EFFECT OF PLANE OF NUTRITION ON NUTRIENT UTILIZATION, GROWTH RATE AND CARCASS CHARACTERISTICS OF RABBITS

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CERTIFICATE

Shri V. Suresh Reddy has satisfactorily prosecuted the course of research and that the thesis entitled "Effect of plane of nutrition on nutrient utilization, growth rate and carcass characteristics of rabbits" submitted is the result of original research work and is of sufficiently high standard to warrant its presentation to the examination. I also certify that the thesis or part thereof has not been previously submitt by him for a degree of any University.

Date: 23-10-86

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Major Advisor

CERTIFICATE

This is to certify that the thesis entitled "Effect of plane of nutrition on nutrient utilisation, growth rate and carcass characteristics of rabbits" submitted in partial fulfilment of the requirements for the degree of 'Doctor of Philosophy' in Veterinary Science of the Andhra Pradesh Agricultural University, Hyderabad is a record of the bonafide research work carried out by Sri V. Suresh Reddy under my guidance and supervision. The subject of the thesis has been approved by the student's Advisory Committee.

No part of the thesis has been submitted for any other degree or diploma or has been published. Published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

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ABSTRACT

Three experimental diets in pellet form (6 mm diameter) were prepared in accordance with the recommendation of N.R.C. (1977) for growing rabbits containing 20, 30 and 40 per cent lucerne hay, which were nearly isonitrogenous and isocaloric. These diets were fed *ad libitum* to rabbits in experiment I and in experiment II, the same diets were fed at 90, 100 and 110 per cent N.R.C. levels. In experiment I, 30 weaned New Zealand White rabbits were randomly distributed into 3 groups of 10 animals each. The experiment was divided into 3 arbitrary phases namely I, II and III at 14, 20 and 36 weeks of age to study the growth rate, feed efficiency and digestibility of nutrients. In experiment II, 63 weaned New Zealand White rabbits were randomly allotted to 3 dietary treatment groups

of 21 animals each. Each group was subdivided into 3 sub-groups of 7 animals each and were fed 90, 100 and 110 per cent N.R.C. level of feeding, to assess feed efficiency and quantitative carcass characteristics.

In experiment I, the average dry matter consumption was higher ($P < 0.01$) in phase II followed by phase I and III, respectively. The dry matter, organic matter and crude protein digestibility between dietary treatments, phases as well as interaction between treatments and phases were highly significant ($P < 0.01$). However, significant ($P < 0.01$) differences in ether extract digestibility were noted between dietary treatments and phases only. Dietary treatments as well as phases were non-significant with regard to crude fibre digestibility, whereas, significant ($P < 0.01$) differences were found between treatments alone for nitrogen-free extract digestibility. All the animals were in positive nitrogen, calcium and phosphorus balance. The mean DCP intake in rabbits fed 20, 30 and 40 per cent lucerne hay during the different phases was comparable with N.R.C. recommendations (1977). The mean TDN intake in animals fed diets containing 20 and 40 per cent lucerne hay at different phases was quite comparable while higher values than suggested by N.R.C. (1977) were noted in animals fed 30 per cent lucerne hay.

There was a significant ($P < 0.01$) difference in average daily gain and feed efficiency between dietary treatments as well as between weeks (ages). A declining trend in average daily gain after 12 weeks of age was noted indicating that young rabbits were more efficient in utilising the dry matter than the older ones, thus revealing that ability to utilise the feed decreased with the increase in age in meat type rabbits.

In experiment II, rabbits fed 20 per cent lucerne showed a better average daily gain, lower cost of feed per kg live weight gain and a better feed efficiency at 80 per cent N.R.C. level of feeding, while in rabbits fed 40 per cent lucerne, better average daily gain, lower cost of feed per kg live weight gain and a very improved feed efficiency was evinced at 120 per cent N.R.C. level of feeding. In rabbits, fed 30 per cent lucerne, the average daily gain was better than those fed 20 and 40 per cent lucerne. The cost of feed was comparatively higher in rabbits fed 30 per cent lucerne when compared to those fed 20 per cent lucerne hay. There was no significant difference in average daily gain between the treatments and levels but significant ($P \angle 0.01$) differences were found pertaining to cost of feed per kg live weight gain.

Though statistically not significant, better dressing percentages were noticed with an increase in the level of feeding. Except for the significant difference ($P \angle 0.01$) with regard to forequarters between treatments, there was no significant difference in mid and hindquarters either between levels of feeding or interaction between treatments and levels. The results indicated that there was a highly significant ($P \angle 0.01$) difference for lean, bone, fat and meat : bone ratio between treatments, while differences between levels and interaction between treatments and levels were not significant. The yields of both edible and non-edible organs were significant ($P < 0.01$) between treatments only. It may be concluded that 110 per cent N.R.C. level of feeding with 20 per cent lucerne in diet, seemed more economical in broiler meat rabbit production.

INTRODUCTION

CHAPTER I

INTRODUCTION

Rabbit farming is not very common in India because not many people are aware of its potential and how profitable it could be as a meat animal. In fact, research has indicated that broiler rabbits can produce meat more economically than broiler poultry and pigs, since they can consume cheaper roughage as a sizable part of their diet.

In developed countries rabbit meat is popular and has a high reputation for quality. The developing countries, of late, are showing an increasing interest in small scale rabbit production to augment the supply of good quality protein food for their growing populations.

Extensive data are available on the rabbit as a laboratory animal, but these are not always applicable unreservedly to the commercial rearing of rabbits for meat. It is only in recent years that intensive research has narrowed the most important gaps in our knowledge.

Improved selection and breeding has produced strains which can grow at rates comparable with the modern broiler chicken. The New Zealand White strain, given an adequate diet can grow at over 40 g/day between weaning and 8 weeks of age (Davidson and Spreadbury, 1975). This high rate of growth and the well known prolificacy of the rabbit, make rabbit meat production worth considering as an alternative to red meat and poultry meat in the human diet.

The domestic rabbit is primarily herbivorous and will consume most types of grains, greens and hay. Roughage consumption alone is insufficient to exploit the genetic potential for reproduction and growth. Grass hay, apart from being less palatable than legume hay, is being more and more replaced by green meal especially lucerne, because of its higher nutritive value. Rabbits show a great predilection for lucerne, whether as hay or as a protein concentrate (Lang, 1981 b).

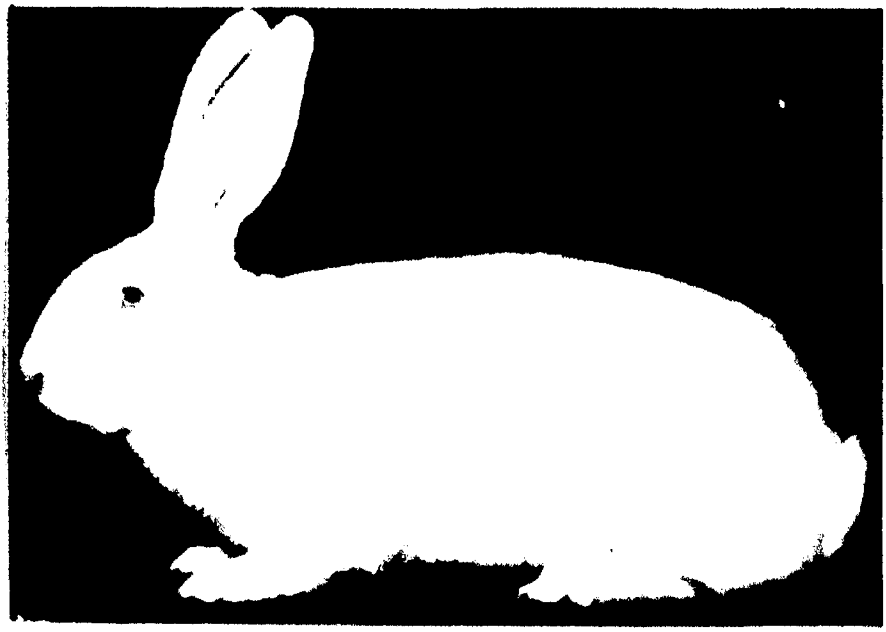
Green forage and roughage are best utilised when mixed with grains and high protein by-products. Feedstuffs such as these were hitherto given without any special preparation, but now compounded mixed feeds are often pelleted. Since the rabbit can utilise a certain amount of forage, it has a place in meat production by making use of some non-competitive feeds.

While the feed requirements for rabbits under intensive systems in temperate climates are now well known, the FAO Expert Consultation on rural poultry and rabbit production (1982) stressed the need for further research and experimentation regarding the nutritional and food requirements of rabbits kept under humid tropical conditions. Little scientific investigation into the feeding and nutritional requirements of the rabbit has been undertaken in our country; the literature on the subject is not, therefore, as extensive as it is for other domestic animals.

This study was undertaken to investigate the effect of plane of nutrition on nutrient utilisation, growth rates and carcass characteristics in New Zealand White rabbits under local conditions.

Photo 1. New Zealand white rabbit.

Photo 2. Rabbitry.



REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

2.1 IMPORTANCE OF RABBITS IN AGRICULTURAL ECONOMY

Rabbit raising is especially adapted to small farms and urban areas where other livestock projects are not practicable. Most domestic rabbits are raised for meat production.

Horne (1975) expressed that there is a magnetic attraction about rabbits as a means of livelihood for many people. Bouwkamp (1983) stated that man needs to take another look at rabbits when trying to solve the world's food shortage. In comparison to other livestock, rabbits possess various advantageous attributes, like feeding on a low grain, high roughage diet and can yet maintain regular growth and reproduction. Thus they have an edge over swine and poultry. The ability to convert forage into meat efficiently could be significant in developing countries where population pressures and food shortages are the greatest.

In 1981 an FAO Expert Consultation on rural poultry and rabbit production, held in Rome, emphasised that if the high rate of growth in meat consumption in future years was to be met, much of the increase in production would have to come from short-cycle animals such as rabbits, especially kept by small-scale farmers (Lebas, 1982). Again the FAO(198[illegible]) reminded that rabbit production has until very recently taken place as small-scale backyard production, both in developed and developing countries; there is no direct competition between food production and small-scale rabbit raising; the potential of this species has apparently not been fully exploited and much remains to be done to enhance its role in small farm economy. A number of developing countries are taking active steps to develop meat production from rabbits.

According to Lebas (1983) the justification for all meat production is the conversion of those plant proteins which are little, or not at all, consumed by man into animal proteins of high biological value. Rabbits can easily take advantage of the forage proteins, whereas chicken, the only animals having higher performance in terms of yields, cannot be fed economically on fibrous roughage feeds.

In many developing countries where there is shortage of animal protein, there has been a growing interest in the rabbit as a meat producer (Leach and Barrett, 1980).

Further, the space requirements for rabbits are small and inexpensive equipment can be used. With the medium breeds, it is possible, under good management for each doe to produce 5 litters each year, with a total weight of 65 to 100 kg. It is possible to raise rabbits using home grown feeds as a back yard small enterprise(Lankford and Barton,1980).

Rabbits are often classed according to mature weight. The small breeds weigh 1.5 to 2.0, medium breeds 4.5 to 6.0 and the large breeds 7.0 to 8.0 kg, respectively. The medium breeds are generally considered best for meat production.

According to the Ministry of Agriculture, Fisheries and Food, U.K. (1972) the main characters influencing the choice of rabbit should include prolificacy, growth rate, feed conversion and yield of meat. One of the two most popular breeds used at present for commercial production is the New Zealand White, the other being the Californian.

In the developed countries, the New Zealand White has to a large extent displaced most other breeds for commercial meat production. This breed has been found to be superior in terms of breeding and meat production when kept under intensive commercial systems. Although no particular breed can be recommended for use in tropical developing countries, a wide variety of improved breeds, including the New Zealand White, can be used, either in their own right or for upgrading purposes (Owen, 1981).

The rabbit does not react to traditional nutrient manipulations like other food producing animals (Patton, 1978). He was of the view that as more and more people become aware of the truly unlimited potential of the rabbit as a source of protein, more attention would be directed to examining the feasibility of producing rabbit both for home consumption and as an economic venture. Further, as competition for cereal grains becomes more keen between human population and livestock, those animals capable of turning grass or plant material into meat will become more important. Secondly, due to lack of space available to raising foraging animals, more attention is being given to these animals that can be raised in close confinement. The rabbit is one of the few animals that fulfils both criteria.

Cheeke (1984 b) stated that the domestic rabbit has great potential as a meat producing animal and can produce more meat from forage-based diets than can any other type of livestock. Feed conversion ratios of 3 to 4:1 can be obtained with high roughage diets, they are adaptable to both small and large scale production, and may be especially useful in tropical developing countries.

Rabbits have been shown to utilise forage protein more efficiently than broilers (Reddy et al., 1981), have a rapid growth rate similar to that of broiler chicken, besides, rabbit meat is a high quality nutritious product.

Cheeke (1984 a) reported that an advantage of rabbits over several other types of livestock is that their nutritional needs can be met by the use of simple mixtures of feed stuffs, and that high quality supplements are not required for a moderate level of productivity.

Low cost roughage feed can be used for efficient rabbit meat production. This is because poultry and swine need fibre content below 7 per cent while rabbits do well on 10 to 20 per cent fibre in the ration (Jordan, 1983).

Schlolaut (1981 a, b) concluded that rabbit production has become increasingly important in the last few years. Rabbit is the most productive meat producing mammal among all domesticated animals. The productivity for meat production from green forage, which is considerably higher than for other types of domesticated animals and the utilization of absolute rabbit feed would tend to indicate that the upward trend will continue in the future in industrial as well as in developing countries.

Regarding the rabbit meat, none can question the potential of the rabbit as a protein source (Horne, 1978). It contains 20.8 per cent edible protein, 3.8 per cent fat (ideal for the health and weight conscious society) and a prolificacy unmatched by any other meat producing mammal, each female being capable of producing at least 15 times her own weight per year. On the basis of cost per kg of edible protein alone, rabbit has better value than lamb, pork, beef or ham. He concluded that these are clear indications of a role for rabbit in the supply of human food.

[illegible] (1982) reported rabbit meat to be very low in sodium and about 10 times more in potassium than beef or poultry. Further, rabbit is termed the only known edible meat containing significant amounts of vitamin B_{12}.

According to International Trade Centre UNCTAD/GATT(1988) a large number of developing countries are becoming increasingly aware of the market potential for rabbit meat, and that the raising of rabbits for the production of meat is actively being encouraged and supported by the Governments of a number of developing countries. Although the principal aim in most developing countries is to develop the production of rabbit meat for the domestic market, some countries have already shown an interest in exporting this type of meat. The reasons attributed are that the rabbit meat has a short production cycle and this type of meat can therefore, help to reduce quickly the gap between demand for, and supply of animal protein for human consumption; rabbits are more efficient feed converters than most other animals usually kept for meat production such as bovines, pigs and sheep; unlike other monogastric animals, such as chicken, rabbits can digest the protein contained in feed with a high fibre content, which is consumed in very small quantities, if at all, by man; the family size carcass does not cause any of the storage problems associated with large domestic animals, and unlike beef and pork, rabbit meat is subject to hardly any religious restrictions. These advantages make the rabbit ideally suited for protein production in small, even very small production units using absolute rabbit feed which cannot be utilised with the same efficiency by man or other animals.

Cheeke (1984 a) opined that a promising area for further research is the assessment of nutritive value of tropical forages and by-products, to be used in rabbit feeding in developing countries. The success of rabbit production in these countries will be influenced to a considerable extent by progress in developing inexpensive feeding programmes based on forages.

There are, of course, also problems associated with this animal (Oehl, 1978), but taking into consideration that the rabbit has received comparatively little research attention, there is great scope fer improvement. It could be said that the rabbit is both a neglected and under exploited animal.

2.2 LUCERNE (ALFALFA) IN RABBIT DIETS

On practical basis, the nutritional requirements of the rabbit are met with quite simple diets. However, rabbit diets are traditionally high in lucerne. A simple mixture of grain or grain by-products, lucerne, a protein supplement and a mineral supplement is satisfactory.

Legume hays are superior to grass hays largely because they contain more protein and calcium and are generally more palatable. In most cases alfalfa hay is the preferred forage. The usual proportions in complete pellets are 50 to 60 per cent concentrates and 50 to 40 per cent hay, with the 40 to 60 per cent proportion preferred (N.R.C., 1966).

Cheeke and Patton (1978 a) proclaimed that alfalfa and rabbits go together. Alfalfa has several qualities that make it a useful feed for rabbits and holds particular promise for rabbit feeding. The rabbits have some unique characteristics that make them especially able to maximally use the nutrients in alfalfa. Further, alfalfa is a feedstuff in a category of its own. It is not a true protein supplement or a concentrate, but for rabbits it is more than just a roughage source. A mixture of grain and alfalfa comes very close to meeting the nutrient requirements of the rabbit. In contrast to animals like swine, they digest the protein in alfalfa very effectively. In pigs and other non-ruminants the digestibility of alfalfa protein is 50 per cent or less whereas, it is 75 to 80 per cent in the rabbit. The authors concluded that since the rabbit efficiently uses the alfalfa protein, it makes more effective use of this protein source than do swine or chicken. Again in 1982 they reiterated that alfalfa is a major component of rabbit feed in the United States. Since it produces more protein per unit land than most crops, and cannot be consumed directly by humans, it has major potential as an animal feed.

Lebas (1976) studied the digested elements in lucerne hay and found the apparent digestible coefficients as follows: Dry matter 48.9, Crude protein 68.3, Ether extract 28.9, Crude fibre 18.5, Lignin 15.5 and Nitrogen-free extract 56.6, while Farrell (1982) reported Organic matter as 54, Crude protein 74, Ether extract 24 and Crude fibre 16.

The addition of 10, 20, 30 and 40 per cent sun-cured alfalfa meal to a high energy, low fibre diet for weanling rabbits gave increased average daily gains as compared to gain on the basal diet (Cheeke and Patton, 1978 b). When 2.5, 5.0, 7.5 and 10.0 per cent alfalfa meal were used, the average daily gains were numerically higher for all alfalfa fed groups than for the basal diet. Results indicated that maximum gains were achieved at the 20 per cent alfalfa level. However, feed preference trials gave conflicting results. In one trial, the basal diet was preferred over all alfalfa diets in a two-choice feed preference test, while in a second trial, all alfalfa trials were preferred over the basal diet. It was concluded that the growth of weanling rabbits fed a high energy diet was improved by the addition of alfalfa meal.

Four experiments were conducted with weanling New Zealand White rabbits by Cheeke and Patton (1980). In experiment 1, treatments were 0, 10, 20, 30 and 40 per cent alfalfa in a yellow corn-soyabean meal diet. Average daily gains were lower ($P < 0.05$) for the 0 per cent alfalfa diet than others. In experiment 2, extraction of alfalfa with ethanol did not remove its growth promoting effect, suggesting that fibre may be the active fraction. In experiment 3, alfalfa meal, oat hulls, beet pulp and wheat straw were compared, at the same level (7.5%) on dietary fibre. Only alfalfa meal gave a greater growth rate ($P < 0.05$) than for the low fibre control diet. In experiment 4, the effectiveness of finely ground alfalfa meal Vs. alfalfa hay *ad libitum* was compared. Both forms of alfalfa gave improved growth ($P < 0.05$). In all but experiment 4, inclusion of alfalfa reduced the incidence of enteritis. It was concluded that alfalfa meal, as a fibre source, improved growth and reduced enteritis in young rabbits.

The digestive tract of the rabbit is capable of selective rapid excretion of dietary fibre, with prolonged retention of soluble and small particles in the caecum. This digestive strategy facilitates the utilization of low energy, high fibre diets. While the digestibility of fibre is low, the non-fibre constituents of forages are used efficiently (Cheeke, 1984 a).

In 1980, Pote *et al.* investigated the effect of replacing grain with lucerne meal on the performance of weanling rabbits. Even when corn was completely replaced by lucerne meal, there was no reduction in average daily gain. As the lucerne level increased, caloric density of the diet decreased, but the animals increased their feed intake to maintain the same caloric intake. This demonstrated that the rabbit, like other species, eats sufficient feed to meet its energy requirements.

In a series of studies on feed preferences, it was shown that the level of alfalfa preferred by rabbits is somewhat less than customarily used. Cheeke and Patton (1978 c) in one study used two types of alfalfa varying in their content of saponin. Rabbits were given a choice between two diets; one without alfalfa and one with. They opined that diets containing 40 per cent alfalfa were sufficiently palatable to rabbits to cause no feed intake problems. Above this level, problems could be encountered with poor feed acceptance due to the high alfalfa level. Whereas, Farrell (1982) reported that rabbits could even grow at 36 g/day on a diet containing 90 per cent lucerne meal.

However, Cheeke et al. (1982) reported that growth was significantly reduced when 90 per cent alfalfa ($P < 0.01$) and 80 per cent alfalfa ($P < 0.05$) were used. The results indicated that upto at least 60 per cent alfalfa can be used in rabbit grower ration with no detrimental effect. It should be noted, the authors opined, that the major nutritional contribution of alfalfa to a rabbit ration will be protein.

Sun cured alfalfa meal appears to be superior to dehydrated alfalfa for rabbit feeding (Cheeke, 1984 a).

From 4 to 8 week old, for 28 days, 3 groups of rabbits were given a complete diet with 54 per cent lucerne which was chopped, sun dried or dehydrated by Harris et al. (1983). There was no significant difference in growth between groups, although groups given diets in order named gained 35.3, 32.5 and 27.1 g daily. When rabbits were offered the free choice between the 3 diets, sun dried lucerne diet was 52.4 per cent, chopped lucerne diet was 39.9 per cent and dehydrated was 7.7 per cent of total intake. Results suggested that growing rabbits performed better on diet with sun dried and chopped than with dehydrated lucerne.

Taylor and Jhonston (1986) conducted trials in 6 groups of rabbits from weaning at about 28 days for 35 days that were given freely a complete pellet diet with 54 per cent lucerne meal that was hydrated, or sun dried or both in proportions of 1:3, 1:1 or 3:1. Mean daily feed intake, feed efficiency, gain and final weight and mortality were not significantly different between treatments. In another trial, the rabbits preferred diets with high proportions of dehydrated lucerne meal, though in a previous trial they had preferred the sun dried. They attributed these contrary findings to their lack of information as to what cuttings were used or at what stage of growth the lucerne had been cut. They stated that further trials were required in this aspect.

2.3 PELLETED FEEDS

Rabbits can eat both fresh and dry portions of a variety of plants and as well as all kinds of kitchen scraps. Thirty five years ago the standard diet for domestic rabbits was composed of whole grains, a plant protein supplement and alfalfa hay or some other legume roughage.

Planned feeding with the intention of fattening in order to compete with other animals bred for meat (especially poultry) is only possible, however, if home produced feed stuffs are supplemented by concentrates to ensure properly balanced rations. This use of compounded feeds, in the form of pellets is being adopted more and more all over the world. Today most rabbits are fed a pelleted feed made up of grains, hay and certain supplements in what is believed to be a balanced diet (Weisbroth, *et al.*, 1974).

According to N.R.C. (1966) an all-grain pellet usually contains grains, their milled by-products, protein supplement and salt. Whereas, a complete pellet may consist of ground cere grains, their milled by-products, protein supplement, salt and a good quality ground hay.

Diets provided, whether home grown or commercially prepared, consist almost entirely of ingredients from plant sources. Although a few producers may still rely on home grown feeds, a major portion of the rabbit feed presently used is commercial pelleted feed (N.R.C., 1977).

If compounded pelleted feeds containing 40 to 50 per cent of lucerne meal and 50 to 60 per cent of concentrates are used, the addition of hay is unnecessary. Commercial feeds and special concentrates are best made in the form of pellets because they mix very well with grains (Braunlich, 1965).

Rations fed to rabbits kept on wire floors are always pelleted to prevent selection and consequent wastage of food. Rabbits are said to find unpelleted mixture less palatable but this is probably because of the dustiness of the meal (Lang, 1981 b).

Pelleting improves the efficiency of feed utilization. Because of the high palatability some rabbits may tend to overeat which is undesirable for reasons of health as well as economy. In practice the quantities to be fed will depend on the size of the breed of the rabbits themselves (Ministry of Agriculture, Fisheries and Food, U.K., 1979).

Observation of rabbits indicates that they prefer a pelleted diet to one in a meal form. They will adjust to a meal diet and accept it satisfactorily, but during the adjustment period intake may be very low and feed spillage excessive. Some individuals may refuse to consume a non-pelleted experimental diet. Unless fat or molasses is added to the diet, dustiness may be a problem with meal type diets, further contributing to their lack of palatability (N.R.C., 1977).

The major disadvantage of pelleting is the added cost. Increased feed and energy costs have prompted a number of investigations into the feeding of non-pelleted (meal type) diets. Most of these investigations have not given encouraging results (Sanchez *et al.*, 1984).

As cited by N.R.C.(1977), Chapin (1968) compared performance of growing rabbits on a commercial pelleted diet with the same diet in the ground form. He also compared performance on a commercial meal-form diet with the same diet pelleted. In each case, growth rate and feed efficiency were significantly better with the pelleted diets. Lebas (1973) also observed improved growth performance with pelleted diets and King (1974) reported similar findings (Cited by N.R.C., 1977).

In the feed preference study (Harris et al., 1983) it was found that weanling rabbits chose pelleted diets over the same diets in meal form. Laplace and Lebas (1977) studied the effects of fineness of grinding of the ingredients of a ration for 8 week old rabbits (cited by Lang, 1981 b). Results showed that retention time was extended by 6 hours and apparent dry matter digestibility increased when a finely ground ration (particle size range 0.25 to 0.08 mm) was compared with one having a higher proportion of larger particles (size range 2.0 to 0.08 mm).

Sanchez et al. (1984) conducted studies to determine if better results could be obtained by feeding rabbits a non pelleted diet containing larger coarser chopped particles than those used previously in non pelleted rations; at what level (0, 5 or 10%) molasses gave the best performance, and whether comparable results could be achieved by mixing a green forage with pellets in 1:1 ratio in the diet. Results indicated that the diet (0, 5 or 10% molasses) gave the best performance. When this diet containing molasses was fed in 1:1 mix with the pelleted control, performance of this diet was comparable to the pelleted control diet.

