±0.21	0.37±0.03	0.42±0.05	0.48±0.07
	150	0.24±0.03	0.24±0.04	0.22±0.10	0.23±0.04
	180	0.25±0.03	0.20±0.04	0.43±0.10	0.20±0.04

NS= Non-significant (p>0.05)

As an indicator of reflecting lipid metabolism, cholesterol level in the serum of kids varied from 58.43 to 115.43, 59.29 to 175.00 and 56.00 to 173.62 mg/dl, respectively in T_{60}, T_{75} and T_{90} groups. Similar to change in pattern of glucose level, the cholesterol level also get deviated due to separation of kids from their dams at their respective age of weaning under various treatment groups. However, early as well as conventionally weaned groups recovered their cholesterol level while approaching at the age of 6 months. This confirms the findings of Xiangmei *et al* (1999) who reported that weaning significantly decreased cholesterol level due to stress on body thus disturbing metabolic activities.

The data for BUN level in the serum of kids which is indicative of liver function during the experimental period varied from 14.57 to 32.43, 13.71 to 35.43 and 14.25 to 27.62 mg/dl, respectively in T_{60}, T_{75} and T_{90} groups. All the kids of different weaning groups had increased level of serum BUN immediate after their separation from dams is indicative of incomplete development of rumen rendering poor utilization of ration and protein absorption. Similar observations for BUN level were indicated by Shi-Gang *et al* (2010).

The data for creatinine level in the serum of kids during the experimental period varied from 0.24 to 0.70, 0.20 to 0.61 and 0.22 to 0.61mg/dl, respectively in T_{60}, T_{75} and T_{90} groups. After birth there was no significant difference in creatinine level between different treatment groups which was indicative of normal health of kids of all treatment groups. Creatinine, which is an indicator of kidney function, was numerically but slightly higher both in T_{60} and T_{75} as compared to T_{90} group. Levels mentioned here throughout the study period was lower than reference value (1.0-1.8

mg/dl) of Kaneko *et al* (2008), which may be due to difference of age, breed or rearing conditions of kids.

Overall, treatment groups did not differ significantly with respect to glucose, cholesterol, blood urea nitrogen and creatinine level in the serum of young kids.

4.8 Enzymatic activity indicators in serum

The activity of enzymes such as AST, ALP and GGT, used as indicators of physical stress, heat stroke and hepatocellular injury may be evaluated by measuring AST (Temizel *et al* 2009, Zubcic 2001), because it has high activity in hepatocytes. At the same time, skeletal muscle tissue also has high AST activity. The data for AST levels under different treatment groups is presented graphically in Fig. 4.11.

The enzyme activity in the form of ALT, AST and GGT levels in the serum of kids under all the treatment groups has been presented in the Table 4.10. The ALT and AST levels in blood serum of kids varied from 4.00 to 17.14; 98.43 to 161.86, 3.29 to 18.57; 88.29 to 175.29 and 5.88 to 26.62; 87.38 to 170.62 µ/l in T_{60}, T_{75} and T_{90} groups, respectively. Overall data indicated that ALT and AST levels did not differ significantly in all the treatment groups during entire study period. The decreased activity of ALT and AST in serum of kids is indicative of development of stress resistance of the body and it might have a positive effect on the liver of early weaned kids (both T_{60} and T_{75}) as compared to late weaned group (T_{90}). These findings are in accordance with the observations by Xiangmei *et al* (1999) who also considered serum ALT and AST values as stress indicators in piglets. Similarly Shi-Gang *et al* (2010) also concluded decreased level of both the enzymes as indicator of stress resistance and relieve the damage degree of liver, heart and kidney.