Owen (1978 and 1981) reported that on a low energy diet (8 MJ/kg MS) weaned New Zealand White rabbits were hardly able to produce any weight gain at all from diets fed in meal and mash form. Diets of identical composition fed in pelleted form produced growth rates of 21 g/day. In the case of high energy diets (12 MJ/kg ME) the rabbits appeared to be able to cope with the meal and mash presentation much better, but again performance was somewhat poorer than in those fed on pelleted diets. Further, wastage was high with meal presentation followed by mash.

Kamchurn (1978) reported that throughout an 8 week experiment with weaned rabbits at 6 weeks of age, the growth rates decreased with the decreasing percentage of complete rabbit pellets used. Group fed with pellets alone performed slightly better than that fed with sugar cane, ad libitum, supplemented by 80 per cent and 60 per cent pellets. In the first month, the growth rate of rabbits fed 80 per cent complete rabbit pellets was the best followed by those fed on pellets alone. On the whole, the growth rates decreased with decreasing percentages of complete rabbit pellets used. Groups fed with pellets alone performed slightly better than that fed with Leucaena species, ad libitum, supplemented by 80 per cent and 60 per cent complete rabbit pellets.

New Zealand white rabbits of 6 week age and 12 week age were randomly allotted to 3 groups by Sastry and Mahajan (1981). One group from each age group was fed with roughage comprising white clover rye grass, hay, green white clover and tree leaves of Robinia each at the rate of 1/3 of total crude protein requirement. The second group was offered roughage(as in first group) at the rate of 1/3 crude protein requirement, and concentrate at the rate of 1/3 crude protein requirement. The total protein requirement of the third group was met by feeding concentrate alone. The daily feed consumption and weekly gains were recorded up to 13 and 20 weeks of age in younger and older groups, respectively. The results indicated that the diet had a significant ($P < 0.01$) influence on the weight gain and efficiency of dry matter intake in younger group. The rabbits on concentrate diet were significant in utilising the dry matter than those of other diets. Rabbits of both the age groups on concentrate diets were about 3 and 2½ times more efficient than those kept on roughage alone.

Several workers conducted studies with regard to the pellet size - length and diameter. Generally all agreed that pelleted rabbit feed should be bite size, since, rabbits were logomorphs (a class very close and yet distinct from rodentia) and possess sharp incisors.

Fraunlich (1968) opined that pellets for rabbits should be about 3 mm long and 5 mm thick, while some other workers suggested 8 to 9 mm long and 4 to 5 mm in diameter.

Schlolaut (1982) was also of the opinion that pellet size should be in the range of 3 to 5 mm, with the length exceeding the diameter, to avoid excessive abbrasion waste with young animals.

N.R.C. (1966) recommended that pellets should be 3/16 inch or less in diameter and about 1/8 inch long; if they are long, there will be considerable waste by young rabbits. However, USDA (1972) stated that pellets should be no larger than 3/16 inch in diameter and 1/4 inch long. If pellets are larger small rabbits will bite off part of a pellet and waste the rest.

Chopin (1966) reported satisfactory findings using the pellets sized 0.48 x 0.63 cm (cited by N.R.C., 1977).

Lebas (1975) studied the influence of diameter on the performance of fattening rabbits. The diameters used were 2.5, 5.0 and 7.0 mm. He reported the daily consumption to be 117, 122 and 131 g, and daily weight gain of 32.4, 33.7 and 31.9 g respectively, for the 3 different pellet diameters in the order mentioned.

The Ministry of Agriculture, Fisheries and Food, U.K. (1979) suggested that the pellet should be about 12 mm long and 5 mm or less in diameter.

Sastry and Mahajan (1981) fed the same diet in two different pellet sizes - 3 and 6 mm diameter, to New Zealand white rabbits of 6 and 12 weeks age respectively and found significant ($P < 0.01$) efficiency of dry matter utilization in both the groups.

New Zealand white rabbits 9 to 10 weeks of age, were divided into 4 treatments and fed diets which had pellet diameters 5/32 and 3/16 inch and length of 1/4 inch (short) and 1/2 inch (long) to measure the effect of pellet size on growth performance by Harris et al. (1984 b). The average daily gains for the four pellet sizes were: 5/32 inch-short = 39.7 g, 5/32 inch-long = 38.5 g; 3/16 inch-short = 40.0 g and 3/16 inch-long = 37.5 g; the feed conversion ratio was 3.30, 3.32, 3.17 and 3.41 respectively for the above sized pellets. Rabbits preferred the following sized pellets in decreasing order: 5/32 inch long, 3/16 inch long, 5/32 inch short and 3/16 inch short. These preliminary results did not show a significant benefit in performance by feeding smaller pellets to young rabbits.

The fibre content of rabbit rations is higher than in rations for most other livestock. When pelleted, high fibre rations are usually very friable and give rise to unacceptable wastage. Steam pelleting may over come this problem but binders additives which improve the consistency of the pellet - are more commonly used.

Substances such as bentonite (a clay) and lignin sulphonate (a derivative of wood) are used in feeds as pellet binders. These are quite important in rabbit feeds. Further, pellet quality is important in a rabbit diet, and the use of a binder is an effective means of making a good firm pellet (Cheeke et al., 1982).

Lang (1981 b) stated the calcium lignosulphonate, a by-product of wood pulp manufacture, is widely used as a pellet binder in animal foods. Calcium and sodium ligno-sulphonate in rabbit diets have been shown to be associated with a high incidence of ulceration of the colon and high mortality, whereas, magnesium lignosulphonate appears to have no harmful effect. All animals fed diets containing lignosulphonates were found to grow more slowly than those on rations which did not contain them.

Grobner *et al.* (1983) conducted experiments to study the effect of sodium bentonite on performance and feed preferences of weanling rabbits. In the first trial rabbits were fed from weaning at 4 weeks old for 28 days on one of the 4 diets with sun-dried lucerne 20 or 54 per cent, each without or with sodium bentonite 5 per cent. The second trial was a 2-choice preference test. There was no significant difference between diets in average daily gain of body weight or feed intake. Gain and intake were less and mortality greater when bentonite was added. Incidence of impacted caecum was highest for diet with both bentonite and the high fibre content of 54 per cent lucerne. Rabbits significantly preferred diet without bentonite to diet with it, by 2:1 with 20 per cent lucerne and by 5:1 with 54 per cent lucerne. Results suggested that the high content of 5 per cent sodium bentonite did not affect performance adversely or induced impaction of the caecum.

2.4 FEED CONSUMPTION

Schlolaut (1982) reviewing extensively on feed consumption in rabbits stated that feed consumption is distributed over relatively frequent meals, the number of which is age-related. Six week old animals on pelleted feed consume approximately 2 g at each meal, 40 times a day. Older animals (16 weeks) consume only 30 meals per day, each of 7 to 8 g. The number of meals is progressively reduced with advancing age; however, there is no change in consumption time. Owing to the older animal's faster eating, the same quantity of feed as for young animals can be consumed, in spite of the fact that the total feeding time is shorter. Concurrent feeding of roughage, however, leads to longer feeding time per day.

Rabbits consume most of their feed (60 to 70%) at night, before dawn and after dusk. The day-night rhythm of feed consumption is less marked in young animals than in older ones (Hornicke et al., 1979).

Braunlich (1966) correlated body weight with daily feed intake. For body weights 1.8, 2.2, 2.7 and 3.2 kg the daily feed intake in percentage of body weight was 8.0, 7.8, 7.0 and 6.7 respectively for normal growth and fattening. It was concluded that as the animal grew, the daily feed intake in percentage of body weight declined.

According to Lebas (1979) the dry matter consumption per kg body weight shows an age related decrease from 42 to 30 g/day during the first 3 weeks of life, when the young are fed exclusively on milk. Once the young have started to accept dry food, dry matter rises until it reaches 62 g/day/kg body weight by the sixth week. Weaned offsprings, after a transition period of about one week, have a higher intake of dry matter than contemporaries still being suckled.

Newstead *et al.* (1978) also stated that feeding varies considerably. All stock over slaughter weight which is being reared for replacement should be rationed 4 oz of pellets daily and also all bucks and any does that are empty or not more than 21 days pregnant.

Lebas (1982) reported that on a dry matter basis, daily requirements can be estimated at 100 to 120 g for adults, at least as much for young animals between 1 and 1½ months of age and 150 to 180 g for animals of 3 to 4 months. For each young rabbit 20 to 30 g must be added when it reaches the age of one month.

In the opinion of Harris *et al.* (1984 a), a common decision rabbit breeders face is whether to full feed or limit feed their fryer rabbits. Some people claim that full feeding causes over eating which increases the incidence of diarrhoea. Others have observed more feed wastage when excess feed is always in front of rabbits. On the other hand, some feel that keeping feed in front of the rabbits at all times eliminates the possibility of under feeding which can happen with a limited feeding programme. The amount of restriction is often an educated guess based on experience and the type of production in the cage. For instance dry does and bucks would receive much less than a doe with a nursing litter. Litters of rabbits would require increasing amounts of feed as they grow. It would take careful management to successfully operate a restricted feeding programme which would give the rabbits all they could consume in a certain period of time and yet not restricting them to the point of limiting the rabbits' growth potential.

In an experiment New Zealand white rabbits were used to determine the effect of full versus limited feeding on growth, feed efficiency and mortality by Harris et al. (1984 a). Restricted fed rabbits received approximately 95 per cent of the feed given to the full fed rabbits. Results showed that feed restriction at that level produced no significant changes in growth, feed efficiency or mortality. The average daily feed consumption of 84 per cent alfalfa sun cured diet restricted and full fed was 124 and 131 g, respectively. The authors stated that limit feeding offers some management benefits, such as providing a daily health check, without adversely affecting animal performance.

Sieuwten and Stahl (1982) reported that when commercial feed containing 16 per cent protein was fed, the resting bucks and does consumed 120, pregnant does 240, lactating does with litters 480 and growing/fattening rabbits after weaning to slaughter or 3½ to 4 months old 980 g/day, respectively.

2.4.1 Effects of High Ambient Temperatures on Feed and Water Intake

Owen *et al.* (1977) reported that ambient temperatures of 30°C decreased the amount and frequency of feed intake of 20 week old rabbits. The average intake at each meal changed very little between ambient temperatures of 10°C and 20°C, but at 30°C the solid food intake had diminished from 5.6 to 4.4 g for each meal and the liquid intake had increased. The water/solid food ratios for the three temperatures were: 1.70 (10°C), 1.85 (20°C) and 2.50 (30°C), respectively.

The effect of ambient temperatures on feed intake of rabbits was investigated by Stephane (1982) on both sexes consisting of either New Zealand White or crosses of it. Different groups were kept at 5°C - 80 per cent R.H., 18°C - 70 per cent RH and 30°C - 60 per cent R.H. and fed on a standard pellet to appetite. Best results were obtained at 18°C. Feed intake was inversely related to temperature while water intake varied directly with the temperature. At the highest temperatur crossbreds performed better than pure breds.

Lobas (1983) observed that at temperatures above 25° to 28°C rabbits decreased their feed consumption more than is strictly necessary to provide for an intake of the DE required to maintain body heat and production. At 30°C average feed consumption was decreased by about 30 per cent and subsequently growth was also affected.

2.5 DIGESTION AND NUTRIENT DIGESTIBILITY

The differentiation of the digestive organs corresponds to that of other monogastric herbivores. The relatively large stomach (34% capacity of the digestive tract) is a notable feature, indicative of the rabbits ability to compensate for the low nutritive value of its diet by devouring larger quantities. The large caecum (49% capacity) indicates the special role of this organ in the digestive process. Its function is the production of soft faecal droppings ("Caecotrophs") which differ from the familair hard faecal droppings. The situation of the digestive apparatus of the rabbit is complicated by the occurrence of an excretion pattern of these two types of faeces. They differ in composition, the soft faeces being relatively richer in water, protein, vitamins and bacteria. The soft faeces are ingested directly from the anus and pass once more through the digestive system. The recycling of the soft faeces, which undergoes bacterial decomposition in the caecum, aids the digestion of crude fibre and protein.

Despite the microbial breakdown in the caecum and subsequent coprophagy, the digestibility coefficient for crude fibre is closer to the rather low values for pigs than it is for cattle (Schlolaut, 1982); less than 1/2 efficient as cattle (Nordic-Baldissera, 1980 a).

Germ free and conventional rabbits wearing collars to prevent coprophagy were fed an autoclaved diet with added cellulose.

their faecal excretion was analysed to determine nutrient digestibility by Yoshida et al. (1968). Clearly distinguishable hard faeces were excreted by germ free rabbits only if the diet contained at least 15 per cent cellulose. Although digestibility of dry matter was similar in the 2 groups, in the germ free rabbits there was a higher digestibility of crude fat and true protein and a lower digestibility of crude fibre and NFE. The results suggested that intestinal microbes, even without the enhancing effect of coprophagy, aid in the digestion of carbohydrate by rabbits. The greater faecal excretion of crude fat and true protein by conventional rabbits could result from poorer digestion and absorption, but could also represent nutrients synthesised by microbes from simpler materials. The reingestion of faecal crude fat and true protein might therefore improve the quality of the total nutrient intake. The results suggested a way of assuring an adequate dietary intake by germ free rabbits in the absence of contributions from an intestinal microflora.

Schlolaut (1982) observed that despite the bacterial synthesis of protein in the caecum and its reingestion with soft faeces, the rabbit is still dependent on an external supply of some essential amino acids. Correspondingly, it is not capable of utilizing NPN compounds to any relevant extent. Still to be determined is the extent to which the utilisation of NPN compounds can be improved when the essential amino acids are fed in the form of a supplement.

There are close similarities between caecal and ruminal digestion but in many respects the rabbit is more akin to a simple stomached herbivorous animal. Although the adult rabbit is able to utilise poor quality forage, the high performance required in commercial meat production necessitates the use of high quality compound feeds.

In an extensive review on the nutrition of commercial rabbit, Lang (1981 a) stated that the rabbit appears to digest protein and fat well but fibre digestibility is very low. Digestibility coefficients of individual feedstuffs are useful indication of their potential, but when included in a compound feed mixture the resultant digestibility is not necessary the mean of the constituents.

Little information is available on the digestibility of compound feed mixtures. Using compound feeds of different composition, Colin (1976) found that digestibilities of organic matter, nitrogen and fibre were slightly higher than values calculated from published data (Cited by Lang, 1981 a).

There are a number of factors affecting digestibility. Differences between individual rabbits appear to be large especially in digestion of fibre and legumes. Breed and strain differences exist, but the meat breeds are superior. New Zealand Whites are slightly more efficient than Californians (Cheek *et al.*, 1978 a).

In young rabbits digestibility is similar in both sexes, but in the adult the buck is poorer than the doe. Digestibility is the resultant of the rate of passage as well as the rate of digestion of a feedstuff. In the rabbits any increase in retention time of food in the caecum increases its digestibility but is also associated with an increase in digestive disorders suggesting that a fast rate of digestive transit is normal in the rabbit. Level of food intake may effect digestibility (Miller et al., 1984).

Duration of light has been shown to affect digestibility of protein and fibre, possibly by its effect on food intake and retention time. Further several experiments confirmed the expected decline in digestibility as plants mature. Drying of forages significantly reduces the digestibilities of protein and lignin (Miller et al., 1984).

Lang (1981 a) observed that as the young rabbit grows digestibility decreases rapidly after weaning until it stabilises at about 10 weeks. In breeding does, digestibility is high at the start of lactation but declines as lactation progresses.

Apparent digestibility coefficients were assessed in New Zealand White rabbits from age 6 to 12 weeks, fed ad libitum by Maertens and Groote (1983). Except for ether extract, the apparent digestibility coefficient of nutrients decreased between 6 and 12 weeks, especially upto week 9, significantly for crude protein and ash ($P \angle 0.01$) and for organic matter and gross energy ($P \angle 0.05$). Sex had no effect.

Gacek (1978 a) estimated the digestibility in New Zealand White and Polish White rabbits of each sex to determine the effect of breed on digestibility of nutrients. The diets tested were pelleted complete feed, various combinations of pelleted feed and roughages, and all roughage feed with 1/3 per cent oats. Results indicated that digestibility of crude fibre did not differ significantly. However, the average digestibility of the diets indicated that the organic matter, crude protein, ether extract and NFE was higher in New Zealand Whites as compared to Polish White rabbits.

In another experiment, Gacek (1978 b) studied the digestibility with New Zealand White rabbits 6 week or 7 month old to assess the effect of age on digestibility of nutrients. It was observed that the average digestibility of organic matter was almost comparable for young and old rabbits. The average digestibility of crude protein and crude fibre was superior in the young whereas, the average digestibility of ether extract and NFE was higher in the adult rabbits.

Schlolaut (1982) reported that the digestibility of organic matter increased from 46.1 per cent, calculated on the basis of hard faeces alone, to 52.5 per cent on the basis of hard and soft faeces together.

Lebas (1979) conducted an experiment involving the feeding of a standard 17.5 per cent protein rabbit ration to a group of

Californian and New Zealand White rabbits. Adults of both breeds digested the diet to a greater extent than did rabbits of 11 weeks of age or less. The digestibility of feed was higher in females than in males for adults; there was no sex difference during growth. The digestibility of dry matter was higher in New Zealand Whites than in Californian rabbits. Thus it was shown that breed, age and sex differences existed in nutrient utilisation.

Sastry and Mahajan (1981) stated that the efficiency of dry matter utilisation decreased with the advancement of age in meat type rabbits. However, the young and adult utilised the dry matter more efficiently on completely concentrated diets when compared to roughage + concentrate and only roughage diets.

2.5.1 Fibre

Slade and Hintz (1969) while comparing the digestion in horses, rabbits and guinea pig stated that the digestibilities of all components of diet decreased as the fibre level increased but it was suggested that effect was unimportant over the ranges of fibre level which are usually consumed. On high fibre diets digestibility is poor than in ruminants, but on low fibre diets the digestibility of organic matter is high. More surprising is the fact that in equine which has a digestive system with a large caecum resembling that of the rabbit, the coefficient of digestibility of fibre is nearly double that in rabbit.

Spreadbury and Davidson (1978) concluded that for the rabbit the nutritive value of the structural protein of plant cells is limited. While apparent crude fibre digestibility as reported by Aigoni et al. (1980) was 19.48 per cent.

Digestibility of 3 feeds with 7, 10 and 13 per cent crude fibre was estimated in rabbits between 8 and 14 weeks of age by Carrogal (1980). It was concluded that the digestibility coefficients of organic matter, protein and NFE reduced with increasing levels of crude fibre, and rise in crude fibre levels of diet increased its digestibility coefficients.

Lebas (1980) stated that digestibility of crude fibre by rabbits is very low as compared with other herbivorous animals, but they may eat very large amounts of crude fibre. Thus rabbits are able to use very efficiently plants and other materials with a high level of both protein and fibre.

According to Nordic-Baldissera (1980 b) animals primarily dependent upon microbial digestion in the bowel are usually less efficient than the ruminants in the digestion of fibre. One explanation for the low efficiency of fibre digestion in rabbit could be the rapid rate of passage of digesta, or the failure of protozoa population in the hind gut, which act mechanically in ruminant and horse. In the rabbit the caecum is well develops for continuous mixing of the contents with a well developed muscular system for metabolites absorption. The end products of fermentation most readily available to the animal are the break down products of carbohydrates, the VFA.

It has been stated by Owen (1981) that hind gut digestion, which takes place in the rabbit, is a superior adaptation for dealing with high fibre herbage, provided that intake is not restricted by the quantity of herbage available.

El-Sarafi *et al*. (1982) reported that at 9 weeks old, body weight and carcass weight were greatest with 15 per cent fibre in diet. At 13 weeks old, body weight and carcass weight were greatest for rabbits given 15 per cent fibre throughout. But the dressing percentage was greater with 20 per cent fibre than with 15 per cent.

Digestibility of crude fibre was estimated in 6, 14 and 22 weeks old rabbits by Partridge (1981). The high fibre diet, compared with the other diet, decreased digestibility of dry matter and NDF. There was no clear relation between dry matter intake and fibre digestibility. Neutral detergent fibre digestibility showed no obvious trend with age.

2.5.2 Protein

Rabbits digest protein, particularly the protein in forages, very efficiently (Miller *et al*., 1984). The digestibility of crude protein increases as the dietary crude protein level rises, but is markedly depressed by an increase in the crude fibre content of the diet. The digestibility of most nutrients has been shown to increase as protein level rises. The quality of the dietary protein affects digestibility. Biological value of poor quality proteins is improved by microbial fermentation in the caecum but the resulting microbial protein may after reingestion be poorly digested (Kennedy and Hershberger, 1974).

Spreadbury (1978) stated that the diets crude protein concentration usually ranged from 110 to 260 g/kg. The results of both growth rate and food intake indicated that daily live weight gain was maximal at dietary protein levels around 160 g/kg. A study of the distribution of dietary nitrogen also indicated a need for 150 g protein/kg diet. Above this concentration the amount of dietary protein apparently retained was almost constant. Further, quality of protein in terms of amino acid balance was important for the growing rabbit. Fish meal, casein and soyabean meal supported growth rates over 40 g/day, whereas, groundnut meal, gelatin and gluten supported rates of up to 30 g/day only. Apparent protein digestibility as reported by Rigoni *et al.* (1980) was 72.86 per cent.

The relation between protein and energy in all mash diets for young rabbits was studied by Jensen (1981). Highest growth rates were obtained with a feed mixture containing digestible protein 130 to 140 g/2000 kcal ME.

Six to 16 week old rabbits were given isoenergetic diets containing graded levels of protein by Chiang *et al.* (1983). From consideration of body weight gain and feed conversion efficiency it was concluded that 12 per cent dietary protein was optimum.

The digestibility of nutrients in diets containing different levels of crude protein (14, 16 and 18%) and crude fibre (12, 14 and 16%) was studied by Carregal (1984) using Californian and New Zealand White rabbits and their crosses. The average digestibility values of 58 days of age were: dry matter 66, crude protein 77, crude fibre 28 and energy 69 per cent, respectively.

Three groups of rabbits were fed on a diet of concentrates (protein 26 and fibre 6.9%) in the morning and hay (protein 12 and fibre 28.8%) in the evening, the same diet with the meal times reversed or a 1:1 mixture of concentrates and hay(Protein 19 and fibre 17%) by Ruffini and Rigoni (1985). Digestibility of protein, fats, fibre and energy was greatest in rabbits given concentrates in the morning; differences were significant compared with values of rabbits given the mixed meals.

The effect of feeding urea (46% N) on growth, nutrient digestibilities and feed efficiency was studied by El-Sarafi et al. (1981). The results suggested that digestible coefficients for dry matter, crude protein and crude fibre were higher in the control rabbits than those fed on urea.

2.6.3 Fat

The effects of fat on digestibility of the diet are equivocal. There was no effect on digestibility of dry matter, ether extract, or crude protein when vegetable oil was added to the ration (Thaler, 1986).

Apparent fat digestibility as reported by Rigoni et al. (1980) was 76.86 per cent.

A decrease in the digestibility of dry matter, organic matter and energy was reported by Lebas (1975) who suggested that the addition of oil did not increase digestible energy content of diet because the maize oil used itself had a low digestibility (Cited by Lang, 1981 b).

Schlolaut (1982) citing several workers reviewed that according to Cheeke (1974), fat improved the palatability of mixed feeds, with the optimum being achieved by a 10 per cent supplement of maize oil. Arrington et al. (1974) found better daily weight gains when the fat content was as high as 14 per cent whilst Parigi Bani (1976) maintained that the fat additive should not exceed 5 per cent of the ration. Further, that the presence in the faeces of saponified fat which is not detected by ether extraction may have resulted in spuriously high apparent digestibilities of fat being quoted in many experiments.

2.5.4 Energy

An adequate supply of energy is recognised to be of primary importance in maintaining optimum performance in all farm livestock.

As fibre level of the diet increases the digestibility of all nutrients has been found to decrease but the effect is most marked on energy and organic matter digestibility (Slade and Hintz, 1969).

Energy requirements for rabbits have been expressed in a multiplicity of way, which make comparison difficult. Recent work using ME or NE would seem to be a satisfactory basis for assessing requirements (Lang, 1981 a). The energy requirements of commercial rabbits are assumed to be met by their differing voluntary intake of a single compound feed.

Spreadbury and Davidson (1978) stated that growing rabbits have been clearly shown to adjust food intake to maintain a constant level of energy intake.

As in ruminants the efficiency of use of ME for maintenance seems to be relatively independent of the level of crude fibre or crude protein in the food. Coprophagy appears to have no significant effect on the digestibility of energy (Lang, 1981 b).

The relative high fibre requirement of the rabbit has resulted in most traditional rations having low energy contents. Recommendations based on observations rather than experimentation (N.R.C., 1966) have far too long been used in compound feed formulations. Young rabbits can grow much faster than the currently accepted rate if their nutrient supply is increased, and as in other species, energy is probably the primary factor which limits growth. Five to eight week old New Zealand White rabbits growing about 40 g/day can adjust their food intake to maintain a constant daily ME intake of about 1.1 MJ (Lang, 1981 b).

Lebas and Matheron (1982) reported that the production of one kg of rabbit meat requires only one quarter of the feed energy needed to produce the same amount of lamb or beef and only 70 per cent of the feed required for the equivalent quantity of pork. However, 30 per cent more feed energy is needed to produce one kg of rabbit meat than is required for the same amount of chicken meat, but rabbits have the economic advantage of thriving on feed stuffs rich in roughage while poultry can not.

High energy diets improve feed conversion efficiency but crude fibre level must be maintained if feed intake and growth rate are to be sustained. Energy level is of necessity usually raised by increasing the fat content of the ration. Some types of fat reduce palatability, so care must be exercised in selection of type as well as level of fat for inclusion (Lang, 1981 a).