Table 4.10: Enzyme activities in kid's serum under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
AST/ SGOT (µ/l)	0	117.14±25.29	110.14±9.83	87.38±6.12	104.09±8.91
	30	132.14±41.01	88.29±4.57	108.75±11.55	109.68±13.62
	60	98.43±6.10	126.43±29.01	126.75±6.86	117.64±9.68
	90	161.86±47.86	129.14±5.81	130.50±7.14	140.05±15.01
	120	150.00±24.93	175.29±27.19	154.12±15.45	159.55±12.58
	150	143.71±20.94	164.43±24.32	170.62±29.88	159.18±13.71
	180	130.00±12.34	116.71±6.74	132.38±1	126.00±7.55
GGT (µ/l)	0	260.14±28.50	251.00±58.16	203.50±30.13	236.64±22.84
	30	135.00±9.12	128.43±10.16	129.62±6.34	130.95±4.71
	60	121.43±15.50	177.57±60.06	149.12±17.71	149.36±20.44
	90	118.29±11.52	119.57±23.28	103.25±7.55	113.23±8.42
	120	167.29±45.18	288.43±37.25	108.25±6.9	184.36±18.44
	150	141.29±20.03	151.43±13.18	238.25±38.15	179.77±16.25
	180	125.00±19.68	104.57±25.39	184.50±40.17	140.14±18.60
ALT/ SGPT (µ/l)	0	4.00±0.57	3.71±0.42	5.88±1.67	4.62±0.68
	30	8.71±3.13	3.29±0.42	6.75±1.66	6.27±1.21
	60	7.29±1.14	5.14±0.82	8.88±1.60	7.18±0.78
	90	11.57±2.1	6.29±1.5	13.25±3.4	10.50±1.5
	120	13.57±2.86	18.57±4.34	23.38±4.74	18.73±2.44
	150	17.14±2.90	13.57±2.34	24.25±4.86	18.59±2.26
	180	10.14±1.10	7.00±1.36	26.62±12.49	15.14±4.78

NS= Non-significant ($p>0.05$)

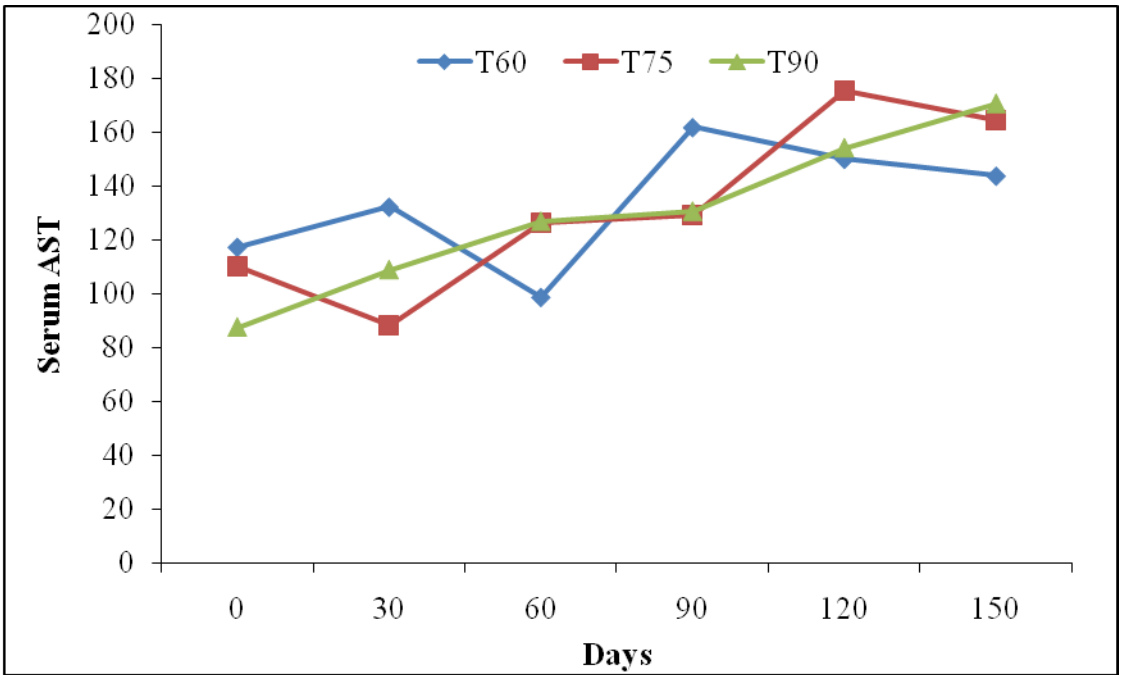

Fig. 4.11: Serum AST profile of Beetal kids under different treatments

The data indicated that level of GGT in serum of kids was higher at the time of birth. However, level of GGT varied in the kids under all the treatment groups with slight trend of decrease up to 3 months and again increased afterwards irrespective of the treatments. The cytoplasmatic enzyme, GGT, is the first which increases even in the condition of slight hepatic sufferance (Kaneko *et al* 1997).

4.9 Cardio- respiratory and thermoregulatory response

Mean values ± SE of monthly respiration rate (RR), heart rate (HR) and rectal temperature (RT) of kids under various treatment groups are presented in Table 4.11. Values for RR and HR in the present study fall within the normal range. Data recorded for rectal temperature of young kids varied from 101.9 ºF to102.5 ºF which did not differ significantly under various treatment groups. Concerning the weaning age, statistical analysis indicated that weaning age had no significant effect on RR and HR of weaned kids. The overall mean of RR and HR recorded was 47.4 r.p.m;105.9 b.p.m, 40.7 r.p.m;106.6 b.p.m, respectively for T_{60} and T_{75} groups vs. 47.9 r.p.m ; 106.8 b.p.m for T_{90} group.

The measured climatic data (Table 4.2) showed that kids were under severe heat stress from birth to 2 months of age stress during hot- humid (mid July to mid September months) period. Which was accompanied with higher RR and HR in kids under all treatment groups, where heat dissipation was lower than the heat gain, therefore, thermal balance could not be maintained.

Table 4.11: Cardio-respiratory and thermoregulatory response of kids under different treatments

Parameter	Days	T_{60}	T_{75}	T_{90}	Overall
HR	30	117.57±1.70	119.14±1.79	119.50±1.64	118.77±0.95
	60	113.86±1.68	115.14±1.89	114.25±1.7	114.41±0.98
	90	111.86±2.0	114.29±1.75	113.38±1.71	113.18±1.04
	120	104.14±2.28	101.00±2.14	101.38±2.66	102.14±1.35
	150	94.00±3.55	95.00±3.47	95.88±3.19	95.00±1.87
	180	94.14±3.22	95.14±3.05	96.62±3.21	95.36±1.76
RR	30	58.29±1.16	57.86±1.14	58.38±0.8	58.18±2.66
	60	51.57±1.17	53.17±1.32	53.00±1.11	52.73±0.68
	90	45.14±1.51	45.29±1.28	44.88±1.12	45.09±0.71
	120	43.29±0.94	46.29±1.2	44.75±1.20	45.09±0.62
	150	43.43±1.28	43.86±1.22	44.25±1.03	43.86±0.672
	180	42.57±1.30	44.00±1.49	42.00±1.25	42.82±0.76
RT	30	102.25±0.13	102.5±0.10	102.3±0.11	102.37±0.07
	60	102.3±0.68	102.25±0.13	102.05±0.08	102.19±0.08
	90	102.44±0.25	102.04±0.16	101.98±0.10	102.15±0.10
	120	102.24±0.11	102.10±0.07	102.25±0.11	102.20±0.05
	150	102.51±0.23	102.38±0.12	102.31±0.13	102.40±0.09
	180	102.31±0.14	102.52±0.17	102.52±0.09	102.45±0.09

NS= Non-significant ($p>0.05$)

HR= Heart rate; b.p.m=Beats per minute, RR=Respiration rate; r.p.m=Respiration per minute, RT=Rectal Temperature, ºF

Therefore, thermoregulatory parameteres dynamics were related with the climatic conditions which represent the main factor depending on their dynamics and not associated with the weaning age. Data recorded under similar climatic conditions and but under different weaning treatments by Abdel-Fattah *et al* 2013 are in agreement with the present findings.

4.10 Serum hormonal attributes

The data presented in Table 4.12 represent the average concentration of cortisol for all kids in each treatment. The cortisol level in serum of kids at birth was high in all the treatment groups pointing towards climatic stress as the rearing of kids started under hot-humid season presumably have adaptive significance. Later on kids under T_{75} and T_{90} groups had slight decrease in level of cortisol as compared to T_{60} group. However, decreased cortisol level at 30 days was indicative of recovery from stress by the kids of T_{60} group. Later on T_{60} showed sudden increased level due to weaning stress immediately after 60 days which was the age of weaning fixed for this group. Similarly, T_{90} group also showed similar pattern of change in cortisol concentration at their respective age of separation from the dams (90 days) (Fig. 4.12).