Metabolizable energy levels found in compound feeds are commonly about 2000 kcal (9 MJ)/kg as fed, but lower values are often reported. Good growth rates have been demonstrated using a ration of 2600 kcal (10.8 MJ)/kg (Davidson and Spreadbury, 1975).

Caecal volatile fatty acid production may contribute a substantial proportion of energy requirements but the importance of the process in rabbits of different ages and on varying diets has not been investigated (Lang, 1981 b).

De blas *et al.* (1981) studied the effect of diet on feed intake and growth of rabbits from weaning to slaughter at different ages and weights. They reported that the digestibility coefficient for energy decreased ($P < 0.01$) with increasing fibre content. The energy to protein ratio (kcal DE/gram DCP) was related to growth traits ($P < 0.01$), DE intake ($P < 0.05$) and rate of mortality($P < 0.05$). All these relationships were curvilinear. The relationship between growth rates and DE intake reached a maximum at an E : P ratio of about 23.5 kcal DE : g DCP, at which mortality rate was minimum. An increase in weaning weight increased ($P < 0.01$), weight at 49 days ($P < 0.01$) and weight at 63 days ($P < 0.05$), but did not affect either average daily gain or weight at 77 days of age. Sex did not have a significant effect on any of the variables considered.

Lebas (1982) stated that one must expend 430 MJ of gross feed energy to produce 1 kg of rabbit meat. As long as the protein content of the diet is not lower than 12 to 13 per cent, growth performance is little affected provided that the energy intake is sufficient.

Effect of feeding two pelleted diets with differing energy density was studied by Ledin (1982) in 14 week old New Zealand white rabbits. The diets contained 18 and 37 per cent dehydrated alfalfa, respectively. Results indicated that the digestibility coefficients for crude protein, crude fat, NFE, organic matter and energy were higher in diet containing 18 per cent dehydrated alfalfa. However, digestibility coefficient for crude fibre was higher in the other diet containing 37 per cent dehydrated alfalfa diet.

As cited by FAO (1982), rabbits ranked second in efficiency as feed converters after chicken so far as the energy needed to produce 1 kg of meat was concerned-430 MJ against 345 MJ in the case of chicken (Dickerson, 1978).

Rodrigues *et al.* (1983) reported that feed efficiency in rabbits weaned at 4 to 5 weeks of age was greater when the DE/DCP was between 22 and 25 kcal/g.

2.5.5 Vitamins and Minerals

Lang (1981 a) stated that the optimum amounts of vitamins for high rates of growth and reproduction are known in very few cases although the minimum to prevent deficiency symptoms and the level above which toxicity occurs have been established for the fat-soluble vitamins and most of the B group. In practice generous levels are usually included in compound feeds as an insurance against deficiencies. Traditional rabbit diets in which large amounts of animal proteins were used probably needed little mineral supplementation. Present day rations in which the major constituents are cereals and plant proteins do however require supplementation with trace and major minerals. Where no specific requirement is known it is common practice to supply a mineral at the minimum level commonly provided for other species (Lang, 1981 b).

Yoshida *et al.* (1968) stated that germ free rabbits excreted a higher percentage of ingested calcium and phosphorus in the urine than did conventional rabbits, whereas, it was the opposite in case of faeces.

Values for certain urinary excretion products of male New Zealand White rabbits were investigated by Weisbroth *et al.* (1974). They reported that Na and K (m Eq./kg/day) ranged from 0.31 to 2.69 with a mean of 1.41, and 4.46 to 15.69 with a mean of 8.67, respectively. Ca and P (mg/kg/day) ranged from 12.1 to 193.2 with a mean of 98 and 5.0 to 32.8 with a mean of 14.0, respectively.

Rabbit urine was analysed for total nitrogen, urea and uric acid by Cheeke *et al.* (1982). A pooled sample was found to contain 0.89 g nitrogen, 1.175 g urea and 14 mg uric acid per 100 ml. Approximately 62 per cent of the total nitrogen excreted was urea. This they stated was somewhat lower figure than other species.

2.6 GROWTH RATE AND FEED EFFICIENCY

Growth rate and feed efficiency are factors of primary importance in determining the profitability of meat rabbit.

In animals that were weaned at 8 weeks of age and fed rations containing 3 parts of alfalfa hay + 2 parts of concentrate mixture, Kellogg *et al.* (1949) reported that the group fed peanut meal required 83.6 days to reach 6 lb with a feed conversion ratio 1:4.26.

Weaning takes place usually at 6 to 8 weeks. After weaning, the young should continue to receive a high protein diet to ensure rapid growth (Braunlich, 1968).

A fast growth rate is desirable as earlier the rabbits are marketed at a particular weight the more profitable they will be. The aim should be to produce uniform litters weighing 4 lb and over at 8 weeks of age (Ministry of Agriculture, Fisheries and Food, U.K. 1972). Further, feed is one of the major costs of a rabbit enterprise, so it is necessary to obtain a low feed conversion ratio. A good standard is 3 lb feed/1 lb body weight or below. This includes the feed consumed by the doe from the time of mating until the litter is weaned at 4 weeks of age, and that consumed by the fattening rabbits from weaning upto meat marketable age.

Some of the characteristics of the growth of rabbits were studied by Rao *et al.* (1977). The average daily gains for period 0 to 2 weeks was 9.3, 2 to 4 weeks - 30.9, 4 to 6 weeks - 39.1 and 6 to 8 weeks - 36.3 g, corresponding to average weekly gain 2.3, 7.6, 9.6 and 8.9 oz, respectively.

New Zealand White rabbits weaned at 4 weeks and dressed at 8 weeks of age showed growth rates comparable to broiler chicken dressed at 8 weeks of age. The live weight at 8 weeks, feed consumption and feed conversion for rabbits and broilers respectively were 1688 and 1833 g; 3840 and 3904 g and 2.46 and 2.81. The average daily gain of the rabbit was 29 g/day and that of chicken was 32 g/day. The results indicated that rabbit grows as fast as modern broiler chicken and utilises feed protein as modern broiler chicken and utilises feed protein more efficiently than borilar (Reddy et al., 1981).

Bednarz and Frindt (1980 a) studied the effect of age at weaning on growth to 10 week old of New Zealand White rabbits. Rabbits in 2 groups were weaned at 4 or 6 weeks of age to a commercial pelleted feed with 21 per cent crude protein and ME 2780 kcal/kg and hay to appetite. Live weight at 8 weeks of rabbits weaned at 4 or 6 weeks was 1738 and 1808 g and at 10 weeks was 2189 and 2203 g; average daily gain during 10 weeks was 29.72 and 30.46 g.

Cheeke and Patton (1978 a) fed weaned rabbits a diet consisting of corn + soyabean meal + lucerne at various levels in two different experiments. In the first experiment, when the percentage dietary alfalfa level was 0, 2.5, 5.0, 7.5, 10.0, 20.0, 30.0 and 40.0, the average daily gain was 34.6, 38.1, 42.6, 37.0, 42.5, 38.6, 31.8 and 32.8 g, respectively. When the same experiment was repeated with the same concentrate ingredients in the diet as in experiment 1 but in combination with ethanol extracted alfalfa fibre at levels as in experiment 1, the daily gain was slightly variable.

To study the influence of weaning at 4, 6 and 8 weeks and of slaughtering at 8, 12 and 16 weeks of age, New Zealand White rabbits were used by Chen et al. (1978). Mean live weights of rabbits ranged from 1388 to 2177 at 8 weeks, 2129 to 2826 at 12 weeks and 2634 to 3284 g at 16 weeks old. Slaughter age influenced the live weight, whereas weaning age showed no effect. Feed efficiency was from 2.29 to 3.72 g/g gained for different weaning and slaughter age group combinations. Slaughter age influenced feed efficiency but weaning age had no effect. The mean feed efficiency of rabbits weaned at different ages but slaughtered at 8 weeks was 2.34.

Horne (1978) stated that meat rabbits can be marketed at 4½ to 6½ lb live weight and this can be achieved at 9 to 11 weeks of age. Feed consumed per lb of meat produced at 4½ lb live weight was 3.25 lb. It was concluded that feed conversion ratio suffers after 5 lb live weight for New Zealand Whites and 4 1/4 lb for Californian breed.

Gohl (1978) stressed that in New Zealand Whites, after an approximate weight of 2.5 kg, the feed efficiency declined.

Owen (1978) stated that weaned New Zealand Whites can produce growth rates of 28 to 39 g a day up to 2 kg live weight on diets consisting solely of dried herbage of lucerne and rye grass.

According to Newstead *et al.* (1978) feed conversion ratio including all feed fed to does and bucks, will probably be between 3.25 and 4.00 to one. Litter from weaning to slaughter will convert from about 2.5 to 1.0. It was opined that the weight of the rabbit at slaughter will have a marked effect on the feed conversion ratio.

The efficiency with which rabbits convert food into meat varies widely with breed and with strains within breeds. A good strain of meat rabbits would have a food conversion of about 3:1 from weaning to slaughter. A better feed conversion is obtained when rabbits are killed at 1.8 to 2.0 kg live weight, which a good strain should reach at 8 weeks old, than when the demand is for a 2.3 to 2.5 kg rabbit which may take 10 or more weeks to produce. For maximum profitability it is important to have a strain which reaches the desired weight in the shortest possible time because feed conversion efficiency deteriorates after 10 weeks of age (Ministry of Agriculture, Fisheries and Food, U.K., 1979).

Rigoni *et al.* (1980) found the body weight gain (g/day) to be 43.84 and feed efficiency (food/gain) 2.83 kg in growing rabbits.

With weaned New Zealand White rabbits, Mahajan *et al.* (1980) observed that the body weights and growth rates at 7, 13 and 21 weeks of age were 562.50, 2215.50 and 3018.75 g for males and 600.0, 2168.75 and 2843.75 g for females, respectively. They concluded that young rabbits gained more weight than adults as the rate of gain in both males and females declined after 12 weeks of age. On an average, males gained 1640.00 between 7 and 12 weeks of age and 1462.00 from 13 to 20 weeks of age at 33.67 and 26.23 g/day respectively during the above ages. The average for females during the corresponding periods were 1568.75 and 1281.25 g of total weight gain and 32.02 and 22.80 g of average daily gain. Seven to 13 weeks aged rabbits were more efficient in utilizing the dry matter (unit feed consumed/per day/unit daily weight gain) than the older ones (13 to 20 weeks) revealing that ability to utilise the feed decreases with the increase in age in meat type rabbits. Further, young and adult utilised the dry matter more efficiently on completely concentrate diets when compared to roughage + concentrate and only roughage diets.

New Zealand White rabbits in 2 groups, fed on a pelleted food with 21 per cent crude protein and hay to appetite, reached 2 kg live weight at 71 days when weaned at 4, or at 64 days when weaned at 6 weeks old. Three kg was reached at 110 and 106 days, respectively (Bednarz and Frindt, 1980 a).

Pote et al. (1980) studied the response of weaning rabbits to diets containing various levels of alfalfa. The percentage dietary alfalfa levels were : 0, 10, 20, 30, 40, 50, 60 and 74. The respective average daily gain observed at these levels were : 31.4, 44.0, 36.6, 40.1, 26.4, 41.1, 37.2 and 38.2 g. The corresponding feed/gain values obtained were 2.7, 2.4, 2.9, 2.8, 3.2, 3.2, 3.6 and 3.9 respectively. The better response, they concluded, was from 10 per cent dietary alfalfa level in the diet which gave the best average daily gain and feed efficiency in comparison to diets containing higher levels of alfalfa.

Gilligan (1980) who investigated flat deck versus colony rearing of weaned New Zealand White rabbits concluded that growth rate was rapid but feed conversion poor in cages than in colonies at 8 weeks of age. The average daily weight gain and feed conversion ratio in colony pens and cages was 1.75 and 2.0 g and 2.84 and 3.04, respectively.

In experiment 1, newly weaned New Zealand White rabbits were given diets based on yellow maize and soyabean oilmeal, without lucerne meal, or with 10, 20, 30 or 40 per cent lucerne meal. Mean daily gains of groups in the above order for 2 replicates of each, were 23.5 and 28.1, 32.9 and 37.9, 38.6 and 41.5, 31.8and 40.1, 32.8 and 35.9 g. In a nother experiment, the effectiveness of finely ground lucerne meal or lucerne hay to appetite was compared. Daily gain was 44.5 and 45.3 g compared with 24.7 g for a control diet without lucerne (Cheeke and Patton, 1981).

New Zealand White rabbits were given isoproteineous and isocaloric diets to appetite in a 4 x 2 factorial experiment by Podren et al. (1981). In males mean daily gain was 34.37, 34.64, 33,24 and 31.67. The feed conversion ratio was of the order 4.65, 4.68, 4.85 and 5.01, respectively. Values for females were : 33.94, 34.11, 32.97 and 30.94 g average daily gain with feed conversion ratio being 4.84, 4.76, 4.65 and 4.97.

Douglas (1981) stated that the New Zealand White converts food at an average of 2.28:1 from birth to 3 1/2 lb live weight and that the food conversion ratio rapidly deteriorates after 8 weeks of age. The food conversion ratio from 8 to 9 weeks is 3.45:1 and 9 to 10 weeks is 4.20:1. It was concluded that the age at market weight increased from between 8 1/2 weeks to 9 1/2 weeks in cages to between 10 and 12 weeks for the colony system by which time any chance of good feed conversion ratios had been negated.

By feeding lucerne meal of composition 21.8 per cent crude protein and 28.9 per cent ADF, Harris et al. (1981) studied the average daily gain in weanling rabbits from 0 to 14, 0 to 21 and 0 to 28 days, which was 33.7, 37.9 and 41.4 g and feed/gain was 2.44, 2.80 and 3.71, respectively.

A growth trial was conducted by Lange and Schlolaut (1981) on New Zealand White rabbits, weaned at 4 weeks, from 8 to 16 weeks of age when the animals attained 2.5 kg. The average daily weight gain was 37.4 g and feed efficiency 1:3.48 kg.

Schlolaut (1981 a) stated that in the rabbit, in contrast to cattle, pigs, sheep and poultry, the sexual dimorphism is characterised by lower weight of fully grown male animals, and also as a result, poor feed conversion and greater fat development of the male animals. The sexually determined differences increase in proportion to the feeding intensity and the final fattening weight.

Cheeke (1984 b) observed that feed conversion ratios of 3 to 4:1 can be obtained with high roughage diets. He opined, that since rabbit meat is low in fat, the energy costs per unit of weight gain may be low. This could at least partially explain the high feed conversions observed.

The effect of feeding urea (46% N) on growth and feed efficiency was studied by El-garafi (1981). Growth of the rabbits during 4 periods : from weaning to 20, 20 to 24, 24 to 28 and 28 to 32 weeks of age were examined. The results showed that daily gains of rabbits fed on urea were inferior (P< 0.05) than those fed on control ration. This was attributed probably due to a lower digestibility of dry matter, crude protein and crude fibre. The difference in gain between rabbits of the 2 nutritional treatments was obvious during the periods from weaning upto 24 weeks of age, decreasing thereafter. Ranges of average daily gains were : from 10 to 17.1 g and from 8.8 to 14.1 g in control rabbits and those fed urea, respectively. Feed efficiency (g gain/100 g DM intake) was better in control than fed urea, especially during weaning to 20 week age.

Lang (1981 b) stated that the young rabbit has an extremely high growth rate which starts before birth and continues exponentially until the animal is about 10 weeks old. Growth rate is reduced after birth, but is still very rapid. The young rabbit approximately doubles its weight every week until it reaches about 0.45 kg at 3 weeks old. Thereafter, the rabbit begins to eat solid feed and growth rate, which is 10 to 20 g/day while milk is the sole food, may attain 30 to 50 g/day between 3 and 8 weeks of age. This is, however, directly related to the supply of dietary nutrients. After 8 weeks, growth rate begins to diminish until to 10 to 12 weeks old and the growth curve flattens. When the rabbit has passed this rapid phase of growth, changes occur in the proportion of fat and in the moisture content of the live weight gain so that more energy is needed per unit of gain than at younger stage. Feed conversion ratio is about 2:1 at 3 weeks but decreases to about 3:1 at 8 weeks old. After 8 weeks feed conversion ratio deteriorates rapidly being about 4:1 at ten weeks and 5:1 or more at 12 weeks old. A meat rabbit should attain 2.4 kg live weight at about 10 weeks old, but the poorer feed conversion and slower growth towards the end of this period results in the last few grams of body weight being achieved at greater cost than the earlier growth. Attainment of desired market weight during or soon after the phase of rapid growth is therefore of paramount importance for economic production of rabbit meat. Many early experiments compared growth rates in rabbits of 12 weeks old or more, when the maximum growth phase was finished and the potential for growth was poor. More recent experiments where growth rates of 30 to 40 g/day are attained would appear to be more reliable estimates of meat rabbits requirements. Young weaned rabbits were found to grow well (about 30 g/day) on diets containing up to 100 per cent of several types of dried forage, and their high reproductive rate makes rabbits potentially more efficient than most farm livestock at converting forage into meat.

Owen (1981) observed that weaned New Zealand Whites can produce growth rates of 38 to 30 g/day up to 2 kg live weight on diets consisting solely of herbage. However, this was achieved with high quality lucerne and rye grass.

Sastry and Mahajan (1981) reported average daily weight gain of 24.11 and 32.84 g, and a significant (P ∠ 0.01) feed conversion ratio of 3.04 and 2.27 in New Zealand white rabbits fed roughage + concentrate, and concentrate alone respectively for 7 to 13 weeks old. In 13 to 20 weeks old, significant (P ∠ 0.01) average daily gain of 17.52 and 24.56 g with significant (P ∠ 0.01) feed efficiency of 5.87 and 4.17 respectively was observed.

Farrell (1982) concluded that rabbits can grow at 38 g/day on diet containing 90 per cent lucerne meal.

From feeding isocaloric diets containing either 14, 16, 18 or 20 per cent protein, Jhonston (1982) found no differences statistically in growth of young to 8 weeks of age. There was, however, a tendency for young consuming the 14 per cent diet to convert feed to gain less efficiently.

Lebas (1982) opined that the question of the feed efficiency of feed conversion for all meat production is the conversion of those plant proteins which are little, or not at all consumed by man, into animal proteins of high biological value. In case where protein content is only 8 to 10 per cent, growth is affected.

Harris *et al.* (1984 a) used New Zealand White rabbits to determine the effect of full versus limited feeding on growth, feed efficiency and mortality. Restricted fed rabbits received approximately 95 per cent of the feed given to the full fed rabbits. Results showed that feed restriction at that level produced no significant changes in growth, feed efficiency and mortality. The diet contained 54 per cent sun cured alfalfa. The average daily gain in restricted and full fed diet was 39.8 and 40.8 g with feed efficiency 3.13 and 3.22, respectively.

Carregal (1984) investigated the effects of different levels of dietary protein (14, 16 and 18%) on the performance of New Zealand Whites. Average weight gain was not affected by level of crude fibre, but feed intake and feed conversion decreased with 12 and 16 per cent crude fibre.

Mean daily gain was 42.0, 36.7 and 32.3 g respectively in rabbits fed on a diet of concentrates in the morning and hay in the evening, the same diet with the meal times reversed, and a 1:1 mixture of concentrates and hay (Ruffini and Rigoni, 1986).

2.7 CARCASS CHARACTERISTICS

In areas where rabbits are produced commercially it is the usual practice, for the medium weight and heavy breeds, to market the young when about 2 months old without previously weaning them. When full fed, these 8 week-old animals weigh about 4 to 5 lb and are known as fryer rabbits. They comprise more than [illegible] per cent of the domestic rabbits marketed (Miner, [illegible]).

As per the regulations governing the voluntary grading of poultry products and rabbit products and U.S.Classes, Standards and Grades ([illegible]) the classes of ready-to-cook rabbits are fryer or young rabbit and roaster or mature rabbit. A fryer or young rabbit is a young rabbit carcass weighing not less than 1 1/2 lb and rarely more than 3 1/2 lb processed from a rabbit usually less than 12 weeks of age. The flesh of a fryer is tender and fine grained, and of a bright pearly pink colour. A roaster or mature rabbit is a mature or old rabbit carcass of any weight, but usually over 4 lb processed from a rabbit usually 8 months of age or older. The flesh of a roaster is more firm and coarse grained, and the muscle fibre is slightly darker in colour and less tender, and the fat may be more creamy in colour than that of a fryer.

According to Simmonds and Stahl ([illegible]) a fryer or young rabbit carcass usually weighs not less than 1.7 kg and should be from 3 1/2 to 4 months old so that the pelt is of prime quality to warrant tanning. Whereas, a roaster or mature is an old domestic rabbit carcass of any weight and has usually out grown its productivity.

Farrell ([illegible]) opined that fryer rabbits may reach 2 kg at about [illegible] weeks of age and that the carcass yield may range from [illegible] to [illegible] per cent, though it is very often [illegible] per cent of live weight. Further, the dressing percentage can be calculated from live weight (W.kg) using the formula [illegible]

Mahajan et al. (1980) however, reported that the dressing percentage for fryers and roasters ranged from 44.90 to 50.88 and 45.21 to 52.05, respectively.

Townsend et al. (1978) suggested that the slaughter weight of the rabbit should be 4 1/2 to 5 lb minimum; the recommended upper limit for slaughter weight was about 2.5 kg (Zugin et al., 1978).

Chen et al. (1978) were of the opinion that since early weaning can return the doe for mating for accelerated breeding, it seems that weaning at 4 weeks and slaughtering at 8 weeks is most economical for rabbit production.

Owen (1978) stressed the need to slaughter at a fixed live weight rather than a fixed age. For New Zealand Whites the approximate weight was 2.5 kg.

In U.K. under intensive commercial units, meat rabbits achieve slaughter weights of 2 kg in 2 1/2 months. In developing countries of tropics slaughter weights of 2 kg are attained in any time up to 6 months or a little more (Owen, 1981).

Quality in meat and meat type rabbits refers to proportions of meat, bone, waste, fat, etc., condition of flesh, distribution of meat, uniformity among littermates, capacity to produce many offsprings, type and build of body to endure the rigours of production etc. (Reverdy, 1988).

Cheeke *et al.* (1982) outlining the method of slaughter in rabbits stated that the first step in slaughtering the rabbit is to render it unconscious in order to prevent suffering and struggling. The method is to hold the rabbit by its hind legs in one hand and the thumb of the other hand is placed on the neck just behind the ears with four fingers extended under the chin. The animal is stretched by pushing down the neck with one hand and with a quick movement the animal's head is jerked upwards to dislocate the neck.

Rummapp (1982) reported that rabbit meat is high in protein, very low in saturated fatty acids, cholesterol, sodium and fat, and has about 10 times more potassium than beef or poultry. Further, rabbit is termed the only known edible meat containing significant amount of vitamin B_{12}.

2.7.1 Dressing Percentage

The New Zealand white rabbit has a good meat conformation; the adults weight 4.0 to 5.5 kg. The end product of the meat rabbit is an 8 to 10 weeks old animal weighing 2.1 to 2.7 kg which has a killing percentage of 50 to 55 (Lang, 1981 a).

The digestive system of the rabbit is so large that the dressed carcass is proportionally small when compared with that of the ruminant, a yield of 50 to 60 per cent is normal (Braunlich, 1980).

According to the Ministry of Agriculture, Fisheries and Food, U.K. (1972), good rabbits should have a prechilled killing out percentage of 55 per cent and over.

Mahajan and Sastry (1982) citing Arrington and Kelly (19 and Sanford (1974) quoted that rabbits give a dressing percentage of about 55 which increases with age until maturity The dressing percentage depends upon the quality of animal at slaughter, breed, age, amount of fat and number of internal organs left with the carcass (liver, heart, kidneys etc.) and whether or not the head is left with the carcass.

Lebas (1982) reported an average carcass yield of 60 per cent in fryer rabbits with head included. Dressed-out carcass with head in relation to live weights and age were reported by Schlolaut (1982). At ages 2, 3, 4, 5 and 6, months, the live weights were 1.53, 2.50, 3.15, 3.65 and 3.95 kg with the dressing percentages being 55, 58, 61, 63 and 62 per cent, respectively.

Kellogg et al. (1949) found that in New Zealand Whites weaned at 8 weeks of age, the dressing percentages including the liver, heart and kidneys of prime, choice and commercial carcasses were 56.8, 53.3 and 52.7 respectively, while, Harris (1978) reported a dressing percentage of 50 to 54 per cent (less the head and feet).

The carcass yield in rabbits weaned at 4 weeks of age and dressed at 8 weeks was 55 per cent when compared with chicken broilers dressed at 8 weeks which was 80 per cent. However, the meat quality of the rabbit was comparable to that of chicken (Reddy *et al.*, 1981).

Rao *et al.* (1978) reported that the mean dressed carcass ranged from 45.6 to 50.2 per cent of live weight. Weaning age had no effect on the carcass yield. Carcass yields were higher at 12 and 16 weeks than at 8 weeks of age.

Dressing percentage was 54.5 at 2 kg live weight irrespective of weaning and 54.5 and 55.2 per cent at 3 kg live weight in rabbits weaned at 4 or 6 weeks. Values for males weaned at 4 weeks were higher than for females, 56.5 and 55.4, as against 52.4 and 53.6 per cent at 2 and 3 kg live weight, respectively. It was concluded that carcass yield and quality were not affected by age at weaning ([illegible] and Frindt, 1980 b).

Schlolaut (1981 b) opined that carcass yield varies according to the final fattening weight, from 50 per cent at 1.8 kg live weight to 60 per cent at 3.0 kg live weight. New Zealand White broiler rabbits were slaughtered at 86 or 100 days old and the quality of the carcass assessed by Rudolph and Fischer (1982). The dressing percentage at 86 and 100 days was 55.62 and 57.34, respectively. Meat quality estimated by moisture content, meat colour, cooking loss, dry matter content, raw protein and fat and dry ash was improved by the extra 14 days fattening.

Lange and Schlolaut (1981) slaughtered New Zealand White rabbits at 16 weeks of age when the animals attained 2.5 kg live weight. The hot carcass yield was 56 per cent and the cold carcass yield was 54.4 per cent with a shrinkage of 2.85 per cent.