Table 4.12: Cortisol (µg/ml) as stress indicator in kid's serum under different treatments

Days	T_{60}	T_{75}	T_{90}	Overall
0	1.35±0.21	1.18±0.13	1.27±0.15	1.27±0.09
30	1.60±0.37	0.87±0.20	0.91±0.17	1.11±0.15
60	0.74±0.23	1.12±0.17	1.00±0.17	0.95±0.11
90	1.08±0.20	0.97±0.21	1.17±0.13	1.08±0.10
120	1.12±0.34	0.82±0.19	1.40±0.32	1.13±0.70
150	0.94±0.08	0.98±0.14	1.20±0.18	1.05±0.08
180	1.65±0.28	1.72±0.17	1.30±0.29	1.55±0.14

NS= Non-significant (p>0.05)

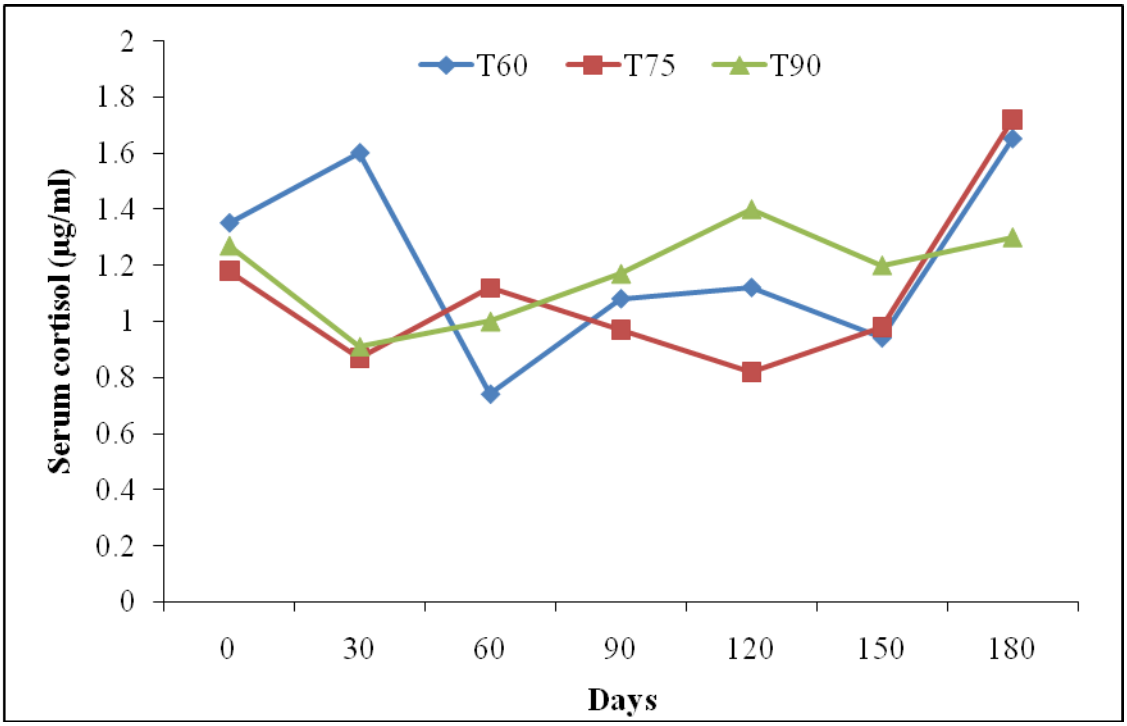

Fig. 4.12: Serum cortisol profile of Beetal kids under different treatments

Though level of cortisol was numerically higher in T_{60} and T_{75} groups at the age of 180 days, but it was within normal range (2.06-2.64 µg/dl) of reference value (Kaneko, *et al* 2008). Pre-weaning samples from kids under all the treatment groups showed similar values for cortisol level except slightly higher value in T_{90} group (Table 4.13). Whereas, higher level in post weaning samples of all the groups as compared to pre-weaning samples was indicative of response to weaning stress. However, this post-weaning increase was positively correlated with the age of weaning as cortisol level was highest in T_{60}, followed by T_{75} and lowest in T_{90} group. Otherwise, there was non-significant difference for cortisol hormone levels among various treatment groups with these few exceptions. Hickey *et al* (2003) also reported that the plasma cortisol concentration was not affected by weaning. The level of cortisol in all the treatment groups did not rise to a level which could affect health and general well being of kids during study period. Since, weaning as management stressor that the kids encountered was imposed once at their respective ages fixed for separation from dams during study period. Which is in agreement with the previous findings by Minton (1994) who reported that homeostatic responses to stressors either environmental or management related when called upon too frequently by repeated exposure to stressors or when evoked strongly by multiple concurrent stressors can be detrimental to the well-being of livestock.