The dressing percentages of rabbits fed 0 to 74 per cent lucerne diets were virtually identical, 48.4 and 49.2 per cent respectively (Cheeke and Patton, 1981). Whereas, Ledin (198 found the dressing percentage to be 47.72 and 47.23 in 14 week old rabbit carcasses that were fed diets containing 18 and 37 per cent alfalfa, respectively.

Rudasin *et al.* (1977) stated that the average dressing percentage in young New Zealand White rabbits was 54 per cent whereas, Mgeni (1978) quoted dressing percentages ranging between 58 and 61 per cent with an average of 57 per cent. However, Owen (1976) added that the dressing percentage might be as low as 40 per cent when the diet was based on a high level of roughage.

New Zealand White rabbits fed on roughage alone, concentrate + roughage (1/3 : 2/3) and concentrate alone to 12 and 20 weeks were slaughtered for studying the carcass characteristics by Mahajan and Sastry (1983). The results revealed that the diets influenced the dressing percentage at 12 and 20 weeks of age both without and with pluck. The pooled averages of the 3 diets at 12 and 20 weeks of age indicated an increase in the dressing per cent and leanness of the carcass with the advancement of age.

However, Schlolaut (1982) concluded that if concentrate pellets of high nutrient density are fed, the slaughter weight should not exceed 80 per cent of the weight of the adult animal.

When rabbits were weaned at 4 weeks and fed a control diet plus a diet with 5 or 8 per cent of maize oil, and slaughtered at 10 weeks of age, King (1983) found insignificant dressing percentages of order 50.56, 51.06 and 51.25 in the three treatment groups, respectively. Likewise, Carregal (1984) reported that carcass yield decreased with low levels of dietary protein.

Dressing percentages (Oven - ready) in relation to different feeding methods was studied by Schlolaut (1984) The average dressed carcass was 59, 56 and 55 per cent for ad libitum, 80 per cent ad libitum and 60 per cent ad libitum respectively.

2.7.2 Carcass Cuts

The carcass of a rabbit (ready-to-cook) is divided into 3 major cuts viz., the forequarter, midquarter and hindquarter.

In the preparation of the carcasses, stated Minor (1980), the hind legs were removed by cutting squarely across the carcass immediately in front of the hip joint and the loin was cut from the forequarter immediately back of the last rib.

the hind legs were separated, the forelegs were removed from the forequarter portion and the remainder of that portion divided into left and right sides, whereas the loin portion was left intact. Thus the forequarters consisted of four pieces, the loin of one piece and the hindquarter of two pieces. The average physical composition of A (Prime), B (Choice) and C (Commercial) grades of fryer rabbits (yields calculated on a carcass weight basis) were 36.36, 37.33 and 38.68 per cent for forequarter, 18.87, 18.00 and 17.63 per cent for loin (midquarter) and 36.60, 36.71 and 36.87 per cent for hindquarter.

However, according to the regulations governing the voluntary grading of poultry products and rabbit products and U.S. Classes, Standards and Grades (1962), the forequarters imply that the forelegs shall be removed by cutting straight across the back bone at the 8th or 9th thoracic vertebrae. The legs are divided by lengthwise cut along the back bone to produce two approximately equal halves. The midquarter imply both sections of ribs and loin. The midquarter is separated from the rump by cutting straight across the back bone between the 6th and 7th lumbar vertebrae. If the ribs are to be made into a separate cut, it shall be removed by cutting straight across the back bone between the 3rd and 4th lumbar vertebrae. The rib section is further divided by a lengthwise cut along the back bone. However, there is no division of the loin section. The hindquarter comprises of sections of rump and hind legs. Rump is separated from the hindlegs by cutting on a straight line from the base of the tail to a point approximately 1/2 an inch above the stifle joint. There is no further division of the rump. Hindlegs need no further division after separation from the rump.

Kellogg *et al.* (1940) stated that the two hindlegs plus loin comprised 60 per cent and that there was no practical difference in weight between standard cuts from bucks and from does.

Rao *et al.* (1978) conducted studies in New Zealand whites weaned at 4, 6 and 8 weeks of age which were slaughtered either at 12 or 16 weeks of age. The percentage yields of forequarter, midquarter and hindquarter in carcasses of animals weaned at 4 weeks and slaughtered at 12 and 16 weeks of age were 39.3 and 40.2, 25.8 and 25.3 and 34.4 and 33.9, respectively. In the rabbits weaned at 6 weeks, the corresponding figures were 41.0 and 41.1, 24.6 and 24.3 and 33.5 and 33.3 per cent, respectively. Whereas, for rabbits weaned at 8 weeks, the values were 40.2 and 39.8, 25.8 and 26.2 and 34.0 and 33.8 per cent, respectively. They concluded that percentage weights of different cuts were not influenced by weaning or slaughter age.

When rabbits were weaned at 4 weeks and slaughtered at 16 weeks, as they attained 2.5 kg live weight, Lange and Schlolaut (1981) found the per cent yields of fore-quarter, midquarter and hindquarter to be 23, 38.5 and 30.0 respectively whereas, Schlolaut (1982) reported the yields as 24.6, 37.8 and 33.4 per cent, respectively.

In New Zealand white male rabbits, fed on roughage alone, concentrate + roughage (1/3 : 2/3) and concentrate alone to 12 and 20 weeks old rabbits, no uniform trend was observed in the percentage proportion of various physical cuts in the carcasses among the three feeding regimes at both the ages (Mahajan and Sastry,1983).

2.7.3 Meat, Bone and Fat Proportions

Hiner (1982) found in A (Prime), B (Choice) and C (Commercial) grades the total edible meat to be 70.86, 68.80 and 67.61 per cent, separable lean 64.46, 62.30 and 64.68 per cent, separable fat 6.80, 5.40 and 2.86 per cent and bone 18.94, 21.51 and 21.50 per cent, respectively.

The average meat, bone and fat percentage found in fore-quarter was 76.7, 16.3 and 4.7, midquarter 81.6, 7.3 and 7.2 and hindquarter 80.6, 16.0 and 1.8, respectively (Rudenko et al., 1977). Whereas, Schlolaut (1982) reported an average percentage of meat, bone and fat in rabbit carcasses to be 65.2, 13.8 and 11.6, respectively.

According to the Ministry of Agriculture, Fisheries and Food, U.K. (1972), good rabbits should have a meat : bone ratio of 6:1, while Reddy et al. (1981) reported 3.6 and 3.0 in rabbits and broiler chicken respectively when slaughtered at 8 weeks.

Mahajan et al. (1980) reported that the bone : meat ratio ranged from 1:3.70 to 1:5.15 and from 1:4.60 to 1:6.17 in fryers and roasters, respectively.

Rao et al. (1978) concluded that weaning age had no significant influence on meat : bone ratio. Meat : bone ratio ranged from 2.85 to 4.01 : 1 and was not influenced beyond 12 weeks of slaughter age.

New Zealand white rabbits were killed at intervals of 0.5 kg from 1.5 to 3.0 kg by Lupin et al. (1978). During growth the proportion of fat changed. Meat from the forequarter had 2 times as much fat as that from the hindquarter.

Lang (1981 b) stated that fat content of the rabbit carcasses increases with age but is generally low in the 8 to 12 week old animals. At this stage the rate of muscle cell hyperplasia which is very rapid in the young rabbit begins to decline. However, Raleigh and Fischer (1981) reported that weights of all tissues except the longissimus dorsi were significantly greater for 14 week old rabbits in comparison with the 12 week old rabbits.

Delaveau (1981) studied the relative evolution of muscular weights percentage as against total muscle from 4 weeks to 26 wee old rabbits and found that there was a decline in the muscular per cent in forequarter, a steady increase in the midquarter, while not much variation in the hindquarter. Regarding the relative evaluation of different tissues during the same period, he found an increasing trend in the percentage of muscle and fat, while a decreasing pattern in the bone was observed.

2.7.4 Edible and Non-edible Organs

The main morphological changes of visceral growth in the rabbit occur at weaning and at sexual maturity. After 9 weeks of age a stabilization of growth of almost all organs are noted. Growth of the viscera was linked to age and only secondly to weight (Ledin, 1982).

New Zealand White broiler rabbits were slaughtered at 86 or 100 days old by Rudolph and Fischer (1981). At 86 days the weight of the liver was 64.8, kidneys 15.0 and heart 5.7 g respectively. Corresponding weights for the 100 day old rabbits were 71.2, 15.8 and 6.7 g, respectively.

However, Rao *et al.* (1979) stated that organ weights decreased with increasing slaughter age. Further, weaning age did not influence percentages of organ weights-both edible and non-edible.

Wadsworth *et al.* (1974) reported that while the weights of spleen, kidneys and heart in young male and female New Zealand

White rabbits were comparable, larger livers were found in females than in males.

At 16 weeks of age, the weight of edible organs (liver, kidney and heart) was found to be 101.6 g which was statistically significant ($P < 0.01$) (Lange and Schlolaut, 1981).

Mahajan *et al.* (1980) stated that in adult rabbits (roasters) the pluck weights ranged between 60 and 126 g.

The percentage yields calculated on carcass weight in A (Prime), B (Choice) and C (Commercial) grades for heart was 0.37, 0.42 and 0.44, liver 6.21, 5.96 and 7.15 and kidney 1.26, 1.53 and 1.60, respectively (Hiner, 1960).

Mahajan and Sastry (1982) stated that with the increase in concentrate, the proportion of edibles decreased as evidenced by ratio of edible to non-edibles 1:20, 1:10.1 and 1:0.80 in younger and 1:1.22, 1:0.86 and 1:0.75 in older rabbits fed concentrate, concentrate + roughage and roughage diets, respectively.

MATERIALS AND METHODS

CHAPTER III

MATERIAL AND METHODS

Two experiments were conducted. Details of the experimental procedures and methods of analysis adopted in this study are given below

3.1 SELECTION OF ANIMALS

In experiment 1 thirty New Zealand white rabbits weaned at 6 weeks of age were selected. They were randomly distributed into three groups of 10 animals each in such a way that the group average body weights were almost similar in all the groups.

In experiment 2 sixty three New Zealand white rabbits weaned at 6 weeks of age were randomly allotted to three diet treatment groups such that each group had 21 animals and the group average body weights were quite similar in all the groups.

3.2 DIETARY TREATMENTS

The three experimental diets were processed into pellets (6 mm diameter and 1/2 inch in length) using varying levels of lucerne hay as roughage source along with other conventional feed ingredients. The ingredient composition as well as the chemical composition of the experimental diets is given in Table 1.

Table 1. Per cent and proximate composition of experimental diets

Ingredients	Pelleted diets		
	1	2	3
Lucerne hay	20	30	40
Maize	35	37	40
Wheat bran	30	20	10
Groundnut cake	12	10	7
Mineral mixture	2	2	2
Common salt	1	1	1
Total*	100	100	100
Proximate composition (dry basis %)			
Crude protein	15.68	16.00	16.28
Ether extract	3.90	3.06	3.10
Crude fibre	11.98	12.12	12.57
Nitrogen-free extract	52.40	56.54	55.97
Total ash	15.90	12.28	12.38
Calcium	1.40	2.29	2.19
Phosphorus	0.50	0.65	0.49

*Rovimix – Vitamin supplement was added at the rate of 10 g per 100 kg of the diet. It contained 40,000 IU vit. A, 20 mg vit. B_2 and 5,000 IU vit. D_3 per g.

The experimental diets were formulated in accordance with the recommendations of N.R.C.(1977) for growing rabbits. Diets 1, 2 and 3 contained lucerne hay at 20, 30 and 40 per cent level respectively as roughage source. All the diets were nearly isocaloric and iso-nitrogenous. The nutritive value of experimental rations is presented in Table 2.

The diets were processed into pellets as follows: Lucerne hay was chaffed by using a forage cutter into 5 cm particles. The chaffed hay with maize, groundnut cake and salt were ground in a hammer mill to pass through a 3 mm screen. The ground material was conveyed to a horizontal double ribbon type mixer by a screw conveyer and bucket elevator. The stipulated quantities of wheat bran, mineral and vitamin supplements were added directly into the mixer for about 10 minutes. The mash thus prepared was used for pelleting. The mash was conveyed to the conditioning chamber of the pellet mill from the mixer through a bucket elevator. The mash was conditioned for 20 seconds by dry steam at 85°C supplied by a boiler of 250 lb/hr capacity with a working pressure of 210 psi. The conditioned mash was extruded through a 6 mm diameter ring type pellet die in a pellet mill. The pellets were then cooled for 15 minutes in a verticle type pellet cooler connected to a blower. The cooled dried pellets from the pellet cooler were collected and stored for experimental feeding.

Table 2. Nutritive values of experimental diets

Diets	DCP*	TDN*	GE** (kcal/kg)	DE** (kcal/kg)
1	12.38	[illegible]	4077	[illegible]
2	12.45	[illegible]	[illegible]	[illegible]
3	12.28	64.80	[illegible]	[illegible]

* Calculated values

** Estimated by Bomb Calorimeter.

In experiment 1 the rabbits were fed to appetite whereas in experiment 2, each diet was fed at 3 different levels - 90, 100 and 110 per cent N.R.C.

3.3 PERIOD OF EXPERIMENT

In experiment 1, to assess the digestibility and availability of nutrients, the experimental period was divided into 3 arbitrary phases namely:

Phase I - 14 weeks of age (slaughter age)

Phase II - 20 weeks of age (age at maturity)

Phase III - 36 weeks of age (adults)

In experiment 2, each of the diet group treatment was subdivided into 3 sub-groups of 7 rabbits each and the following plane of nutrition was allotted for a period of 8 weeks (6 weeks to 14 weeks of age).

Sub-group I 90% N.R.C.

Sub-group II 100% N.R.C.

Sub-group III 110% N.R.C.

3.4 PARAMETERS STUDIED

The following observations were recorded during the course of the experiments:

In the first experiments

a) Daily record of feed consumption

b) Weekly body weight records

d) Metabolism trials were conducted at 3 different ages, viz., 14 weeks, 20 weeks and 26 weeks to determine the digestibility coefficient of various nutrients and nutrient balances in rabbits fed diets having different roughage to concentrate ratios.

In the second experiment:

a) Daily record of feed consumption

b) Weekly body weight records

c) Three representative animals from each sub-group were slaughtered at the end of growth trial to study the dressing percentage, various cuts, proportion of lean, bone and fat, and percentage of edible and non-edible organs.

3.5 HOUSING AND MANAGEMENT OF EXPERIMENTAL ANIMALS

All the animals were housed and fed individually in 16 mm gauge all metal wire cages (18" x 18" x 16") containing self feeders and waterers in a well ventilated shed. Light was provided during the nights.

3.6 LIVE WEIGHT RECORDS

The rabbits were weighed before the commencement of the experiment and thereafter at weekly intervals before feed or water was offered.

3.7 DAILY RECORD OF FEED CONSUMPTION

The diets were weighed and offered to the animals in the morning daily at 9 a.m. The leftover was weighed next morning. Clean drinking water was made available to the animals at all times.

3.8 METABOLISM TRIALS

Metabolism trials were conducted in experiment 1 on representative animals (4 male rabbits from each group) at ages 14, 20 and 26 weeks, respectively. The collection period was of 7 days duration.

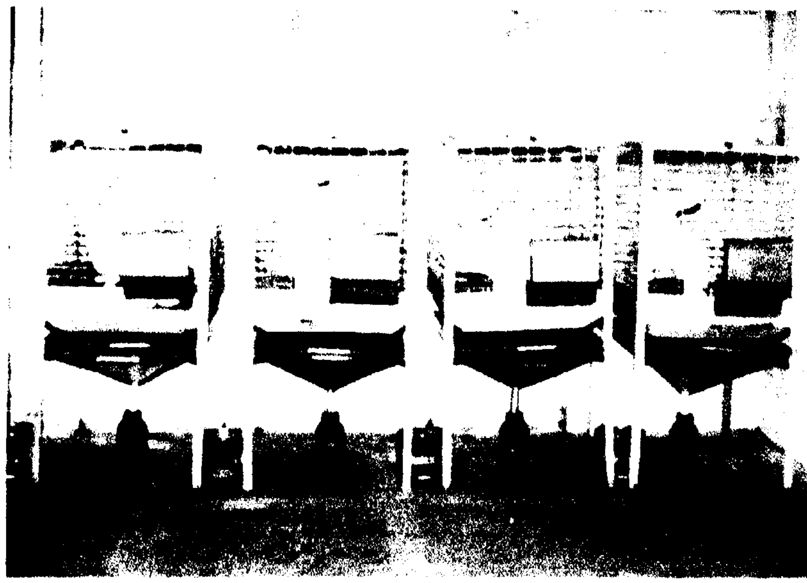
The faeces and urine were quantitatively collected as described by Spreadbury (1978). Galvanised screen having a 4 mm mesh was placed beneath the metabolism cage to retain faeces, but allow free passage of urine which was funnelled into a collecting bottle. Both mesh screen and collecting funnel were removable for gathering the faeces and removal of urine collecting bottle (Photos 3 and 4). Daily records of feed consumption as well as the faeces and urine voided were maintained for 7 consecutive days.

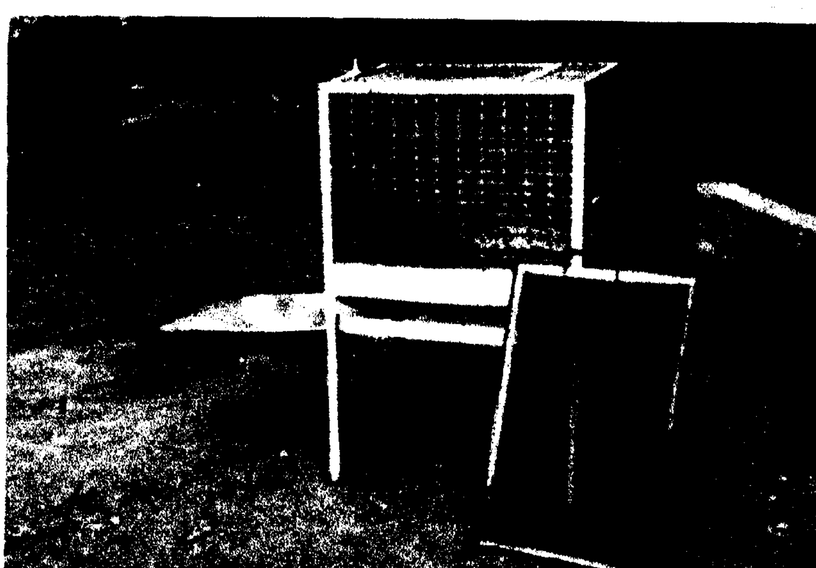
3.9 METHODS OF ANALYSIS

The samples of feed, residues, faeces and urine were analysed as per the procedures laid down in A.O.A.C. (1970) for the proximate composition.

Photo 3. Metabolism cages.

Photo 4. Parts of metabolism cage showing faeces separation screen and urine collection funnel.





3.8.1 Dry Matter

About 5 g of ground sample was weighed in a moisture cup and dried to a constant weight in a thermostatic electric oven at 100 to 105°C overnight for the determination of dry matter.

3.8.2 Total Ash

About 5 to 10 g of ground sample was weighed in a vitreosil basin and desmoked on a low flame and then ashed in a muffle furnace at 600°C for about half an hour. The completely decarbonised sample was then cooled in a desiccator and weighed. This amount of ash was then expressed on dry matter basis.

3.8.3 Crude protein

Crude protein was determined by conventional Kjeldahl method. Suitable amount of material was digested with concentrate sulphuric acid using a mixture of anhydrous sodium sulphate and copper sulphate (10:1) as catalyst. The ammonium sulphate thus formed was distilled directly adding 40 per cent sodium hydroxide in excess and the ammonia liberated was quantitatively collected in a 2 per cent boric acid solution containing Tashiro's indicator, and titrated against decinormal sulphuric acid solution. By multiplying the nitrogen content with factor 6.25, the crude protein content was obtained.

3.9.4 Ether Extract

Weighed amount of dry sample powder was transferred to filter paper thimble and extracted with petroleum ether for 8 hours in soxhlets assembly. Receiving flask was then removed and dried in the oven and weighed. The difference in the initial and final weights of the receiving flask gave the amount of ether extract present in the sample.

3.9.5 Crude Fibre

Crude fibre was estimated by treating fat free dried sample by successive boiling with 1.25 per cent sulphuric acid solution and 1.25 per cent sodium hydroxide solution for half an hour. The residue left after treating the sample with acid and alkali was washed with hot water and transferred to a silica crucible for drying. It was weighed and then ashed at 600°C for 30 minutes. The loss in weight was the crude fibre content of that samples.

3.9.6 Mineral Extract

The ash was dissolved in 10 ml of concentrated hydrochloric acid and the contents transferred into a beaker by giving repeated washings. The beaker was then heated to boiling, then cooled and finally the contents filtered into 250 ml volumetric flask till it was acid free. Finally the volume was made upto 250 ml.

3.9.7 Calcium

Calcium was estimated by absorption spectrophotometer.

3.9.8 Phosphorus

Determination of phosphorus was carried out on the ash solution by first treating with ammonium molybdate, the phosphomolybdic acid thus formed was reduced by adding hydroquinone which gave blue colour. The blue colour developed was estimated colorimetrically at 660 mμ.

3.10 MEAT CHARACTERISTICS

In experiment 2, nine representative animals from each group (3 from each sub-group and level of feeding at 90, 100 and 110% N.R.C.) were slaughtered at the end of growth trial of 8 weeks. The age of the animals at slaughter was 14 weeks. Various quantitative meat characteristics like dressing percentage (hot and chilled), shrinkage, carcass cuts, proportions of meat, bone and fat, percentage of edible and non-edible organs in the carcass were studied.

3.10.1 Slaughter Method

The animals were fasted over night (but had access to drinking water) and the weights were recorded before slaughter. The animals were first rendered unconscious by the dislocation of the neck and then slaughtered, dressed and eviscerated according to the procedure described by Cheeke *et al.*(1982).

The weights of the carcass, edible (liver, heart, spleen and kidneys) and non-edible (lungs, trachea, empty stomach and intestines) offals were recorded. The dressed carcass was kept over night for chilling in a walk-in-cooler at a temperature of $3^{\circ}C$ to evaluate the chilling percentage and shrinkage. The carcass was cut into 3 major cuts viz., forequarter, midquarter and hindquarter in accordance with regulations governing the voluntary grading of poultry products and rabbit products and U.S. Classes, standards and Grades ([illegible]). The carcass was totally and closely dissected (cut wise) and the muscle and fat were separated. The weight of the fat was recorded. The bones were cooked in 2 per cent sodium hydroxide solution for 15 minutes under low temperature till the adhering muscle was loosened. The bones were removed, scraped free of muscle, washed, air dried and weighed. The weight of the muscle was estimated by difference.

3.11 STATISTICAL ANALYSIS

Statistical analysis of the data was carried out as per the methods suggested by Nageswara Rao ([illegible]).

RESULTS

CHAPTER IV

RESULTS

Experiment I

4.1 NUTRIENT UTILIZATION STUDIES

Metabolism trials to assess the utilization of nutrients in rabbits fed experimental diets were conducted at 14, 20 and 26 weeks of age by taking 4 representative animals from each group and are referred hereto for convenience in text and tables as phases I, II and III, respectively. The chemical composition of the three experimental rations is shown in Table 1.

4.1.1 Dry Matter Intake

The average dry matter intake by experimental animals fed 3 experimental diets was 120.81, 124.53 and 122.76 g in phase I (14 weeks), 158.57, 177.04 and 136.49 g in phase II (20 weeks) and 114.82, 121.34 and 115.29 g in phase III (26 weeks) (Table 3).

There was a significant ($P < 0.01$) difference in dry matter intake between the phases, whereas, the differences were not significant between treatments and interaction between treatments and phases (Table 3 a).

4.1.2 Dry Matter Digestibility Coefficient

The mean dry matter digestibility coefficients were 65.25, 63.45 and 67.17 in phase I (Table 4), 66.48, 62.33 and 66.94 in

TABLE 3. Dry matter intake by experimental animals of different dietary treatments at 3 phases

Phase		Wt. of animal (g)	Intake (g) Diet 1 (20% lucerne hay)	Wt. of animal (g)	Intake(g) Diet 2 (30% lucerne hay)	Wt. of animal (g)	Intake(g) Diet 3 (40% lucerne hay)
I (14 weeks)		3200	154.51	3365	100.28	3206	134.31
		3120	117.94	3370	167.06	3150	116.29
		3160	122.30	3245	123.21	3360	116.11
		3085	128.49	3280	117.57	3040	124.20
	Mean	3141	130.81	3315	124.63	3186	122.75
II (20 weeks)		4365	141.06	4895	183.43	4780	168.88
		4395	177.81	4810	180.36	4806	126.13
		4415	162.16	4765	162.89	4710	107.70
		4376	163.25	4586	181.27	4600	129.22
	Mean	4385	158.67	4764	177.04	4724	136.49
III (36 weeks)		3415	103.01	3995	121.76	3320	112.20
		4275	146.49	4280	129.94	3040	91.72
		3960	104.46	4070	110.83	3560	141.23
		4445	104.10	4080	112.84	3380	115.02
	Mean	4021	114.52	4090	121.34	3325	115.29

Table 3 a. Analysis of variance of dry matter intake

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	1651.70	825.85	2.49 NS
Between phases	2	10512.28	5256.14	15.87**
Between treatments x phases	4	267.89	66.97	0.20 NS
Error	27	8943.15	331.23	
Total	35	21376.02		

** Significant ($P < 0.01$)

NS - Not significant.

Phase averages	117.05^{a}	126.03^{a}	156.94^{b}
	A_3	A_1	A_2

The phases have been tested with the help of DMR test.