Table 4.13: Comparative cortisol concentration (μg/ml) of pre weaning and post weaning period

Treatment	Pre weaning	Post weaning
T_{60}	0.81±0.21	1.65±0.23
T_{75}	0.83±0.20	1.56±0.21
T_{90}	1.05±0.11	1.48±0.18

NS= Non-significant (p>0.05)

Pre-weaning and post-weaning period varies with respect to weaning under different treatments

4.11 Morbidity and mortality

During the entire experimental period, all the kids displayed good health despite being under environmental and managemental stress like, heat stress and weaning. The kids under different weaning treatments had similar morbidity and mortality rate. Incidence of respiratory, fungal infection and diarrohoea were noticed in one or two kids of all the groups, which had no relation with the weaning treatment. Overall per cent survivability ranged from 87.5% to 100% throughout the study period irrespective of treatment.

4.12 Economics of kid production

Apart from the biological and physiological aspects of early weaning of Beetal kids, the economics of feeding of young kids must also be considered. Therefore, a comparative economics of kid production for different weaning ages was worked out on the basis of following assumptions:

- The cost of creep, milk and green fodder was calculated on the basis of current ingredient prices mentioned below:

Ingredients	Price (Rs. per kg)
Maize	15.15
Soybean	20.00
Oiled rice bran	12.50
Mineral Mixture	55.00
Salt	9.00
Wheat bran	10.80
Green fodder	1.50
Goat Milk	25.00

- Cost of Feed:

Component	Price (Rs. Per kg)
Creep feed	16.52

Cost of production of unit body weight gain was minimum (Rs. 76) in T_{60} followed closely by T_{75} (Rs. 88) and maximum Rs. 96 for T_{90} (Table 4.14). Milk saved during early weaning contributed markedly towards lowering the cost of gain in body weight to the extent of 20.8 and 8.3 per cent respectively for T_{60} and T_{75} group over the T_{90}. These observations agree with that of Nagpal *et al* (1995) who have reported lower cost of gain in body weight to the extent of 41.5 per cent through early weaning under intensive system of goat rearing.

Table 4.14: Cost-benefit analysis of Beetal kids under different weaning treatments

Parameters	Weaning age (days)	
Feed Intake, Kg		
60-90 days	60	6.31
90-180days		47.61
60-180 days		**53.92**
Milk saved, Kg **60-90 days**		**22.29**
Feed Intake, Kg		
75-90 days	75	3.94
90-180days		46.7
75-180 days		**50.64**
Milk saved, Kg **75-90 days**		**12.05**
Feed Intake, Kg		
90-180days	90	**48.18**
Milk intake, Kg **60-90 days**		**22.29**
BW gain (Kg)		
60-180 days	60	7.45
75-180 days	75	6.07
90-180 days	90	5.27
Cost per Kg gain (Rs.)		
60-180 days	60	76.00
75-180 days	75	88.00
90-180 days	90	96.00

4.13 Dam performance

The observations recorded for fortnightly body weight of dams separated from respective kids of all the treatment groups indicated that post parturient body weight of dams decreased gradually upto 2 – 2.5 months. However, recovery of body weight in dams occurred after these months irrespective of the effect of weaning treatment. Moreover, all the dams of respective treatment groups were capable of showing regular estrous cycles after 40 days of parturition. However, weaning age might act as one of the factor affecting body conditions of goat dams optimum for regular estrus cycles conceiving and maintaining pregnancy by day 40 post parturient.

CHAPTER – V

SUMMARY

Kid mortality has been a major hindrance in the path of goat farming on large scale. Kid mortality may be very high when weaning is not practiced on scientific lines. To explore a midway and successful weaning practice without adverse effects on growth and health of kids, reproduction efficiency of dam as well as can support ever increasing demand of goat milk by public. This study was planned with the aim to improve the performance along with economic viability of goat kids in relation to weaning age, severity and duration of weaning stress in Beetal kids.