$P = 2$: 15.26

$P = 3$: 16.06

Table 4. Digestibility coefficient of dry matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase I (14 weeks)			
1 (20% lucerne hay)		3200	154.61	100.86	65.23
		3120	117.94	78.42	66.49
		3160	122.30	81.41	66.57
		3086	128.49	85.67	66.67
	Mean	3141	130.81		66.25
	S.E.				0.33
2 (30% lucerne hay)		3365	100.28	66.55	66.36
		3370	157.06	97.80	62.14
		3245	123.21	73.75	59.86
		3280	117.57	76.83	65.43
	Mean	3315	124.53		63.45
	S.E.				1.60
3 (40% lucerne hay)		3205	134.31	87.63	65.24
		3150	116.29	78.47	67.48
		3380	116.11	80.36	69.21
		3040	124.30	82.95	66.73
	Mean	3194	122.75		67.17
	S.E.				0.83

Table 4 a. Digestibility coefficient of dry matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase II (20 weeks)			
1 (20% lucerne hay)		4356	141.06	94.13	66.74
		4396	177.81	116.06	65.27
		4415	152.15	100.60	66.19
		4376	163.26	110.52	67.70
	Mean	4386	158.67		66.48
	S.E.±				0.51
2 (30% lucerne hay)		4896	183.63	117.88	64.19
		4810	180.36	111.49	61.82
		4765	162.80	101.88	62.55
		4595	181.27	110.14	60.76
	Mean	4764	177.04		62.23
	S.E.±				0.72
3 (40% lucerne hay)		4760	168.89	107.08	63.40
		4806	136.13	91.22	67.01
		4720	107.70	73.93	68.64
		4600	129.22	88.80	68.72
	Mean	4724	135.49		66.94
	S.E.±				1.24

Table 4 b. Digestibility coefficient of dry matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
			<u>Phase III (36 weeks)</u>		
1 (20% lucerne hay)		3416	103.01	61.43	59.63
		4276	146.49	86.21	58.85
		3960	104.46	67.63	64.74
		4445	104.10	62.87	60.39
	Mean	4021	114.52		60.98
	S.E.				1.21
2 (20% lucerne hay)		3995	131.76	74.30	56.39
		4280	129.94	69.84	53.75
		4070	110.83	60.10	54.23
		4060	112.84	58.62	51.95
	Mean	4090	121.34		54.08
	S.E.				0.91
3 (40% lucerne hay)		3320	112.20	70.86	62.60
		3060	91.72	64.55	70.38
		3660	141.22	93.28	66.06
		3360	115.02	75.17	65.35
	Mean	3328	115.29		66.10
	S.E.				1.61

Table 4 e. Analysis of variance of dry matter digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	287.57	143.79	30.79**
Between phases	2	206.50	103.25	22.11**
Between treatments x phases	4	84.59	21.15	4.53**
Error	27	126.06	4.67	
Total	35	704.72		

** Significant ($P < 0.01$)

Treatment means	58.95[a]	64.55[b]	65.73[c]
	T_2	T_1	T_3
Phase averages	60.37[a]	65.25[b]	66.66[b]
	A_3	A_2	A_1

The treatments/phases have been tested with the help of DMR test.

$P = 2$: 1.812

$P = 3$: 1.875

phase II (Table 4 a) and 60.82, 54.08 and 66.10 in phase III (Table 4 b) in groups fed diets 1, 2 and 3, respectively.

The differences in dry matter digestibility coefficients between phases, dietary treatments as well as interaction between treatments and phases were highly significant ($P < 0.01$) (Table 4 c).

4.1.3 Organic Matter Digestibility Coefficient

The mean coefficients of digestibilities of organic matter were 66.44, 64.68 and 67.48 in phase I (Table 5), 65.72, 63.23 and 67.11 in phase II (Table 5 a) and 61.77, 55.90 and 65.18 in phase III (Table 5 b) in groups fed diets 1, 2 and 3, respectively.

Analysis of variance revealed highly significant differences($P < 0.01$) between treatments, between phases and interaction between treatments and phases (Table 5 c).

4.1.4 Crude Protein Digestibility Coefficient

The mean coefficients of crude protein digestibility in animals fed diets 1, 2 and 3 were 60.09, 59.02 and 62.00 in phase I (Table 6), 61.48, 54.46 and 62.45 in phase II (Table 6 a) and 63.10, 54.71 and 59.90 in phase III (Table 6 b),respectively.

There was a highly significant ($P < 0.01$) difference in crude protein digestibility coefficients between the treatments, between the phases and interaction between treatments and phases (Table 6 c).

Table [illegible]. Digestibility coefficient of organic matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
			Phase I (14 weeks)		
1 (20% lucerne hay)		2200	1[illegible].94	[illegible].03	[illegible].67
		2150	[illegible].19	[illegible].11	[illegible]
		2160	102.[illegible]	67.78	[illegible]
		2085	108.06	70.[illegible]	[illegible]
	Mean	2141	110.01		[illegible]
	S.E.				0.[illegible]
2 (30% lucerne hay)		[illegible]	87.97	59.[illegible]	67.[illegible]
		2270	137.77	87.[illegible]	[illegible]
		[illegible]	106.08	[illegible]	61.[illegible]
		[illegible]	103.13	[illegible]	[illegible]
	Mean	[illegible]	108.[illegible]		64.[illegible]
	S.E.				1.[illegible]
3 (40% lucerne hay)		[illegible]	117.[illegible]	77.[illegible]	[illegible].75
		2180	101.[illegible]	[illegible]	67.[illegible]
		[illegible]	101.74	70.[illegible]	[illegible]
		2040	106.[illegible]	72.[illegible]	[illegible]
	Mean	[illegible]	107.[illegible]		67.48
	S.E.				0.[illegible]

Table 8 a. Digestibility coefficient of organic matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase II (20 weeks)			
1 (20% lucerne hay)		4366	118.62	76.66	64.[illegible]
		4386	140.84	96.[illegible]	64.[illegible]
		4416	127.96	83.[illegible]	65.[illegible]
		4376	137.[illegible]	91.64	66.75
	Mean S.E.	4386	133.36		65.72 0.[illegible]
2 (30% lucerne hay)		4[illegible]	161.06	106.06	65.[illegible]
		4820	156.21	99.27	62.76
		4766	142.[illegible]	90.77	63.[illegible]
		4686	160.01	98.[illegible]	61.[illegible]
	Mean S.E.	4764	155.30		63.[illegible] 0.7[illegible]
3 (40% lucerne hay)		4780	147.06	96.57	65.48
		4806	120.[illegible]	80.30	67.[illegible]
		4720	94.37	64.04	68.[illegible]
		4600	113.22	77.06	68.57
	Mean S.E.	4726	118.71		67.11 1.[illegible]

Table 5 b. Digestibility coefficient of organic matter

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase III (26 weeks)			
1 (20% lucerne hay)		3415	86.43	52.21	60.41
		4275	122.30	73.30	59.93
		3950	87.85	57.40	65.36
		4445	87.56	53.74	61.38
	Mean	4021	96.31		61.77
	S.E.				1.23
2 (30% lucerne hay)		3705	115.58	67.54	58.44
		4280	113.98	62.79	55.09
		4070	97.22	54.75	56.26
		4060	98.98	53.53	54.08
	Mean	4029	106.44		55.98
	S.E.				0.[illegible]
3 (40% lucerne hay)		2820	99.19	64.04	64.56
		3060	80.37	52.50	65.32
		2850	122.24	82.47	67.46
		3380	100.78	67.29	66.87
	Mean	3028	101.02		66.13
	S.E.				0.[illegible]

Table 5 e. Analysis of variance of organic matter digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	187.52	93.76	25.20**
Between phases	2	150.41	75.21	20.22**
Between treatments x phases	4	67.11	16.78	4.51**
Error	27	100.52	3.72	
Total	35	505.56		

** Significant (P ∠ 0.01)

Treatment means	61.23[a]	64.21[b]	66.06[c]
	T_2	T_1	T_3
Phase average	61.21[a]	65.26[b]	65.55[b]
	A_3	A_2	A_1

The treatments/phases have been tested with the help of DMR test.

P = 2 : 1.417

P = 3 : 1.478

Table 6. Digestibility coefficient of crude protein

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase I (14 weeks)			
1 (20% lucerne hay)		3200	24.13	14.73	61.04
		3130	18.42	11.08	60.15
		3160	19.10	11.61	60.78
		3085	20.07	11.72	58.39
	Mean	3141	20.43		60.09
	S.E.				0.44
2 (30% lucerne hay)		3065	16.04	9.56	59.60
		3370	25.13	14.18	56.43
		3045	19.71	11.34	57.53
		2980	18.51	11.76	63.51
	Mean	3115	19.85		59.27
	S.E.				1.34
3 (40% lucerne hay)		3205	21.57	13.40	62.14
		3150	18.93	11.62	61.38
		3380	18.90	12.00	63.49
		3040	20.24	12.34	60.97
	Mean	3186	19.91		62.00
	S.E.				0.56

Table 6 a. Digestibility coefficient of crude protein

Diet	Wt. of Animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase II (20 weeks)		
1 (20% lucerne hay)	4365	22.03	14.42	65.46
	4395	27.77	17.83	64.21
	4415	23.77	13.37	56.25
	4375	25.50	15.30	60.00
Mean S.E.	4385	24.77		61.48 2.10
2 (30% lucerne hay)	4805	29.37	16.54	56.32
	4810	28.25	15.28	52.84
	4765	26.05	14.04	53.88
	4505	29.00	15.86	54.69
Mean S.E.	4764	28.22		54.48 0.72
3 (40% lucerne hay)	4700	27.50	16.72	60.84
	4805	22.16	14.44	65.16
	3710	17.62	10.66	60.51
	4680	21.03	13.41	63.77
Mean S.E.	4724	22.06		62.46 1.31

Table 6 b. Digestibility coefficient of crude protein

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase III (26 weeks)			
1 (20% lucerne hay)		3415	16.00	8.31	51.95
		4275	22.53	11.66	52.37
		3920	16.21	9.26	56.77
		4445	16.26	8.41	51.72
	Mean	4021	17.80		53.10
	S.E.				1.23
2 (30% lucerne hay)		3905	21.03	11.50	54.62
		4280	20.79	11.06	53.07
		4070	17.73	9.70	54.72
		4080	18.05	9.83	54.46
	Mean	4089	19.41		54.71
	S.E.				0.76
3 (40% lucerne hay)		3960	18.45	10.00	54.26
		3060	14.83	9.41	63.46
		3650	22.90	13.94	60.84
		3960	18.73	11.56	61.67
	Mean	3658	18.77		[illegible]
	S.E.				1.94

Table 6 c. Analysis of variance of crude protein digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	163.87	81.90	12.72**
Between phases	2	131.43	65.72	10.26**
Between treatments x phases	4	107.34	26.84	4.17**
Error	27	173.88	6.44	
Total	35	575.62		

** Significant (P ∠ 0.01)

Treatment means	56.07[a]	58.22[b]	61.45[c]
	T_2	T_1	T_3
Phase average	55.80[a]	59.46[b]	60.37[b]
	A_3	A_2	A_1

The treatments/phases have been tested with the help of DMR test.

P = 2 : 2.125

P = 3 : 2.231

4.1.5 Ether Extract Digestibility Coefficient

The mean coefficients of ether extract digestibility in rabbits fed diets 1, 2 and 3 were 69.02, 64.83 and 67.00 in phase I (Table 7), 68.74, 66.88 and 66.64 in phase II (Table 7 a) and 66.96, 61.60 and 63.48 in phase III (Table 7 b), respectively

The differences in ether extract digestibility coefficients between the treatments and between the phases were highly significant ($P < 0.01$). There were, however, no significant differences in the coefficient of ether extract digestibility in the interaction between the treatments and phases (Table 7 c).

4.1.6 Crude Fibre Digestibility Coefficient

The mean crude fibre digestibility coefficients in animals fed diets 1, 2 and 3 were 18.23, 18.24 and 18.46 in phase I (Table 8), 16.97, 16.20 and 17.71 in phase II (Table 8 a) and 18.09, 17.78 and 18.40 in phase III (Table 8 b), respectively.

The differences in the crude fibre digestibility coefficients between treatments, between phases and between interaction of treatments and phases were not significant statistically (Table 8 c).

4.1.7 Nitrogen-free Extract Digestibility Coefficient

The mean coefficients of digestibilities of nitrogen-free extract in animals fed dietary treatments 1, 2 and 3 were 65.18, 64.61 and 67.61 in phase I (Table 9), 64.88, 68.90 and 68.17 in phase II (Table 9 a) and 62.90, 61.86 and 60.86 in phase III (Table 9 b), respectively.

Table 7. Digestibility coefficient of ether extract

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase I (14 weeks)			
1 (20% lucerne hay)		3200	6.03	4.12	68.40
		3120	4.60	3.19	69.26
		3160	4.77	3.29	68.97
		3085	5.01	3.47	69.26
	Mean S.E.±	3141	5.10		69.02 0.19
2 (30% lucerne hay)		3365	3.07	2.02	65.80
		3370	4.81	3.12	64.86
		3045	3.77	2.40	63.64
		3280	3.66	2.34	65.00
	Mean S.E.±	33.15	3.81		64.83 0.44
3 (40% lucerne) hay)		3205	4.16	2.74	65.87
		3150	3.60	2.47	68.41
		3260	3.60	2.46	68.33
		3040	3.86	2.51	65.19
	Mean S.E.±	3196	3.80		67.00 0.33

Table 7 a. Digestibility coefficient of ether extract

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase II (20 weeks)			
1 (20% lucerne hay)		4355	5.60	3.76	6[illegible].18
		4395	6.80	4.71	67.[illegible]
		4415	5.93	4.09	68.97
		4375	6.37	4.45	[illegible]
	Mean S.E.	4385	6.18		65.74 0.43
2 (30% lucerne hay)		4825	5.62	3.89	69.22
		4810	5.52	3.63	65.76
		4765	4.85	3.24	67.06
		4[illegible]	5.56	3.62	65.22
	Mean S.E.	4764	5.42		66.83 0.89
3 (40% lucerne hay)		4750	5.24	3.34	63.74
		4805	4.22	2.86	67.77
		4720	3.34	2.27	67.96
		4800	4.01	2.60	67.08
	Mean S.E.	4784	4.20		66.64 0.88

Table 7 h. Digestibility coefficient of ether extract

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
			Phase III (24 weeks)		
1 (20% lucerne hay)		3415	4.02	[illegible]	[illegible]
		4275	5.71	3.75	65.67
		3960	4.07	2.71	66.75
		4445	4.06	2.73	67.24
	Mean	4021	4.47		[illegible]
	S.E.				0.52
2 (30% lucerne hay)		3995	4.03	2.60	64.27
		4250	3.96	2.42	60.80
		4070	3.39	2.05	60.47
		4060	3.45	2.10	60.87
	Mean	4099	3.71		61.60
	S.E.				0.89
3 (40% lucerne hay)		3320	3.51	2.19	62.39
		3060	2.84	1.84	64.79
		3660	4.38	2.79	63.70
		3360	3.57	2.25	63.03
	Mean	[illegible]	3.58		63.48
	S.E.				0.41

Table 7 c. Analysis of variance of ether extract digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	90.76	45.38	24.01**
Between phases	2	81.20	40.60	21.48**
Between treatments x phases	4	14.26	3.56	1.88 NS
Error	27	51.01	1.89	
Total	35	237.21		

** Significant (P < 0.01)

NS = Not significant

Treatment means	64.41^{a}	65.70^{b}	68.24^{c}
	T_2	T_3	T_1
Phase averages	61.01^{a}	66.26^{b}	67.40^{b}
	A_3	A_1	A_2

The treatments/phases have been tested with the help of DMR test.

P = 2 : 1.18[illegible]

P = 2 : 1.19[illegible]

Table 8. Digestibility coefficient of crude fibre

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
			Phase I (14 weeks)		
1 (20% lucerne hay)		3200	18.61	3.16	17.02
		3120	14.13	2.[illegible]	18.[illegible]
		3160	14.46	2.[illegible]	18.[illegible]
		3085	15.39	2.72	17.67
	Mean	3141	15.67		18.[illegible]
	S.E.+				0.[illegible]
2 (30% lucerne hay)		3365	12.16	2.43	20.00
		3370	18.04	3.[illegible]	17.02
		[illegible]	14.[illegible]	2.[illegible]	18.02
		[illegible]	14.[illegible]	2.41	16.[illegible]
	Mean	[illegible]	15.09		18.[illegible]
	S.E.+				0.7[illegible]
3 (40% lucerne hay)		3206	16.42	2.97	18.08
		3150	14.27	2.71	19.00
		[illegible]	14.[illegible]	2.[illegible]	[illegible]
		3040	15.[illegible]	2.[illegible]	16.[illegible]
	Mean	[illegible]	15.06		18.[illegible]
	S.E.+				0.[illegible]

Table 8 a. Digestibility coefficient of crude fibre

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
			Phase II (20 weeks)		
1 (20% lucerne hay)		4265	16.[illegible]	3.04	18.00
		4296	21.20	3.41	16.01
		4416	18.[illegible]	3.07	16.84
		4376	19.56	3.23	17.03
	Mean	4285	19.00		16.97
	S.E.M.				0.41
2 (30% lucerne hay)		4[illegible]	22.25	4.05	18.18
		4[illegible]	21.[illegible]	3.[illegible]	16.[illegible]
		4766	19.74	3.36	17.03
		4[illegible]	21.06	3.[illegible]	15.[illegible]
	Mean	4764	21.46		16.[illegible]
	S.E.M.				0.[illegible]
3 (40% lucerne hay)		4780	[illegible].73	3.[illegible]	16.03
		4[illegible]	16.70	2.46	15.[illegible]
		4720	13.21	2.64	20.[illegible]
		4800	15.[illegible]	3.01	18.[illegible]
	Mean	4784	16.62		17.[illegible]
	S.E.M.				1.[illegible]

Table 8 b. Digestibility coefficient of crude fibre

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase III (36 weeks)			
1 (20% lucerne hay)		3415	12.34	2.47	20.02
		4275	17.55	3.16	18.01
		3960	12.51	2.30	18.38
		4445	12.44	2.19	17.56
	Mean S.E.	4021	13.72		18.50 0.66
2 (30% lucerne hay)		3995	15.97	2.60	16.28
		4230	15.75	2.89	18.35
		4070	13.42	2.69	20.05
		4060	13.48	2.14	15.86
	Mean S.E.	4090	14.71		17.78 1.06
3 (40% lucerne hay)		3620	12.39	2.78	20.01
		3060	11.25	1.85	16.44
		3550	17.23	3.13	18.00
		3530	14.11	2.70	19.13
	Mean S.E.	3388	14.15		18.40 0.77

Table 8 e. Analysis of variance of crude fibre digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	2.38	1.19	0.50 NS
Between phases	2	11.15	5.58	2.36 NS
Between treatments x phases	4	2.30	0.57	0.008 NS
Error	27	63.64	2.36	
Total	35	79.47		

NS - Not significant ($P > 0.05$).

Table 9. Digestibility coefficient of nitrogen-free extract

Diet	Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase I (14 weeks)		
1 (20% lucerne hay)	3200	61.27	41.44	63.30
	3120	63.04	41.26	65.67
	3160	64.33	41.66	64.69
	3086	67.59	44.63	66.03
Mean S.E.M.	3141	63.51		65.15 0.75
2 (30% lucerne hay)	3365	56.70	38.12	67.24
	3370	55.60	36.03	63.10
	3045	60.66	42.07	[illegible]
	2920	66.47	43.76	[illegible]
Mean S.E.M.	3018	70.41		64.61 1.34
3 (40% lucerne hay)	3206	70.17	48.70	66.12
	3150	65.00	46.12	70.87
	2960	64.90	45.63	70.21
	3040	60.67	42.90	[illegible]
Mean S.E.M.	3186	65.71		67.41 1.60

Table 9 a. Digestibility coefficient of nitrogen-free extract

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase II (20 weeks)			
1 (20% lucerne hay)		4365	74.19	45.46	61.28
		4395	93.53	59.80	63.94
		4415	80.03	52.83	66.01
		4375	86.87	57.80	67.07
	Mean	4385	83.41		64.58
	S.E.				1.28
2 (30% lucerne hay)		4895	103.82	63.47	61.13
		4810	101.98	65.56	64.28
		4765	92.10	60.72	65.93
		4585	102.49	65.85	64.25
	Mean	4764	100.10		63.90
	S.E.				1.00
3 (40% lucerne hay)		4780	84.53	58.72	68.18
		4806	76.19	52.11	68.39
		4710	60.28	42.80	71.00
		4600	72.32	50.71	70.12
	Mean	4724	73.33		69.17
	S.E.				1.76

Table 9 b. Digestibility coefficient of nitrogen-free extract

Diet		Wt. of animal (g)	Intake (g)	Digested (g)	Digestibility coefficient
		Phase III (24 weeks)			
1 (20% lucerne hay)		3415	54.13	33.[illegible]	61.[illegible]
		4275	77.05	46.45	60.29
		[illegible]	56.[illegible]	36.55	65.70
		4445	54.75	36.15	66.03
	Mean S.E.	4031	60.24		63.[illegible] 1.[illegible]
2 (30% lucerne hay)		3985	74.80	47.40	63.74
		[illegible]	73.47	44.37	60.39
		4070	[illegible]	38.53	61.47
		4080	63.80	38.[illegible]	60.[illegible]
	Mean S.E.	40[illegible]	[illegible]		61.[illegible] 0.75
3 (40% lucerne hay)		[illegible]	63.34	43.14	68.09
		[illegible]	52.24	37.70	73.48
		[illegible]	76.04	50.[illegible]	66.01
		[illegible]	64.35	44.40	69.[illegible]
	Mean S.E.	[illegible]	64.53		[illegible] 1.[illegible]

Table 9 c. Analysis of variance of nitrogen-free extract digestibility

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	184.12	92.06	13.23**
Between phases	2	3.33	1.67	0.24NS
Between treatments x phases	4	33.06	8.26	1.19NS
Error	27	187.89	6.96	
Total	35	408.39		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	63.28^a	64.46^a	68.57^b
	T_2	T_1	T_3

The treatments have been tested with the help of DMR test.

$P = 2$: 2.912

$P = 3$: 2.983

There was a highly significant difference ($P < 0.01$) in nitrogen-free extract digestibility between treatments, whereas the differences were insignificant between phases and interaction between treatments and phases (Table 9 c).

4.2 BALANCE STUDIES

4.2.1 Nitrogen balance

The data pertaining to retention of nitrogen in rabbits fed different diets during the three phases are presented in Table 10, 10 a, 10 b and 10 c.

Average intakes of nitrogen were 3.259, 3.187 and 3.197 g during phase I (14 weeks of age) (Table 10), 3.883, 4.881 and 3.628 g during phase II (20 weeks of age) (Table 10 a) and 2.881, 3.106 and 3.003 g during phase III (26 weeks of age) (Table 10 b), respectively in rabbits fed diets 1, 2 and 3. All the experimental animals were in positive nitrogen balance. The average daily nitrogen retention was 1.716, 1.648 and 1.663 in phase I, 2.778, 2.368 and 1.867 g in phase II and 1.828, 1.644 and 1.606 g in phase III in animals fed diets 1, 2 and 3, respectively.

Statistical analysis (Table 10 c) indicated that there was a significant difference ($P < 0.01$) in nitrogen balance between different phases. However, there was no significant difference between the treatments and interaction between treatments and phases.

Table 1[illegible]. Nitrogen balance data as affected by different dietary treatments at 14 weeks of age

Treatment	Wt. of animal (g)	Nitrogen intake (g)	Nitrogen outgo: Faeces (g)	Nitrogen outgo: Urine (g)	Nitrogen outgo: Total (g)	Balance (g)
1 (20% lucerne hay)	3200	3.960	1.043	0.812	1.855	2.005
	3120	2.947	0.784	0.596	1.380	1.565
	3160	3.085	0.827	0.641	1.468	1.[illegible]
	3065	3.211	0.854	0.676	1.530	1.672
Mean	3141	3.250				1.716
S.E.						0.048
2 (30% lucerne hay)	3066	2.986	0.668	0.515	1.183	1.303
	2770	4.020	1.127	0.884	2.011	2.009
	3065	3.153	0.853	0.661	1.514	1.639
	2980	3.009	0.816	0.633	1.448	1.561
Mean	3015	3.137				1.648
S.E.						0.128
3 (40% lucerne hay)	2806	3.460	0.844	0.734	1.578	1.881
	3160	3.068	0.819	0.637	1.456	1.572
	3200	3.064	0.815	0.636	1.451	1.573
	3040	3.286	0.575	0.678	1.253	1.635
Mean	3165	3.197				1.663
S.E.						0.040

Table 10 c. Nitrogen balance data as affected by different dietary treatments at [illegible] weeks of age

Treatment		Wt. of animal (g)	Nitrogen intake (g)	Nitrogen outgo: Faeces (g)	Urine (g)	Total (g)	Balance (g)
1 (20% Lucerne hay)		4365	3.524	0.853	0.742	1.595	1.929
		4395	4.444	1.242	0.977	2.219	2.225
		4415	3.803	1.025	0.799	1.824	1.979
		4375	4.030	1.145	0.897	2.042	2.028
	Mean	4385	3.983				2.778
	S.E.						0.461
2 (30% Lucerne hay)		4695	4.609	1.313	1.032	2.345	2.264
		4680	4.414	1.191	1.015	2.206	2.208
		4765	4.109	1.167	0.916	2.083	2.026
		4695	4.640	1.297	1.021	2.318	2.322
	Mean	4704	4.531				[illegible]
	S.E.						[illegible]
3 (40% Lucerne hay)		4780	4.400	1.220	0.937	2.157	2.243
		4806	3.545	0.883	0.785	1.668	1.867
		4720	2.894	0.732	0.584	1.316	1.578
		4600	3.204	0.706	0.708	1.414	1.790
	Mean	4726	3.536				1.887
	S.E.						0.144

Table 10b. Nitrogen balance data as affected by different dietary treatments at 26 weeks of age

Treatment		Wt. of animal (g)	Nitrogen intake (g)	Nitrogen outgo			Balance (g)
				Faeces (g)	Urine (g)	Total (g)	
1 (20% lucerne hay)		3415	2.574	0.673	0.515	1.187	1.387
		4375	3.400	0.9[illegible]	0.704	1.765	1.[illegible]
		3950	2.609	0.670	0.5[illegible]	1.202	1.407
		4445	2.601	0.675	0.521	1.196	1.405
	Mean	4021	2.881				1.[illegible]
	S.E.d.						0.125
2 (30% lucerne hay)		3965	3.372	0.913	0.706	1.619	1.753
		4390	3.326	0.896	0.698	1.594	1.732
		3070	2.834	0.739	0.567	1.306	1.530
		4050	2.888	0.752	0.575	1.328	1.560
	Mean	4090	3.106				1.644
	S.E.d.						0.0[illegible]
3 (40% lucerne hay)		3330	2.9[illegible]	0.763	0.[illegible]	1.[illegible]	1.[illegible]
		3060	2.[illegible]	0.4[illegible]	0.475	1.0[illegible]	1.[illegible]
		3650	3.473	0.[illegible]	0.773	1.7[illegible]	1.[illegible]0
		3390	2.9[illegible]	0.776	0.[illegible]	1.374	1.[illegible]
	Mean	3328	3.003				1.605
	S.E.d.						0.127

Table 10 c. Analysis of variance of nitrogen balance

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.148	0.074	1.721^{NS}
Between phases	2	1.348	0.674	15.674^{**}
Treatments x phases	4	0.281	0.070	1.628^{NS}
Error	27	1.166	0.043	
Total	35	2.943		

** Significant ($P < 0.01$)

NS - Not significant

Phase averages	1.591^{a}	1.675^{a}	2.289^{b}
	A_3	A_1	A_2

The phases have been tested with the help of DMR test.

$p = 2 \; : \; 0.17$

$p = 3 \; : \; 0.18$

4.2.2 Calcium Balance

The mean retention of calcium in animals fed diets 1, 2 and 3 was 0.160, 0.210 and 0.156 g in phase I (Table 11), 0.151, 0.223 and 0.189 g in phase II (Table 11 a) and 0.129, 0.137 and 0.147 g in phase III (Table 11 b), respectively. All the experimental animals were in positive calcium balance.

Calcium retention was highly significant ($P \angle 0.01$) between diets, between phases and interaction between treatments and phases (Table 11 c).

4.2.3 Phosphorus Balance

The mean retention of phosphorus in rabbits fed diets 1, 2 and 3 were 0.037, 0.049 and 0.030 g in phase I (Table 12), 0.068, 0.068 and 0.044 g in phase II (Table 12 a) and 0.041, 0.038 and 0.034 g in phase III (Table 12 b), respectively. All the animals were in positive phosphorus balance.

There were highly significant ($P \angle 0.01$) difference in phosphorus retention between treatments and between phases. The interaction between treatment and phases was not significant (Table 12 c).

The average apparent digestibility coefficients and balances of different nutrients on different ration treatments are shown in Table 13.

Table 11. Calcium balance data as affected by different dietary treatments at 14 weeks of age

Treatment		Wt. of animal (g)	Calcium intake (g)	Calcium output			Balance (g)
				Faeces (g)	Urine (g)	Total (g)	
1 (20% lucerne hay)		3200	2.302	1.407	0.703	2.110	0.192
		3120	1.767	1.071	0.553	1.624	0.123
		3160	1.822	1.036	0.638	1.673	0.149
		3085	1.884	1.078	0.671	1.749	0.165
	Mean	3141	1.949				0.160
	S.E.						0.012
2 (30% lucerne hay)		3345	2.206	1.253	0.778	2.034	0.172
		3370	3.455	2.102	1.072	3.174	0.281
		3245	2.720	1.666	0.843	2.509	0.201
		3300	2.586	1.572	0.827	2.399	0.187
	Mean	3315	2.730				0.210
	S.E.						0.024
3 (40% lucerne hay)		3205	2.941	1.882	0.945	2.827	0.114
		3150	2.546	1.623	0.792	2.415	0.131
		3300	2.542	1.537	0.843	2.380	0.162
		3040	2.722	1.581	0.926	2.511	0.215
	Mean	3188	2.688				0.156
	S.E.						0.022

Table 11 a. Calcium balance data as affected by different dietary treatments at 20 weeks of age

Treatment		Wt. of animal (g)	Calcium intake (g)	Calcium outgo: Faeces (g)	Calcium outgo: Urine (g)	Calcium outgo: Total (g)	Balance (g)
1 (10% Lucerne hay)		4365	2.101	1.327	0.656	1.983	0.118
		4395	2.640	1.581	0.843	2.424	0.215
		4415	2.267	1.367	0.751	2.118	0.149
		4375	2.422	1.456	0.855	2.311	0.111
	Mean	4385	2.362				0.151
	S.E.±						0.023
2 (20% Lucerne hay)		4865	4.039	2.309	1.238	3.547	0.392
		4820	3.967	2.427	1.236	3.662	0.305
		4765	3.583	2.147	1.152	3.299	0.284
		4585	3.797	2.220	1.216	3.436	0.361
	Mean	4704	3.884				0.339
	S.E.±						0.024
3 (40% Lucerne hay)		4780	3.688	2.581	0.826	3.407	0.281
		4805	2.961	1.868	0.926	2.794	0.167
		4710	2.358	1.489	0.754	2.243	0.115
		4600	2.829	1.730	0.937	2.667	0.162
	Mean	4724	2.967				0.180
	S.E.±						0.037

Table 11 b. Calcium balance data as affected by different dietary treatments at 36 weeks of age

Treatment		Wt. of animal (g)	Calcium intake (g)	Calcium outgo: Faeces (g)	Calcium outgo: Urine (g)	Calcium outgo: Total (g)	Balance (g)
1 (20% Lucerne hay)		3415	1.534	0.918	0.503	1.421	0.112
		4275	2.452	1.561	0.746	2.307	0.145
		3980	1.556	0.934	0.501	1.436	0.121
		4445	1.551	0.880	0.534	1.414	0.137
	Mean	4021	1.706				0.129
	S.E.						0.007
2 (30% Lucerne hay)		3905	2.898	1.761	0.982	2.743	0.155
		4230	2.863	1.771	0.965	2.736	0.128
		4070	2.438	1.482	0.836	2.318	0.120
		4050	2.472	1.800	0.543	2.343	0.129
	Mean	4090	2.609				0.137
	S.E.						0.007
3 (40% Lucerne hay)		2320	2.479	1.421	0.825	2.246	0.133
		3080	2.008	1.183	0.664	1.847	0.161
		3650	3.092	1.946	0.982	2.928	0.164
		3320	2.518	1.582	0.806	2.388	0.130
	Mean	3228	2.524				0.147
	S.E.						0.009

Table 11 c. Analysis of variance of calcium balance

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.0425	0.0212	12.529**
Between phases	2	0.0453	0.0227	13.352**
Treatments x phases	4	0.0394	0.0099	5.824**
Error	27	0.0469	0.0017	
Total	35	0.1742		

** Significant ($P < 0.01$)

Treatment averages	0.146^a	0.166^a	0.226^b
	T_1	T_3	T_2
Phase averages	0.137^a	0.175^b	0.224^c
	A_3	A_1	A_2

The treatments/phases have been tested with the help of DMR test.

$P = 2 : 0.03$

$P = 3 : 0.04$

Table 12. Phosphorus balance data as affected by different dietary treatments at 14 weeks of age

Treatment		Wt. of animal (g)	Phosphorus intake (g)	Phosphorus outgo: Faeces (g)	Phosphorus outgo: Urine (g)	Phosphorus outgo: Total (g)	Balance (g)
1 (20% lucerne hay)		3200	0.772	0.681	0.031	0.712	0.060
		3120	0.589	0.523	0.033	0.556	0.033
		3160	0.611	0.545	0.024	0.569	0.042
		3085	0.642	0.602	0.019	0.621	0.021
	Mean	3141	0.654				0.037
	S.E.						0.008
2 (30% lucerne hay)		3305	0.551	0.482	0.016	0.498	0.053
		3270	0.863	0.780	0.034	0.814	0.049
		3315	0.477	0.403	0.027	0.430	0.047
		3380	0.646	0.571	0.019	0.590	0.056
	Mean	3315	0.634				0.048
	S.E.						0.004
3 (40% lucerne hay)		3225	0.577	0.504	0.043	0.547	0.030
		3180	0.500	0.436	0.040	0.476	0.024
		3340	0.499	0.463	0.015	0.478	0.021
		3040	0.534	0.470	0.021	0.491	0.043
	Mean	3196	0.528				0.030
	S.E.						0.005

Table 12 a. Phosphorus balance data as affected by different dietary treatments at 20 weeks of age

Treatment		Wt. of animal (g)	Phosphorus intake (g)	Phosphorus outgo: Faeces (g)	Phosphorus outgo: Urine (g)	Phosphorus outgo: Total (g)	Balance (g)
1 (20% lucerne hay)		4365	0.705	0.632	0.021	0.653	0.052
		4365	0.839	0.771	0.026	0.797	0.042
		4415	0.760	0.670	0.030	0.700	0.060
		4375	0.816	0.724	0.024	0.748	0.068
	Mean	4385	0.783				0.058
	S.E.±						0.009
2 (30% lucerne hay)		4895	1.009	0.881	0.040	0.921	0.078
		4810	0.921	0.820	0.029	0.849	0.072
		4765	0.895	0.804	0.026	0.840	0.055
		4595	0.906	0.801	0.029	0.830	0.044
	Mean	4764	0.973				0.062
	S.E.±						0.006
3 (40% lucerne hay)		4780	0.736	0.655	0.029	0.684	0.042
		4805	0.595	0.512	0.017	0.529	0.066
		4710	0.463	0.416	0.018	0.434	0.029
		4690	0.555	0.490	0.017	0.507	0.048
	Mean	4734	0.582				0.046
	S.E.±						0.006

Table 12 b. Phosphorus balance data as affected by different dietary treatments at 26 weeks of age

Treatment		Wt. of animal (g)	Phosphorus intake (g)	Phosphorus outgo			Balance (g)
				Faeces (g)	Urine (g)	Total (g)	
1 (20% lucerne hay)		3415	0.515	0.462	0.015	0.477	0.038
		4275	0.732	0.654	0.029	0.683	0.049
		3950	0.522	0.473	0.021	0.494	0.028
		4445	0.520	0.455	0.016	0.471	0.049
	Mean	4021	0.572				0.041
	S.E.						0.005
2 (30% lucerne hay)		3995	0.724	0.662	0.022	0.684	0.040
		4200	0.714	0.631	0.029	0.660	0.054
		4070	0.609	0.554	0.018	0.572	0.037
		4060	0.620	0.573	0.025	0.598	0.022
	Mean	4090	0.667				0.038
	S.E.						0.007
3 (40% lucerne hay)		3350	0.486	0.425	0.014	0.439	0.047
		3040	0.394	0.352	0.016	0.368	0.026
		2650	0.607	0.553	0.018	0.571	0.036
		2380	0.494	0.447	0.019	0.466	0.028
	Mean	2328	0.495				0.034
	S.E.						0.005

Table 12 c. Analysis of variance of phosphorus balance

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.0017	0.0008	8.00**
Between phases	2	0.0038	0.0019	19.00**
Treatments x phases	4	0.0007	0.0002	2.00NS
Error	27	0.0036	0.0001	
Total	35	0.0098		

** Significant ($P < 0.01$)

NS - Not significant

Treatment averages	0.036[a]	0.048[b]	0.054[b]
	T_3	T_1	T_2
Phase averages	0.037[a]	0.038[a]	0.060[b]
	A_3	A_1	A_2

The treatments/phases have been tested with the help of DMR test.

P = 2 : 0.008

P = 3 : 0.009

Table 13. Average apparent digestibility coefficient and balance of different nutrients on various dietary treatments

Nutrient	Phase I (14 weeks)			Phase II (20 weeks)			Phase III (36 weeks)		
	Per cent lucerne hay			Per cent lucerne hay			Per cent lucerne hay		
	20	30	40	20	30	40	20	30	40
Dry matter	65.25	63.45	67.17	66.48	62.23	65.94	60.92	54.08	66.10
Organic matter	65.44	64.68	67.48	66.72	63.23	67.11	61.77	55.90	66.18
Crude protein	60.09	60.02	62.00	61.48	54.46	62.45	58.10	54.71	58.90
Ether extract	60.02	64.83	67.00	62.74	66.82	66.64	66.96	61.40	63.48
Crude fibre	18.33	18.24	18.46	16.97	16.80	17.71	18.89	17.78	18.40
Nitrogen-free extract	64.58	63.90	66.17	65.15	64.51	67.61	63.59	61.56	69.95
Balance									
Nitrogen (g)	1.716	1.648	1.663	2.773	2.268	1.827	1.626	1.644	1.606
Calcium (g)	0.160	0.210	0.158	0.151	0.228	0.189	0.129	0.137	0.147
Phosphorus (g)	0.037	0.049	0.039	0.063	0.068	0.044	0.042	0.038	0.034

4.3 PLANE OF NUTRITION

4.3.1 Digestible Crude Protein (DCP)

The daily intake of DCP during phases of growth is shown in Table 14. The mean daily intake of DCP were 12.28, 12.69 and 11.56 g in groups fed diets 1, 2 and 3 in phase I at body weights of 3.12, 3.30 and 3.26 kg, respectively. In phase II at body weights of 4.55, 4.81 and 4.76 kg, the mean daily intakes of DCP were 11.96, 15.42 and 12.34 g in animals fed diets 1, 2 and 3, respectively. When the body weights were 3.74, 3.92 and 3.65 kg during phase III, the mean daily intakes of DCP were 10.18, 11.86 and 11.24 g, respectively. There were no significant differences in DCP intake per day between the phases and also between the dietary treatments (Table 14 a).

4.3.2 Total Digestible Nutrients (TDN)

The total digestible nutrients intake in animals fed different treatments at three phases are presented in Table 14. The mean TDN intake per day was 67.80, 81.09 and 62.86 g in phase I, 64.29, 82.12 and 65.92 g in phase II and 61.82, 67.86 and 64.09 g in phase III in groups fed diets 20, 30 and 40 per cent lucerne hay, respectively. There were no significant differences in TDN intake per day between phases and also between the dietary treatments (Table 14 b).

Table 14. Plane of nutrition of experimental animals on different dietary treatments

Treatment	Average body weight (kg)	Intake per day (g)			DE (kcal)	ME (kcal)	DCP:TDN	DE:DCP
		DM	DCP	TDN				
		Phase I (14 weeks)						
1 (20% Lucerne hay)	3.12	120.81	12.38	67.90	298.8	245.0	1:5.53	1:24.33
2 (30% Lucerne hay)	3.30	158.57	12.60	81.09	356.8	292.6	1:6.39	1:28.12
3 (40% Lucerne hay)	3.26	114.62	11.55	62.85	276.5	226.3	1:5.44	1:23.93
		Phase II (20 weeks)						
1 (20% Lucerne hay)	4.55	124.53	11.96	64.29	282.9	230.0	1:5.38	1:23.67
2 (30% Lucerne hay)	4.51	177.04	15.42	91.12	401.0	328.3	1:5.91	1:26.00
3 (40% Lucerne hay)	4.75	121.34	12.34	65.92	290.4	241.4	1:5.42	1:23.56
		Phase III (26 weeks)						
1 (20% Lucerne hay)	3.74	122.75	10.18	61.22	269.4	220.0	1:6.01	1:26.46
2 (30% Lucerne hay)	3.92	125.40	11.86	67.65	297.7	244.1	1:5.70	1:25.10
3 (40% Lucerne hay)	3.65	116.20	11.24	64.09	282.0	231.2	1:5.70	1:25.09

DE = 4.4 kcal per g TDN

ME = 3.6 kcal per g TDN

Table 14 a. Analysis of variance of DCP intake per day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.847	0.424	0.034^NS
Between phases	2	0.120	0.060	0.005^NS
Error	21	274.605	12.536	
Total	25	275.572		

NS - Not significant (P > 0.05)

Table 14 b. Analysis of variance of TDN intake per day

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	8.807	4.404	0.007^NS
Between phases	2	0.406	0.203	0.0003^NS
Error	21	12662.622	602.794	
Total	25	12671.835		

NS - Not significant (P > 0.05)

4.3.3 Intake of Digestible Energy (DE) and Metabolisable Energy (ME)

The intakes of DE and ME by experimental animals of different groups were calculated from TDN intake (Table 14). The mean intake of DE ranged from 276.5 to 356.8 kcal in phase I, from 282.9 to 401.0 kcal in phase II and from 269.4 to 297.7 kcal in phase III in rabbits fed different ration treatments. The mean intake of ME ranged from 226.8 to 292.6 kcal in phase I, from 232.0 to 328.8 kcal in phase II and from 220.9 to 244.1 kcal in phase III in animals fed different ration treatments. The DCP : TDN ratio ranged from 1:5.44 to 1:6.30 in phase I, from 1:5.38 to 1:5.91 in phase II and from 1:5.70 to 1:6.01 in phase III in animals fed different diets. The DE : DCP ratio ranged from 1:23.92 to 1:28.12, 1:23.67 to 1:26.00 and 1:25.09 to 1:26.44 at phases I, II and III in animals fed different diets, respectively.

4.4 GROWTH STUDIES

The initial and final body weights along with average daily feed consumption, daily weight gain and feed conversion ratio of the animals fed 3 dietary treatments in experiment I are shown weekwise in Table 15.

The average initial body weights were 1270, 1272 and 1266 g in rabbits fed diets 1, 2 and 3 respectively at 7 weeks of age. The corresponding final body weights were 4546, 4814 and 4748 g at 20 weeks of age, respectively. Average gain in body weights of rabbits fed diets 1, 2 and 3 at 20 weeks of age were 3376, 3542 and 3498 g, respectively. The average daily weight gain corresponding to above treatments ranged from 27 to 42, 30 to 48 and 29 to 46 g, respectively. At 12 weeks of age the animals attained an average body weight of 2.552, 2.655 and 2.641 kg in the 3 dietary treatments, respectively. The average daily weight gain increased from 30 g at 7 weeks of age to 42 g at 11 weeks of age in rabbits fed diet 1, 32 g at 7 weeks to 48 g at 12 weeks of age in rabbits fed diet 2 and 32 to 46 g from 7 to 11 weeks of age in rabbits fed diet 3. Thereafter, a declining trend was observed in the average daily weight gain in all the treatments, as age advanced. At 20 weeks of age the average gains declined to 27, 30 and 29 g per day in rabbits fed diets 1, 2 and 3, respectively.

4.4.1 Feed Consumption

The average daily feed consumption which was 91, 95 and 97 g during the 7th week of age gradually increased as the age progressed to 265, 265 and 260 g at 20th week of age in rabbits fed diets 1, 2 and 3, respectively (Table 15).

The average feed consumption per animal during the experimental period i.e., from 7 to 20 weeks was 12.474, 12.828 and 12.987 kg for dietary treatments 1, 2 and 3, respectively. The feed consumed on an average by individual animal during 7 to 12 weeks of age when the animals in all the 3 groups

Particulars	Age in weeks 7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total weight gain (g)
	ANIMALS FED RATION CONTAINING 20% LUCERNE HAY														
weight of animal(g)	1270	1480	1711	1970	2267	2558	2838	3118	3384	3643	3883	4112	4336	4546	
daily food consumption(g)	91	106	136	174	202	200	215	213	220	225	235	240	250	265	
daily food intake(per cent body weight)	7.17	7.16	7.89	8.83	8.85	8.85	7.68	6.83	6.80	6.20	6.04	5.84	5.77	5.83	3
daily gain (g)	30	33	37	41	43	40	40	38	37	35	32	32	30	27	
food conversion ratio	3.03	3.21	3.65	4.24	4.70	5.00	5.38	5.62	6.22	6.46	7.36	7.50	8.33	9.81	
	ANIMALS FED RATION CONTAINING 30% LUCERNE HAY														
weight of animal (g)	1272	1488	1765	2042	2330	2656	2963	3265	3575	3885	4134	4380	4597	4824	
daily food consumption(g)	95	108	125	177	200	215	208	214	222	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
daily food intake(per cent body weight)	7.47	7.22	7.40	8.67	8.61	8.07	6.98	6.40	6.21	6.31	6.05	5.78	5.42	5.50	3
daily gain(g)	33	37	41	44	46	48	42	40	40	37	35	34	31	30	
food conversion ratio	2.97	2.92	3.29	4.02	4.44	4.48	4.96	5.35	5.55	6.62	7.11	7.41	8.03	8.83	
	ANIMALS FED RATION CONTAINING 40% LUCERNE HAY														
weight of animal(g)	1265	1479	1731	2018	2330	2641	2963	3267	3544	3817	4069	4300	4531	4748	
daily food consumption(g)	97	112	130	180	206	209	213	220	220	241	247	245	252	260	
daily food intake(per cent body weight)	7.78	7.57	8.03	8.92	8.86	7.91	7.19	6.76	6.40	6.31	6.07	5.70	5.56	5.48	3
daily gain(g)	32	36	41	43	46	46	42	41	39	35	33	32	31	30	
food conversion ratio	3.03	3.11	3.30	4.17	4.48	4.54	5.07	5.37	5.90	6.89	7.48	7.42	8.12	8.97	

reached an average live weight of 2.5 kg and above was of the order 6.386, 6.510 and 6.601 kg for dietary treatments 1, 2 and 3, respectively.

The daily feed intake as percentage of body weight ranged from 7.17 to 5.83 from 7 to 20 weeks of age in dietary treatment 1, while the percentages in dietary treatment 2 ranged from 7.47 to 5.60 and 7.73 to 5.48 in dietary treatment 3, respectively (Table 15). The daily feed intake as percentage of body weight increased gradually to 8 and above (but below 9%) during 10 to 12 weeks when the average body weights of animals ranged between 1.970 to 2.558 kg and 2.042 to 2.686 kg in dietary treatment 1 and 2, whereas in treatment 3, it was during 9 to 11 weeks when the average body weights ranged between 1.731 to 2.319 kg, respectively. Thereafter, the percentages progressively declined as the animals aged and grew.

4.4.2 Feed Efficiency

The feed consumed per unit gain (Feed/gain ratio) also increased with the age (7 to 20 weeks) from 3.08 to 9.81, 2.97 to 8.83 and 3.02 to 8.97 in the 3 respective treatments (Table 15). Feed conversion ratio of 5.00, 4.48 and 4.84 were observed when the animals attained a live weight of about 2.5 kg at weeks 11, 12 and 11 in rabbits fed dietary treatments 1, 2 and 3, respectively. The feed conversion ratio between ages 7 to 9 weeks ranged from 2.97 to 3.29, 3.03 to 3.30 and 3.03 to 3.65 in rabbits fed dietary treatments 2, 3 and 1 respectively when the animals reached a live weight of about 1700 g. A range of 4.02 to 4.95 was observed in treatment 2 between 10 and 13 weeks age when the group average body weight increased from 2 to 3 kg; 4.17 to 4.54 in treatment 3 between 10 and 12 weeks as the group average live weight increased from 2.00 to 2.64 kg; 4.24 to 5.00 between 10 and 12 weeks with live weight from 1.97 to 2.55 kg in treatment 1.

Though the average feed consumption was lowest in animals fed dietary treatment 1 and highest in treatment 3, better average daily gain and feed conversion ratio was observed with diet 2 containing 30 per cent lucerne than animals of dietary treatment 3 and 1 containing 40 and 20 per cent lucerne, respectively. While comparing diets 3 and 1, results indicated better performance in rabbits fed diet 3 than diet 1. However, average feed consumption was higher with group 3 as compared to group 1.

Statistical analysis of average daily gain (Table 15 a) and feed efficiency (Table 15 b) were significant ($P < 0.01$) between the treatments and between the weeks.

The average weight gains, feed consumption and feed efficiency of experimental animals fed ad libitum in experiment I are presented in Table 16.

Table 15 a. Analysis of variance of average daily gain

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	67.47	33.74	35.89**
Between weeks	13	1080.40	83.11	88.41**
Error	26	24.53	0.94	
Total	41	1172.40		

** Significant ($P < 0.01$)

ADG - Weekly means:

28.67^{a}	30.67^{b}	31.33^{c}	33.00^{d}	33.33^{d}
W_{20}	W_{19}	W_{7}	W_{18}	W_{17}
36.33^{e}	36.60^{f}	38.67^{g}	39.67^{h}	39.67^{h}
W_{8}	W_{16}	W_{15}	W_{14}	W_{9}
41.33^{i}	42.67^{j}	44.67^{k}	44.67^{k}	
W_{13}	W_{10}	W_{11}	W_{12}	

The treatments/weeks have been tested with the help of DMR test.

P = 2 : 0.51	P = 6 : 0.57	P = 10 : 0.59
P = 3 : 0.53	P = 7 : 0.58	P = 11 : 0.60
P = 4 : 0.55	P = 8 : 0.58	P = 12 : 0.60
P = 5 : 0.55	P = 9 : 0.59	P = 13 : 0.60

Table 15 b. Analysis of variance of feed efficiency

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.74	0.37	12.33**
Between weeks	13	146.97	11.31	376.86**
Error	26	0.68	0.03	
Total	41	148.39		

** Significant (P ∠ 0.01)

Feed efficiency - weekly means

3.01[a]	3.06[a]	3.44[b]	4.14[c]	4.84[d]
W_7	W_8	W_9	W_{10}	W_{11}
3.67[e]	5.13[f]	5.44[g]	5.80[h]	6.59[i]
W_{12}	W_{13}	W_{14}	W_{15}	W_{16}
7.21[j]	7.44[k]	8.16[l]	9.27[m]	
W_{17}	W_{18}	W_{19}	W_{20}	

The treatments/weeks have been tested with the help of DMR test.