This experiment was conducted at Goat Research Farm, Department of Livestock Production Management, College of Veterinary Science, Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, Punjab, India. After completion of colostrum feeding period, 24 kids of 3-4 kg, ageing 3 days with equal number of males and females, were randomly distributed in three treatments having 8 kids in each. Performance of kids was tested at different weaning ages either at 60 days (T_{60}), 75 days (T_{75}) or 90 days (T_{90}) thus forming three treatment groups. The kids (both male and female) were reared under identical conditions of rearing except weaning age treatment. Kids were kept in groups in an enclosure made up of wire meshed iron panels having an effective area of $1.44m^2$. Five-day old kids were milk-fed @ 10% of their body weight up to weaning by baby feeder. Creep feed (CP 23.18%) and green fodder were introduced from 15^{th} days onwards to all kids on *ad libitum* basis. Grower ration (CP 20.04%) was offered after weaning at 3-months of age on *ad libitum* basis. Different observations like micro- and macro-climate; milk,

feed, fodder intake; body weight; heart and respiration rate; rectal temperature and body measurements were recorded to evaluate environmental comfort, dry matter intake, growth in the form of weight gain and efficiency to utilize feed and protein along with the economic viability of kids weaned at different ages.

The minimum temperature was always higher during different months within the shed as compared to outer climate. Which may created either stressful or comfortable environment depending upon the prevailing seasons throughout the study period. Kids of T_{60} group which were subjected to early weaning at 60 days of age had achieved numerically highest body weight followed closely by those of T_{90} group and lowest by those under T_{75} group weaned at 75 days of age. Though, there was no significant difference in the body weight of kids at pre-weaning and post weaning periods under all the treatment groups. This equality in ADG among the kids of both T_{60} and T_{90} groups is indicative of the successful response of early weaned kids to improve their performance compared with their late weaned counterparts. The male kids grew more by 6.7% and 7.4 %, respectively in T_{90} and T_{60} over T_{75} group. However, female kids of T_{90} group gained about 2.5% higher body weight than their counterparts in T_{75} and T_{60} groups during entire study period. Overall, T_{60} group had highest growth rate (29.70%) followed closely by T_{90} group (29.17%) and had lowest by T_{75} group (28.15%).

While comparing milk intake of all the groups up to weaning of T_{60} group (First weaning group), there was no difference in milk intake between different treatments. There was no difference in creep feed intake under various treatment groups. However, the numerical variation in the DMI values under different treatment groups had no statistical difference during entire study period. The difference in FCR and PER values under different weaning treatments had no statistical difference. The shift in the values of FCR and PER indicated poor efficiency of kids to achieve desired weight gain in proportion to feed and its protein content, respectively in the later stages of growth period might be due to weaning and climatic stress under different treatments.

The overall haematological profile of kids indicated that Hb, PCV, total circulating leukocyte count and the subsets percentages were not statistically different due to weaning under different treatment groups. Overall, the treatment groups did not differ significantly with respect to glucose, cholesterol, blood urea nitrogen and creatinine level in the serum of young kids. Similarly, ALT, AST levels did not differ significantly in all the treatment groups during entire study period. Statistical analysis indicated that weaning age had no significant effect on RR and HR of weaned kids. Pre-weaning samples from kids under all the treatment groups showed similar values for cortisol level except slightly higher value in T_{90} group. Whereas, higher level of cortisol in post weaning samples of all the groups as compared to pre-weaning samples was indicative of response to weaning stress.

From the present study, following conclusions and recommendations were drawn.

- Early weaning at 60-days of age was able to maintain growth performance in terms of ADG, growth rate without negative effects on morbidity and mortality rate of kids parallel to conventional weaning at 90 days of age.
- The economic efficiency of early weaning portrays reduction in the aggregate cost of production in terms of per unit weight gain of kids, could be important validation for weaning age shift from 90 days to 60 days in kids.

- The production advantages of having Beetal dams in moderate to high body condition at the next kidding cycle may improve conception rates, decreased reproductive culls and supplementation cost of nursing the kids and weaning weight in the next kidding.

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