P = 2 : 0.09	P = 6 : 0.10	P = 10 : 0.11
P = 3 : 0.10	P = 7 : 0.10	P = 11 : 0.11
P = 4 : 0.10	P = 8 : 0.10	P = 12 : 0.11
P = 5 : 0.10	P = 9 : 0.11	P = 13 : 0.11

Table 16. Average weight gain, food consumption and food efficiency of experimental animals fed ad libitum in different dietary treatments in experiment 1

Particulars	ANIMALS FED RATION CONTAINING		
	20% Lucerne hay	30% Lucerne hay	40% Lucerne hay
Number of animals	10	10	10
Experimental period (days)	56	56	56
Average initial weight (kg)	1.270	1.273	1.286
Average final weight (kg)	3.118	3.296	3.287
Average weight gain in 56 days (kg)	1.848	2.023	2.003
Average daily gain (g)	33.00	36.13	35.76
Average dry matter intake/animal/day (g)	150.30	152.16	155.20
Dry matter intake/kg live weight gain (kg)	4.55	4.21	4.34
Cost of feed/kg live weight gain (Rs.)	11.13	11.56	12.37
Total feed consumption of animals (kg)	93.52	94.64	96.32
Feed conversion ratio	1:5.06	1:4.63	1:4.81

Experiment II

Having ascertained the availability of nutrients and growth rates from the three dietary treatments at 14, 20 and 36 weeks of age, when the rabbits were fed ad libitum, it was evident (Table 15) that after 12 weeks of age the growth rate declined in all treatment groups. An attempt was therefore made to assess the growth rates, efficiency and carcass characteristics in rabbits fed various ration treatments and planes of nutrition.

A 56-day growth trial was conducted (6 to 14 weeks) to study the effect of plane of nutrition on growth rate, feed efficiency and carcass characteristics. In this study, 63 weaned New Zealand Whites (6 weeks of age) were allotted to 3 groups of 21 animals each, referred to as main groups, and the 3 diets prepared for experiment were fed. Each main group was subdivided into sub-groups of 7 animals each and the sub-groups were offered 90, 100 and 110 per cent levels of N.R.C. requirements to assess the growth rate and feed cost of meat production.

4.5 LEVEL OF DRY MATTER INTAKE ON GROWTH RATE

The growth performance in rabbits fed diets containing 20, 30 and 40 per cent lucerne hay indicated that the maximum growth rates were observed between 11 and 12 weeks of age, especially when ration contained 30 and 40 per cent lucerne hay (Table 15). It was thought desirable, whether levels of intake of dry matter during active growth (12 weeks of age) with similar diets, influence the growth performance in rabbits as in the case of poultry (Reddy et al., 1977). With this in view, a second growth trial was initiated, wherein, each of the 3 main groups fed rations containing 20,30 and 40 per cent lucerne hay were sub-divided into 3 sub-groups of 7 rabbits each and fed dry matter intakes of 90, 100 and 110 per cent level of N.R.C. to assess growth performance upto 12 weeks of age.

4.5.1 Growth Studies

The initial and final body weights along with average daily gains of all the animals subjected to 20, 30 and 40 per cent of lucerne hay incorporation in diet at 3 levels of feeding (90, 100 and 110% N.R.C.) in experiment II are shown in Table 17, 17 a and 17 b, respectively.

The average daily gain of experimental rabbits was 20.01, 19.76 and 18.80 g in diet containing 20 per cent lucerne hay at 3 levels of feeding, respectively (Table 17). The corresponding average daily gain was 26.42, 26.17 and 27.76 g in rabbits fed diet containing 30 per cent lucerne hay(Table 17 a) and 19.63, 20.41 and 24.22 g in rabbits fed diet containing 40 per cent lucerne hay (Table 17 b) at 3 levels of feeding, respectively.

Analysis of variance of average daily gain indicated no significant difference between different treatments containing 20,30 and 40 per cent lucerne hay and between levels of feeding within the treatment (Table 17 c).

Table 17. Weight gain of animals during experimental period (56 days) fed 20 per cent lucerne hay

Level	Animal No.	Initial weight (kg)	Final weight (kg)	Total gain (kg)	Average daily gain (g)	Group average daily gain (g)
90% N.R.C.	1	1.270	2.400	1.130	20.18	
	2	1.380	2.280	0.900	16.43	
	3	1.140	2.340	1.200	21.43	
	4	1.180	2.360	1.180	21.07	20.01
	5	1.240	2.300	1.060	18.93	
	6	1.350	2.485	1.135	20.27	
	7	1.320	2.540	1.220	21.79	
	Mean	1.283	2.408	1.125	20.01	
	S.E.d.	0.030	0.033	0.039	0.70	
100% N.R.C.	8	1.325	2.240	0.915	16.34	
	9	1.250	2.340	1.090	19.46	
	10	1.200	2.400	1.200	21.43	
	11	1.235	2.250	1.015	18.13	19.75
	12	1.215	2.290	1.075	19.20	
	13	1.375	2.530	1.155	20.57	
	14	1.180	2.480	1.300	23.21	
	Mean	1.269	2.376	1.106	19.75	
	S.E.d.	0.029	0.035	0.043	0.65	
110% N.R.C.	15	1.280	2.410	1.130	20.18	
	16	1.230	2.200	0.970	17.32	
	17	1.190	2.340	1.150	20.54	
	18	1.315	2.320	1.005	17.95	19.39
	19	1.280	2.420	1.140	20.36	
	20	1.640	2.420	0.780	13.93	
	21	1.300	2.620	1.320	23.57	
	Mean	1.316	2.404	1.088	19.39	
	S.E.d.	0.053	0.057	0.067	1.21	

Table 17 a. Weight gain of animals during experimental period (56 days) fed 30 per cent lucerne hay

Level	Animal No.	Initial weight (kg)	Final weight (kg)	Total gain (kg)	Average daily gain (g)	Group average daily gain (g)
90% N.R.C.	1	1.4[illegible]5	2.[illegible]0	1.[illegible]	24.[illegible]	
	2	1.360	2.400	1.040	18.57	
	3	1.150	2.290	1.140	20.36	
	4	0.[illegible]0	2.[illegible]5	1.415	25.27	25.46
	5	0.780	2.275	1.495	26.70	
	6	0.785	2.[illegible]5	1.[illegible]0	22.50	
	7	0.690	2.330	1.640	29.29	
	Mean	1.006	2.429	1.426	25.46	
	S.E.d.	0.122	0.067	0.100	1.79	
100% N.R.C.	8	1.470	2.600	1.130	20.18	
	9	1.3[illegible]5	2.475	1.120	20.00	
	10	1.[illegible]0	2.[illegible]5	1.345	24.0[illegible]	
	11	1.080	2.495	1.415	25.27	26.17
	12	0.785	2.[illegible]0	1.[illegible]5	2[illegible]	
	13	0.720	2.[illegible]0	1.670	29.82	
	14	0.670	2.445	1.775	31.70	
	Mean	1.067	2.5[illegible]	1.46[illegible]	26.17	
	S.E.d.	0.129	0.0[illegible]	0.100	1.[illegible]	
110% N.R.C.	15	1.415	3.090	1.675	29.[illegible]	
	16	1.4[illegible]5	3.0[illegible]	1.585	28.30	
	17	1.170	2.4[illegible]0	1.[illegible]0	2[illegible].04	
	18	1.27[illegible]	2.4[illegible]0	1.[illegible]5	2[illegible].[illegible]7	27.76
	19	0.760	2.[illegible]0	1.[illegible]0	2[illegible]	
	20	0.725	2.[illegible]0	1.[illegible]5	2[illegible]	
	21	0.670	2.510	1.840	32.86	
	Mean	1.084	2.619	1.535	27.76	
	S.E.d.	0.130	0.106	0.089	1.40	

Table 17 b. Weight gain of animals during experimental period (56 days) fed 40 per cent lucerne hay

Level	Animal No.	Initial weight (kg)	Final weight (kg)	Total gain (kg)	Average daily gain (g)	Group average daily gain (g)
90% N.R.C.	1	1.340	2.380	1.0[illegible]	18.[illegible]	
	2	1.[illegible]	2.[illegible]	1.146	20.4[illegible]	
	3	1.190	2.[illegible]	1.[illegible]	19.7[illegible]	
	4	0.[illegible]	1.[illegible]	1.0[illegible]	1[illegible].7[illegible]	19.[illegible]
	5	0.445	2.0[illegible]	1.[illegible]	[illegible]	
	6	0.3[illegible]	1.0[illegible]	0.7[illegible]	12.77	
	7	0.[illegible]	1.[illegible]	1.070	19.11	
	Mean	0.[illegible]	1.[illegible]	1.0[illegible]	19.[illegible]	
	S.E.	0.1[illegible]	0.170	0.0[illegible]	1.7[illegible]	
100% N.R.C.	8	1.400	2.480	1.080	18.[illegible]	
	9	1.2[illegible]	2.400	1.146	20.4[illegible]	
	10	1.0[illegible]	2.140	1.[illegible]	19.[illegible]	
	11	0.[illegible]	1.[illegible]	0.[illegible]	1[illegible].[illegible]	20.[illegible]
	12	0.5[illegible]	2.[illegible]	1.7[illegible]	20.[illegible]	
	13	0.480	1.[illegible]	1.0[illegible]	1[illegible].77	
	14	0.[illegible]	1.4[illegible]	1.1[illegible]	21.1[illegible]	
	Mean	0.[illegible]7	2.01[illegible]	1.1[illegible]	20.[illegible]	
	S.E.	0.1[illegible]	0.1[illegible]	0.0[illegible]	1.[illegible]	
110% N.R.C.	15	1.[illegible]	2.[illegible]	0.[illegible]	1[illegible].[illegible]	
	16	1.[illegible]	2.[illegible]	1.3[illegible]	24.[illegible]	
	17	0.[illegible]	2.400	1.440	2[illegible].[illegible]7	
	18	0.7[illegible]	2.1[illegible]	1.[illegible]	2[illegible].7[illegible]	24.[illegible]
	19	0.[illegible]	2.1[illegible]	1.[illegible]0	[illegible]	
	20	0.415	1.[illegible]	1.0[illegible]0	1[illegible].7[illegible]	
	21	0.[illegible]	2.140	1.700	21.[illegible]	
	Mean	0.[illegible]	2.[illegible]	1.[illegible]	24.[illegible]	
	S.E.	0.176	0.144	0.112	1.[illegible]	

Table 17 c. Analysis of variance of plane of nutrition in different treatments and levels on average daily gain

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	10.856	5.428	0.07[illegible] NS
Between levels	2	0.[illegible]	0.4[illegible]	0.00[illegible] NS
Error	[illegible]	[illegible].315	[illegible]	
Total	[illegible]	[illegible].040		

NS = Not significant (P > 0.05)

4.5.2 Feed Efficiency

Average dry matter intake, average weight gain and feed efficiency in different groups are shown in Table 18, 18 a and 18 b, respectively.

The average dry matter intake per animal per day was 56.77, 58.21 and 62.62 g, the average daily gain per animal per day was 20.01, 19.75 and 19.20 g and the feed efficiency was 2.87, 2.98 and 3.26 in rabbits fed diet containing 20 per cent lucerne hay at 3 levels of feeding, respectively (Table 18). In rabbits fed diet containing 30 per cent lucerne hay, the average dry matter intake per animal per day was 76.39, 82.26 and 84.98 g, the average daily gain per animal per day was 25.42, 26.17 and 27.76 g, while the feed efficiency was 2.98, 3.16 and 3.09 at different levels of feeding (Table 18 a), respectively. The corresponding figures for group of rabbits fed diet containing 40 per cent lucerne hay were 51.84, 60.21 and 64.55 g for dry matter intake per animal per day, 19.63, 20.61 and 24.28 g for average daily gain per animal per day and the feed efficiency was of the order 2.64, 2.94 and 2.66 in 3 levels of feeding (Table 18 b), respectively. Thus the feed efficiency was highest in group that was fed ration containing 40 per cent lucerne hay whereas the feed efficiency of animals fed ration containing 20 and 30 per cent lucerne hay were comparable.

Table 18. Weight gain, food consumption and efficiency of food conversion of experimental animals

DIET 1 (20% Lucerne hay)

Particulars	Level of feeding		
	90% N.R.C.	100% N.R.C.	110% N.R.C.
Number of animals	7	7	7
Experimental period (days)	56	56	56
Average initial weight (kg)	1.288	1.269	1.346
Average final weight (kg)	2.430	2.374	2.404
Average weight gain in 56 days (kg)	1.142	1.106	1.058
Average daily gain (g)	20.41	19.75	18.89
Average D.M.intake/animal/day (g)	56.77	58.21	60.63
D.M. intake per kg live weight gain (kg)	2.87	2.98	3.28
Cost of feed per kg live weight gain (Rs)	6.93	7.33	8.06
Total feed consumption of animals (kg)	24.727	25.437	27.076
Feed conversion ratio	1:3.15	1:3.30	1:3.73

Table 18 a. Weight gain, feed consumption and efficiency of feed conversion of experimental ani[mals]

DIET 2 (30% lucerne hay)

Particulars	Level of feeding		
	80% N.R.C.	100% N.R.C.	110% N.R.C.
Number of animals	7	7	7
Experimental period (days)	56	56	56
Average initial weight (kg)	1.006	1.087	1.084
Average final weight (kg)	2.4[illegible]	2.5[illegible]	2.6[illegible]
Average weight gain in 56 days (kg)	1.4[illegible]	1.4[illegible]	1.5[illegible]
Average daily gain (g)	25.4[illegible]	26.17	27.75
Average D.M.intake/animal/day (g)	75.20	82.[illegible]	[illegible]
D.M. intake per kg live weight gain (kg)	2.[illegible]	3.16	3.0[illegible]
Cost of feed per kg live weight gain (Rs)	[illegible].11	[illegible]	[illegible]
Total feed consumption of animals (kg)	22.704	25.[illegible]	27.[illegible]
Feed conversion ratio	1:3.[illegible]	1:3.40	1:3.42

Table 18 b. Weight gain, food consumption and efficiency of food conversion of experimental ani

Diet 3 (40% Lucerne hay)

Particulars	Level of feeding		
	90% N.R.C.	100% N.R.C.	110% N.R.C.
Number of animals	7	7	7
Experimental period (days)	56	56	56
Average initial weight (kg)	0.[illegible]	0.[illegible]	0.[illegible]
Average final weight (kg)	1.[illegible]	2.[illegible]	2.[illegible]
Average weight gain in 56 days (kg)	1.[illegible]	1.1[illegible]	1.[illegible]
Average daily gain (g)	19.[illegible]	[illegible]	[illegible]
Average D.M.intake/animal/day (g)	51.[illegible]	[illegible]	[illegible]
D.M. intake per kg live weight gain (kg)	2.[illegible]	2.[illegible]	2.[illegible]
Cost of feed per kg live weight gain (Rs)	7.[illegible]	[illegible]	7.7[illegible]
Total feed consumption of animals (kg)	[illegible]	[illegible]	[illegible]
Feed conversion ratio	1:2.[illegible]	1:3.1[illegible]	1:2.[illegible]

Table 18 c. Analysis of variance of cost of feed per kg live weight gain in different treatments and levels of feeding

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	0.96	0.48	12.00**
Between levels	2	0.64	0.32	8.00**
Error	58	2.28	0.04	
Total	62	3.88		

** Significant (P∠ 0.01)

Treatment means	7.62[a]	8.08[b]	8.40[c]
	T_1	T_3	T_2
Level means	7.88[a]	8.15[b]	8.26[c]
	L_1	L_2	L_3

The treatments have been tested with the help of DMR test.

P = 2 : 0.12

P = 3 : 0.12

4.5.3 Feed Cost per Unit Live Weight Gain

In the calculation of cost of feed, the prices at which various feed ingredients were procured at the start of the experiment were taken into consideration (Table 19). However, it is recognised that the cost of feed ingredients change from time to time. In order to give uniform basis, the feed cost at the beginning of the experiment was taken so as to give an indication as to the comparative cost of growth performance in animals fed different ration treatments. The flow-sheet of processing cost of experimental rations is shown in Table 19 a. Based on the total feed consumed during the experimental period, the feed cost per unit of live weight gain was calculated

The feed cost per kg live weight gain was Rs 6.98, 7.28 and 8.08 for 3 levels of feeding respectively in diet 1 (Table 18), Rs 8.11, 8.63 and 8.46 in diet 2 (Table 18 a) and Rs 7.94, 8.58 and 7.72 in diet 3 (Table 18 b), respectively. There were significant ($P < 0.01$) differences in cost per kg gain between animals fed various diets due to differences in the level of lucerne incorporated and the level of feeding adopted in each dietary treatment (Table 18 c). Generally the feed efficiency and the time taken to attain slaughter weight are regarded as indices of production efficiency of broiler rabbits.

4.6 CARCASS CHARACTERISTICS

The mean body weights at slaughter were 2.18, 2.31 and 2.20 kg in animals fed 20 per cent lucerne hay in diet 1 at 3 different levels of feeding, respectively (Table 20).

Table 19. Cost of experimental rations per quintal

	Cost per quintal (Rs)	Cost of rations (Rs)		
		20% lucerne hay	30% lucerne hay	40% lucerne hay
Lucerne hay*	400.00	80.00	120.00	160.00
Maize	158.00	55.30	58.46	63.20
Wheat bran	122.50	36.75	24.50	12.25
Groundnut cake	210.00	25.20	21.00	14.70
Salt	42.00	0.42	0.42	0.42
Mineral mixture	170.00	3.40	3.40	3.40
Rovimix per kg	175.00	1.75	1.75	1.75
Processing cost	-	17.15	17.60	18.10
Total cost of ration per quintal Rs		219.97	247.13	273.82

* Obtained from Livestock Research station, Rajendranagar.

Table 19 a. Processing cost of experimental ration

Particulars	Ration		
	20% lucerne hay	30% lucerne hay	40% lucerne hay
1. DIRECT CHARGES			
a) Power cost @ Rs 0.45/KWH	245.89	266.83	294.66
(power consumption in KWH)	(546.42)	(592.96)	(654.80)
b) Operators (two) @ Rs 20/- per day	40.00	40.00	40.00
c) Labour (six) @ Rs 10/- per day	60.00	60.00	60.00
d) Cost of diesel @ Rs 3.85 per litre	693.50	704.28	720.88
(diesel consumption in litres)	(180.00)	(183.50)	(187.50)
2. FIXED CHARGES*			
Total expenditure per day (Rs)	1371.72	1408.14	1447.74
Production per day (tonnes)	8.00	8.00	8.00
Processing	17.15	17.60	18.10

* Fixed charges

	Rs
a) Depreciation on building and machinery	
i) Depreciation @ 5% per year per 1.00 lakh on civil works for 1 year	5,000.00
ii) Depreciation @ 10% per year on 3.5 lakhs plant machinery	35,000.00
b) Interest @ 10% per year on block investment (4.5 lakhs) per year	45,000.00
c) Insurance @ 0.6% per year	2,700.00
d) Maintenance @ Rs 1,000/- per month	12,000.00
Total per year of 300 working days	99,700.00
Fixed charges per day	332.33

Photo 5. Dressed carcasses of rabbits (warm).

Photo 6. Dressed carcasses of rabbits (cooled).

The mean hot carcass weights were 1.16, 1.26 and 1.31 kg, while the mean chilled carcass weights were 1.11, 1.20 and 1.23 kg, respectively. The mean dressing percentage of hot carcass was 53.12, 54.65 and 56.25 whereas, the average dressing percentage of chilled carcass was 50.57, 51.94 and 53.59, the shrinkage percentage being 4.83, 4.96 and 5.74, respectively (Table 20).

In animals fed 30 per cent lucerne hay, the mean body weights at slaughter in 3 different levels of feeding were 2.28, 2.39 and 2.50 kg, the mean hot carcass weights were 1.29, 1.18 and 1.31 kg, the mean chilled carcass weights were 1.10, 1.13 and 1.26 kg (Table 20 a), respectively. The mean dressing percentage of hot carcass was 49.90, 49.41 and 52.30 while the mean dressing percentage of chilled carcass was 48.20, 47.20 and 50.18, the shrinkage percentage being 3.43, 4.45 and 4.08, respectively.

The corresponding figures for animals fed 40 per cent lucerne hay, the mean body weights were 2.35, 2.41 and 2.66 kg, the mean hot carcass weights were 1.14, 1.25 and 1.32 kg, the average chilled carcass weights were 1.07, 1.20 and 1.25 kg (Table 20 b), respectively. The mean dressing percentage of hot carcass was 48.34, 51.93 and 49.57 while the mean dressing percentage of chilled carcass was 45.54, 49.65 and 47.17, respectively. The percentage of shrinkage were 5.78, 4.44 and 4.83 respectively in 3 different levels of feeding(Table 20 b).

Table 20. Dressing percentage of hot and chilled carcass of animals fed ration containing 20 per cent lucerne hay

Group		Live weight (kg)	Hot carcass weight (kg)	Chilled carcass weight (kg)	Dressing percentage: Hot carcass	Dressing percentage: Chilled carcass	Shrinkage (%)
90% N.R.C.		1.960	0.980	0.924	50.00	47.14	5.72
		2.240	1.234	1.182	55.09	52.77	4.21
		2.340	1.270	1.212	54.27	51.79	4.57
	Mean	2.18	1.16	1.11	53.12	50.57	4.83
	S.E.±	0.11	0.09	0.09	1.58	1.74	0.45
100% N.R.C.		2.090	1.158	1.103	55.41	52.78	4.75
		2.370	1.298	1.234	54.77	52.07	4.93
		2.460	1.323	1.254	53.78	50.98	5.21
	Mean	2.31	1.26	1.20	54.65	51.94	4.96
	S.E.±	0.11	0.05	0.05	0.47	0.52	0.13
110% N.R.C.		2.280	1.296	1.220	56.84	53.51	5.86
		2.200	1.285	1.210	58.41	55.00	5.84
		2.430	1.344	1.270	55.31	52.26	5.51
	Mean	2.30	1.31	1.23	56.85	53.59	5.74
	S.E.±	0.07	0.02	0.02	0.89	0.79	0.11

Table 20 a. Dressing percentage of hot and chilled carcass of animals fed ration containing 30 per cent lucerne hay

Group		Live weight (kg)	Hot carcass weight (kg)	Chilled carcass weight (kg)	Dressing percentage Hot carcass	Dressing percentage Chilled carcass	Shrinkage (%)
90% N.R.C.		2.238	1.112	1.068	49.70	47.39	4.64
		2.132	1.060	1.018	49.72	47.76	3.95
		2.376	1.195	1.175	50.29	49.45	1.67
	Mean	2.25	1.29	1.10	49.90	48.20	3.42
	S.E.	0.08	0.17	0.05	0.19	0.64	0.90
100% N.R.C.		2.368	1.256	1.194	53.04	50.42	4.94
		2.420	1.162	1.110	47.92	45.88	4.47
		2.360	1.118	1.074	47.37	45.50	3.95
	Mean	2.39	1.18	1.13	49.41	47.30	4.45
	S.E.	0.02	0.04	0.04	1.82	1.41	0.29
110% N.R.C.		2.206	1.195	1.126	50.72	48.17	5.03
		2.268	1.135	1.120	50.30	48.06	4.47
		2.780	1.550	1.484	55.85	54.24	2.75
	Mean	2.50	1.31	1.26	52.30	50.16	4.08
	S.E.	0.14	0.12	0.13	1.79	2.08	0.69

Table 20 b. Dressing percentage of hot and chilled carcass of animals fed ration containing 40 per cent lucerne hay

Group		Live weight (kg)	Hot carcass weight (kg)	Chilled carcass weight (kg)	Dressing percentage Hot carcass	Dressing percentage Chilled carcass	Shrinkage (%)
90% N.R.C.		2.351	1.156	1.066	49.17	45.34	7.79
		2.366	1.150	1.090	48.61	46.07	5.22
		2.345	1.108	1.060	47.25	45.20	4.34
	Mean	2.35	1.14	1.07	48.34	45.54	5.78
	S.E.	0.01	0.02	0.01	0.57	0.27	1.03
100% N.R.C.		2.386	1.324	1.270	55.49	53.23	4.07
		2.490	1.268	1.220	50.92	49.00	3.77
		2.362	1.170	1.106	49.53	46.82	5.47
	Mean	2.41	1.25	1.20	51.98	49.68	4.44
	S.E.	0.04	0.05	0.05	1.80	1.88	0.52
110% N.R.C.		2.645	1.338	1.262	50.59	47.71	5.68
		2.770	1.350	1.288	48.74	46.50	4.59
		2.553	1.261	1.207	49.39	47.28	4.27
	Mean	2.66	1.32	1.25	49.57	47.17	4.85
	S.E.	0.06	0.03	0.02	0.54	0.34	0.44

Table 20 e. Analysis of variance of dressing percentage of hot carcass

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	156.745	78.372	16.865**
Between levels	2	27.747	13.873	2.985 NS
Treatments x levels	4	1.263	0.316	0.068 NS
Error	18	83.653	4.647	
Total	26	269.408		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	48.99^{a}	50.56^{a}	54.57^{b}
	T_3	T_2	T_1

The treatments have been tested with the help of DMR test.

P = 2 : 2.13

P = 3 : 2.24

Table 20 d. Analysis of variance of dressing percentage of chilled carcass

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	102.882	51.441	10.315**
Between levels	2	23.074	11.537	2.312 NS
Treatments x levels	4	30.721	7.680	1.540 NS
Error	18	89.767	4.987	
Total	26	246.445		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	47.44^{a}	48.88^{a}	52.08^{b}
	T_3	T_2	T_1

The treatments have been tested with the help of DMR test.

$p = 2 : 2.21$

$p = 3 : 2.32$

Statistical analysis revealed a significant difference ($P < 0.01$) between the treatments for both hot (Table 20 c) and chilled (Table 20 d) carcasses whereas, differences between the levels and interaction between the treatments and levels were not significant.

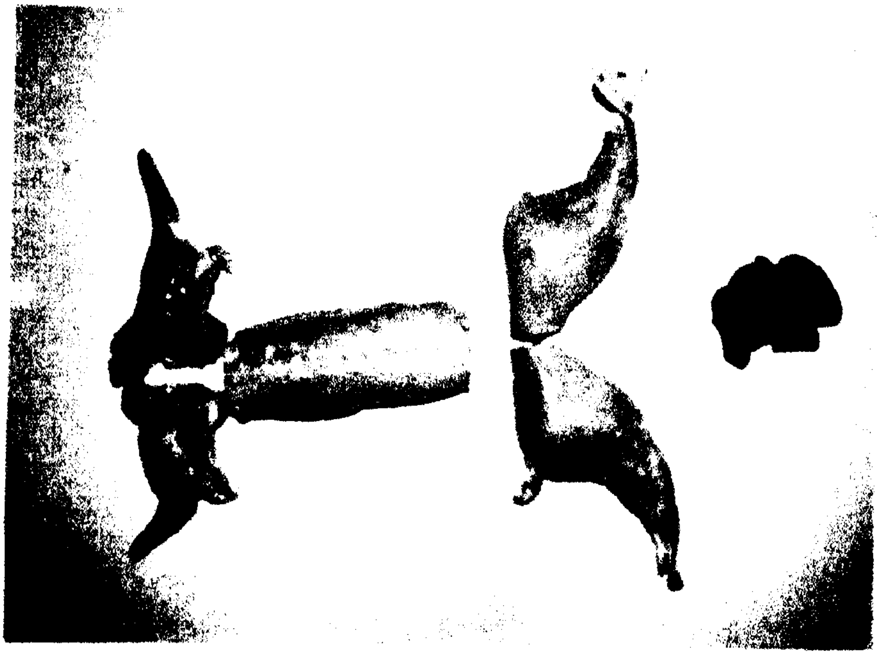
4.6.1 Relationship of Various Cuts (quarters) to Chilled carcass in Different Treatments

The mean proportion of the fore, mid and hindquarters expressed as percentage of chilled carcass weight was [illegible], 26.647 and 27.800; 34.267, 35.203 and 36.[illegible]; 36.[illegible], 36.180 and 36.603 in animals fed 20 per cent lucerne hay at different levels of feeding (Table 21). In animals fed 30 per cent lucerne (Table 21 a), the percentage was [illegible], [illegible].780 and 26.143 for forequarter, 37.[illegible], 36.[illegible] and 37.[illegible] for mid-quarter and 36.[illegible], 37.[illegible] and 37.[illegible] for hindquarter respectively at different levels of feeding. The corresponding percentages for animals fed 40 per cent lucerne were [illegible], 26.420 and 25.047; 36.[illegible], 36.[illegible] and 37.[illegible]; [illegible], [illegible] and 37.450 for fore, mid and hindquarters at 3 levels of feeding, respectively (Table 21 b).

Analysis of variance revealed only significant difference ($P < 0.01$) for percentages of forequarters between treatments (Table 21 c) while there was no significant difference for mid (Table 21 d) and hind (Table 21 e) quarters. Further, there was no significant difference between the levels and interaction between the treatments and levels for fore, mid and hindquarters, respectively.

Photo 7. Various cuts of the rabbit carcass after chilling.

Photo 8. Visceral organs (liver, kidneys, heart, spleen and lungs) of the rabbit.



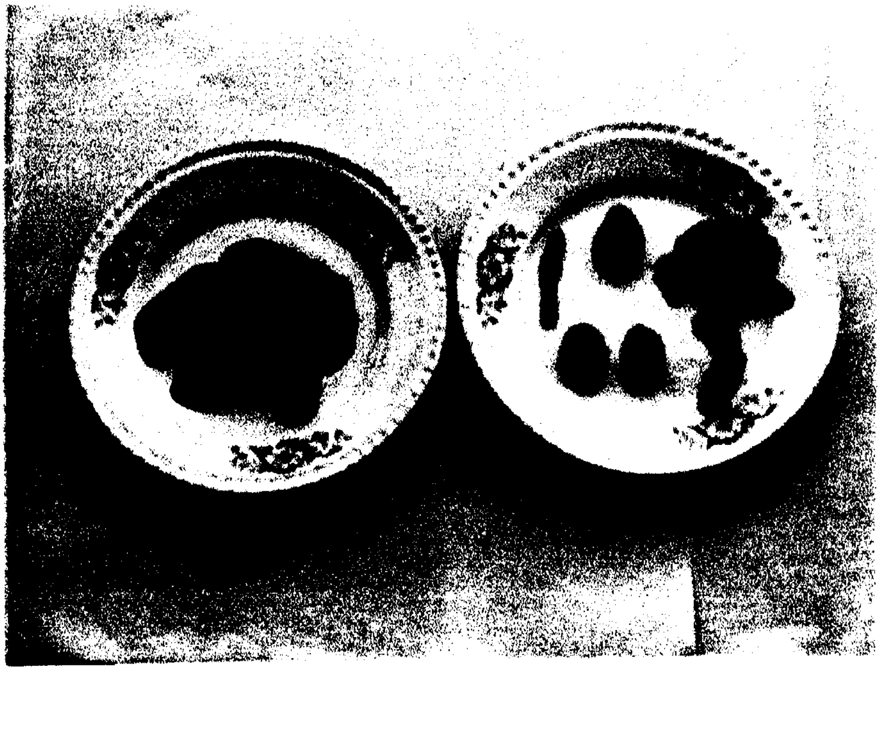


Table 21. Effect of levels of food on the proportions (%) of fore, mid and hindquarters in the chilled carcass

Group		Chilled ½ carcass weight (kg)	Forequarter		Midquarter		Hindquarter	
			weight (kg)	%	weight (kg)	%	weight (kg)	%
			ANIMALS FED RATION CONTAINING 20 PER CENT LUCERNE HAY					
90% N.R.C.		0.924	0.255	27.60	0.308	33.33	0.361	39.07
		1.182	0.304	25.72	0.430	36.38	0.448	37.90
		1.212	0.334	27.56	0.404	33.33	0.474	39.11
	Mean	1.106	0.298	26.960	0.381	34.347	0.428	38.693
	S.E.	0.091	0.023	0.630	0.037	1.017	0.034	0.397
100% N.R.C.		1.103	0.302	27.38	0.371	33.64	0.430	38.98
		1.224	0.317	25.90	0.454	37.10	0.453	36.71
		1.254	0.337	26.87	0.431	34.37	0.486	38.76
	Mean	1.197	0.319	26.667	0.422	35.203	0.456	38.150
	S.E.	0.047	0.010	0.500	0.027	1.227	0.205	0.789
110% N.R.C.		1.220	0.325	26.58	0.441	36.15	0.451	36.97
		1.210	0.330	27.27	0.450	37.19	0.430	35.54
		1.270	0.360	28.35	0.440	34.65	0.470	37.00
	Mean	1.233	0.338	27.400	0.444	35.997	0.450	36.503
	S.E.	0.019	0.010	0.440	0.003	0.737	0.012	0.488

Table XI a. Effect of levels of feed on the proportions (%) of fore, mid and hindquarters in the chilled carcass

Group		Chilled carcass weight (kg)	Forequarter		Midquarter		Hindquarter	
			Weight (kg)	%	Weight (kg)	%	Weight (kg)	%
				ANIMALS FED RATION CONTAINING 20 PER CENT LUCERNE HAY				
90% N.R.C.		1.108	0.297	26.81	0.398	35.92	0.412	37.27
		1.018	0.254	24.95	0.382	38.51	0.372	36.54
		1.175	0.296	25.19	0.448	38.12	0.431	36.69
	Mean	1.100	0.282	25.650	0.412	37.517	0.405	36.833
	S.E.	0.046	0.014	0.584	0.018	0.806	0.017	[illegible]
100% N.R.C.		1.194	0.253	21.12	0.424	35.51	0.482	40.37
		1.119	0.310	27.93	0.395	35.63	0.404	36.39
		1.074	0.270	25.14	0.415	38.64	0.389	36.22
	Mean	1.129	0.280	25.730	0.412	36.610	0.425	37.660
	S.E.	0.035	0.012	1.129	0.008	1.016	0.029	1.306
110% N.R.C.		1.126	0.280	24.87	0.426	37.83	0.420	37.30
		1.123	0.300	25.49	0.415	36.43	0.418	36.88
		1.536	0.368	24.27	0.580	38.26	0.558	37.47
	Mean	1.261	0.316	25.143	0.474	37.473	0.472	37.383
	S.E.	0.137	0.027	0.423	0.577	0.471	0.046	0.359

Table 21 b. Effect of levels of feed on the proportions (%) of fore, mid and hindquarters in the chilled carcass

Group		Chilled carcass weight (kg)	Forequarter		Midquarter		Hindquarter	
			Weight (kg)	%	Weight (kg)	%	Weight (kg)	%
			ANIMALS FED RATION CONTAINING 40 PER CENT LUCERNE HAY					
90% N.R.C.		1.066	0.268	25.14	0.384	36.02	0.414	38.84
		1.090	0.255	23.39	0.411	37.71	0.424	38.90
		1.060	0.261	24.62	0.379	35.76	0.420	39.62
	Mean	1.072	0.261	24.383	0.391	36.497	0.419	39.120
	S.Ed	0.009	0.003	0.519	0.009	0.611	0.003	0.251
100% N.R.C.		1.270	0.288	22.68	0.492	38.74	0.490	38.58
		1.220	0.302	24.75	0.460	37.71	0.458	37.54
		1.106	0.286	25.86	0.378	34.18	0.442	39.96
	Mean	1.199	0.292	24.430	0.443	36.877	0.463	38.693
	S.Ed	0.049	0.005	0.932	0.034	1.381	0.014	0.701
110% N.R.C.		1.262	0.317	25.12	0.470	37.24	0.475	37.64
		1.289	0.317	24.59	0.480	37.24	0.492	38.17
		1.207	0.307	25.43	0.459	38.03	0.441	36.54
	Mean	1.263	0.314	25.047	0.470	37.503	0.469	37.450
	S.Ed	0.024	0.003	0.245	0.006	0.263	0.015	0.480

Table 21 e. Analysis of variance of forequarter percentage

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	26.871	13.436	9.757**
Between levels	2	0.433	0.216	0.157^{NS}
Treatments x levels	4	2.115	0.529	0.384^{NS}
Error	18	24.784	1.377	
Total	26	54.203		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	24.67^{a}	25.61^{a}	27.08^{b}
	T_3	T_2	T_1

The treatments have been tested with the help of DMR test.

P = 2 : 1.16

P = 3 : 1.22

Table XI 4. Analysis of variance of midquarter percentage

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	24.090	12.045	4.942 NS
Between levels	2	4.050	2.025	0.831 NS
Treatments x levels	4	0.884	0.221	0.091 NS
Error	18	43.870	2.437	
Total	26	72.894		

NS = Not significant ($P > 0.05$)

Table 21 e. Analysis of variance of hindquarter percentage

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	5.768	2.884	2.366^{NS}
Between levels	2	7.002	3.501	2.872^{NS}
Treatments x levels	4	6.380	1.595	1.308^{NS}
Error	18	21.942	1.219	
Total	26	41.092		

NS = Not significant ($P > 0.05$).

4.6.2 Proportions of Lean, Bone, Fat and Bone : Meat Ratio in the Chilled Carcass

The proportions (%) of lean, bone, fat and bone : meat ratio in animals fed 20 per cent lucerne were 84.31, 86.28 and 85.63; 10.94, 10.78 and 10.66; 4.75, 2.94 and 3.72; 1:8.27, 1:8.40 and 1:8.41 at three levels of feeding (Table 22), respectively. In animals fed 30 per cent lucerne, the figures were 80.78, 79.96 and 81.28 for lean; 12.44, 13.12 and 11.89 for bone; 6.77, 6.92 and 7.18 for fat; 1:7.16, 1:6.62 and 1:7.65 bone : meat ratio respectively for three different levels of feeding (Table 22 a). Whereas, the mean percentages for lean were 87.36, 86.37 and 85.46; for bone 9.48, 9.42 and 10.14; for fat 3.17, 4.29 and 4.39 and the bone : meat ratio 1:9.56, 1:9.71 and 1:8.26 respectively in rabbits fed 40 per cent lucerne at various levels of feeding (Table 22 b).

There was a significant difference ($P < 0.01$) between treatments for lean (Table 22 c), bone (Table 22 d), fat (Table 22 e) and bone : meat ratio (Table 22 f), whereas the differences were insignificant between levels and interaction between treatments and levels for the above characteristics.

4.6.3 Effect of Different Ration Treatments on Edible and Non-edible Organs

The effect of different dietary treatments and feeding levels on edible and non-edible organs and their proportions in relation to slaughter weight are presented in Table 23, 23 a and 23 b.

Group		Chilled carcass weight (kg)	Proportion of Lean (%)	Proportion of Bone (%)	Proportion of Fat (%)	Bone:Meat Ratio
		ANIMALS FED RATION CONTAINING 20 PER CENT LUCERNE HAY				
90% N.R.C.		0.904	83.87	12.45	3.68	1:7.03
		1.182	85.95	9.30	4.65	1:9.65
		1.212	83.09	10.97	5.94	1:8.12
	Mean	1.106	84.31	10.94	4.76	1:8.27
	S.E.	0.09	0.85	0.88	0.65	0.76
100% N.R.C.		1.109	86.40	10.97	2.63	1:8.12
		1.234	87.76	9.24	3.00	1:9.52
		1.254	84.69	12.12	3.19	1:7.95
	Mean	1.197	86.28	10.78	2.94	1:8.40
	S.E.	0.05	0.89	0.84	0.16	0.76
110% N.R.C.		1.220	87.05	10.08	2.87	1:8.92
		1.210	83.85	10.90	5.46	1:8.10
		1.270	86.30	10.87	2.83	1:8.20
	Mean	1.233	85.43	10.65	3.72	1:8.41
	S.E.	0.02	1.05	0.30	0.87	0.35

Table III a. Effect of level of feed on the proportion of lean, bone and fat

Group		Chilled carcass weight (kg)	Proportion of			Bone:Meat Ratio
			Lean (%)	Bone (%)	Fat (%)	
ANIMALS FED RATION CONTAINING 30 PER CENT LUCERNE HAY						
90% N.R.C.		1.108	78.23	14.71	6.96	1:6.80
		1.018	79.96	11.39	8.65	1:7.78
		1.176	83.06	11.23	5.71	1:7.90
	Mean	1.100	80.78	12.44	6.77	1:7.16
	S.E.	0.05	1.15	1.13	0.94	0.88
100% N.R.C.		1.194	79.21	12.73	7.86	1:6.36
		1.110	78.46	13.42	7.12	1:6.45
		1.074	81.10	13.22	5.68	1:6.58
	Mean	1.126	79.59	13.12	6.88	1:6.62
	S.E.	0.04	0.57	0.20	0.67	0.12
110% N.R.C.		1.136	78.56	12.16	8.28	1:7.28
		1.133	79.96	11.92	8.12	1:7.20
		1.536	84.17	10.69	5.14	1:8.35
	Mean	1.281	81.23	11.59	7.18	1:7.66
	S.E.	0.13	1.47	0.44	1.02	0.36

Group		Chilled carcass weight (kg)	Proportion of Lean (%)	Proportion of Bone (%)	Proportion of Fat (%)	Bone:Meat Ratio
ANIMALS FED RATION CONTAINING 40 PER CENT LUCERNE HAY						
90% N.R.C.		1.066	87.43	9.85	2.72	1:9.15
		1.020	86.70	9.45	3.75	1:9.08
		1.080	87.83	9.15	3.02	1:9.93
	Mean	1.073	87.25	9.48	3.17	1:9.55
	S.E.$\bar{x}$	0.009	0.30	0.20	0.21	0.23
100% N.R.C.		1.270	86.14	9.53	4.33	1:9.49
		1.220	86.26	8.93	5.82	1:10.20
		1.106	87.71	9.58	2.71	1: 9.44
	Mean	1.199	86.37	9.42	4.29	1: 9.71
	S.E.$\bar{x}$	0.05	0.72	0.19	0.90	0.25
110% N.R.C.		1.262	86.12	10.46	3.41	1: 8.56
		1.280	86.50	9.78	3.72	1: 9.22
		1.207	83.75	10.19	6.05	1:8.81
	Mean	1.263	85.46	10.14	4.39	1:8.86
	S.E.$\bar{x}$	0.024	0.86	0.20	0.83	0.19

Table 22 e. Analysis of variance of percentage of lean

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	169.360	84.68	32.432**
Between levels	2	0.038	0.019	0.007 NS
Treatments x levels	4	13.898	3.474	1.330 NS
Error	18	46.994	2.611	
Total	26	230.290		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	80.06^{a}	85.41^{b}	86.30^{b}
	T_2	T_1	T_3

The treatments have been tested with the help of DMR test.

$P = 2 \; : \; 1.00$

$P = 3 \; : \; 1.08$

Table 22 d. Analysis of variance of percentage of bone

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	33.815	16.907	15.745**
Between levels	2	0.377	0.188	0.176 NS
Treatments x levels	4	4.380	1.095	1.020 NS
Error	18	19.334	1.074	
Total	26	57.905		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	9.46[a]	10.79[b]	12.25[c]
	T_3	T_1	T_2

The treatments have been tested with the help of DMR test.

$P = 2$: 1.03

$P = 3$: 1.08

Table 22 e. Analysis of variance of percentage of fat

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	57.032	28.516	16.515**
Between levels	2	0.658	0.329	0.190^{NS}
Treatments x levels	4	7.350	1.837	1.064^{NS}
Error	18	31.081	1.727	
Total	26	96.121		

** Significant at (P < 0.01)

NS - Not significant

Treatment means	2.80^{a}	3.05^{a}	6.88^{b}
	T_1	T_3	T_2

The treatments have been tested with the help of DMR test.

P = 2 : 1.30

P = 3 : 1.37

Table 22 f . Analysis of variance of bone: meat ratio

Source of variation	d.f.	S.S.	M.S.	F
Between treatments	2	22.43	11.22	17.00**
Between levels	2	0.06	0.03	0.05 NS
Treatments x levels	4	2.81	0.70	[illegible] NS
Error	18	11.79	0.66	
Total	26	37.07		

** Significant ($P < 0.01$)

N.S - Not significant

Treatment means	7.14^{a}	8.26^{b}	9.37^{c}
	T_2	T_1	T_3

The treatments have been tested with the help of DMR test.

P = 2 : 0.80

P = 3 : 0.84

Table No. [illegible] Effect of level of feed on the percentage of edible and non-edible organs

Group		Slaughter weight (kg)	Weight of edible organs (kg)	Edible organs (%)	Weight of non-edible organs (kg)	Non-edible organs (%)
		ANIMAL FED RATION CONTAINING 20 PER CENT LUCERNE HAY				
90% N.R.C.		0.989	0.092	4.18	0.137	6.89
		1.224	0.100	4.46	0.158	7.05
		1.270	0.102	4.36	0.150	6.41
	Mean	1.161	0.098	4.333	0.148	6.817
	S.E.	0.091	0.003	0.082	0.006	0.204
100% N.R.C.		1.158	0.082	3.92	0.130	6.22
		1.308	0.110	4.64	0.156	6.58
		1.328	0.120	4.88	0.152	6.18
	Mean	1.260	0.104	4.480	0.146	6.327
	S.E.	0.051	0.011	[illegible]	0.008	0.127
110% N.R.C.		1.356	0.100	4.20	0.175	7.48
		1.335	0.100	4.55	0.158	7.18
		1.244	0.116	4.77	0.150	6.17
	Mean	1.308	0.105	4.570	0.161	7.030
	S.E.	0.038	0.005	0.120	0.007	0.444

Table [illegible] a. Effect of level of feed on the percentage of edible and non-edible organs

Group		Slaughter weight (kg)	Weight of edible organs (kg)	Edible organs (%)	Weight of non-edible organs (kg)	Non-edible organs (%)
		ANIMAL FED RATION CONTAINING 20 PER CENT LUCERNE HAY				
90% N.R.C.		1.[illegible]	0.0[illegible]	3.[illegible]	0.157	8.43
		1.0[illegible]	0.097	4.[illegible]	0.1[illegible]	7.13
		1.1[illegible]	0.110	4.[illegible]	0.[illegible]	8.76
	Mean	1.2[illegible]	0.100	4.370	0.185	8.103
	S.E.	0.1[illegible]	0.005	0.[illegible]	0.017	0.[illegible]
100% N.R.C.		1.[illegible]	0.12[illegible]	5.11	0.200	8.45
		1.1[illegible]	0.12[illegible]	5.19	0.178	7.21
		1.118	0.107	4.[illegible]	0.[illegible]	[illegible]
	Mean	1.179	0.118	4.[illegible]	0.190	8.[illegible]
	S.E.	0.041	0.006	0.[illegible]	0.012	0.[illegible]
110% N.R.C.		1.1[illegible]	0.0[illegible]	3.74	0.1[illegible]	7.72
		1.1[illegible]	0.0[illegible]	3.[illegible]	0.1[illegible]	7.[illegible]
		1.[illegible]	0.0[illegible]	3.15	0.[illegible]	[illegible]
	Mean	1.213	0.0[illegible]	3.457	0.[illegible]	7.[illegible]
	S.E.	0.1[illegible]	0.002	0.171	0.019	0.[illegible]

Group		Slaughter weight (kg)	Weight of edible organs (kg)	Edible organs (%)	Weight of non-edible organs (kg)	Non-edible organs (%)
		ANIMAL FED RATION CONTAINING 40 PER CENT LUCERNE HAY				
90% N.R.C.		1.156	0.122	5.01	0.202	8.59
		1.150	0.126	5.75	0.200	8.45
		1.108	0.107	4.86	0.181	7.72
	Mean	1.138	0.118	5.207	0.194	8.253
	S.E.	0.015	0.006	0.276	0.007	0.270
100% N.R.C.		1.324	0.118	4.96	0.193	8.06
		1.288	0.140	5.98	0.180	7.63
		1.270	0.165	6.56	0.176	7.46
	Mean	1.294	0.141	5.830	0.183	7.710
	S.E.	0.046	0.011	0.471	0.005	0.178
110% N.R.C.		1.338	0.151	5.71	0.187	7.07
		1.360	0.157	5.67	0.214	7.72
		1.281	0.186	7.36	0.201	7.57
	Mean	1.326	0.165	6.247	0.201	7.453
	S.E.	0.023	0.011	0.557	0.008	0.206

The mean proportion of edible organs expressed as percentage of slaughter weight was 4.333, 4.480 and 4.870 and of non-edible organs was 6.817, 6.327 and 7.010 respectively in animals fed 20 per cent lucerne (Table 23). In animals fed 30 per cent lucerne, the percentage was 4.370, 4.943 and 3.457 for edible organs and 8.103, 8.360 and 7.900 for non-edible organs (Table 23 a), respectively. The percentage of edible organs in animals fed 40 per cent lucerne was 5.307, 5.830 and 6.347 and that for non-edible organs was 8.283, 7.710 and 7.553, respectively (Table 23 b).

Statistical analysis indicated significant differences ($P < 0.01$) between treatments both for edible (Table 23 c) and non-edible organs (Table 23 d) while the effect between levels and interaction between treatments and levels were not significant.

Table 23 c. Analysis of variance of percentage of edible organs

Source of variation	d.f.	S.S.	M.S.	F
Treatments	2	12.56	6.28	20.93**
Levels	2	0.86	0.43	1.43 NS
Treatments x levels	4	3.38	0.86	2.87 NS
Error	18	5.37	0.30	
Total	26	22.72		

** Significant ($P < 0.01$)

NS = Not significant

Treatment means	4.26[a]	4.46[a]	5.80[b]
	T_2	T_1	T_3

The treatments have been tested with the help of DMR test.

P = 2 : 0.84

P = 3 : 0.87

Table 23 d. Analysis of variance of percentage of non-edible organs

Source of variation	d.f.	S.S.	M.S.	F
Treatments	2	10.23	5.12	14.22**
Levels	2	0.34	0.17	0.47 NS
Treatments x levels	4	1.43	0.36	1.00 NS
Error	18	6.52	0.36	
Total	26	18.[illegible]		

** Significant ($P < 0.01$)

NS - Not significant

Treatment means	6.75[a]	7.86[b]	8.15[b]
	T_1	T_2	T_3

The treatments have been tested with the help of DMR test.

P = 2 : 0.[illegible]

P = 3 : 0.62

DISCUSSION AND CONCLUSION

CHAPTER V

DISCUSSION AND CONCLUSIONS

Since the metabolism trials were conducted with essentially similar feed but at different phases of growth, it was thought desirable to consider the results together in this chapter and compare their relative performances with increase in the lucerne hay component in the diet on digestibility of nutrients, growth performance and carcass characteristics.

5.1 DIGESTIBILITY OF NUTRIENTS

The differences in the dry matter consumption between the three ration treatments containing 20, 30 and 40 per cent lucerne hay were not significant at approximately 14 weeks of age (Table 3 a). However, there was a gradual insignificant (Table 3) decrease in dry matter consumption with increase in the lucerne hay component of the feed at 14 weeks of age. The differences in dry matter consumption at 20 and 36 weeks were also not significant with increase in the lucerne component of the ration (Table 3 a) but there is a slight increase in dry matter consumption at 30 per cent level which gets levelled off with further increase in lucerne component. When the 3 phases were compared, it was discernible that the average dry matter consumption (Table 3 a) was significantly higher ($P \angle 0.01$) in rabbits of phase II (20 weeks) followed by those at phase I (14 weeks) and phase III (36 weeks), respectively.

Dry matter intake in terms of percentage of body weight at 14 weeks of age was highest (Table 16) in rabbits fed 20 per cent lucerne while it was comparable in those fed 30 and 40 per cent. At 20 and 36 weeks of age there was a slight increase in dry matter intake when the component of lucerne was increased from 20 to 30 per cent (Table 3). Gradual increase in dry matter consumption with increase in roughage component from 20 to 30 per cent of the diet at 20 and 36 weeks of age (Table 3) is in partial agreement with the results of Klasin (1978) who observed that like ruminants, the rabbit increases its feed intake with increase in the fibre content of the diet. It is quite likely that the higher utilisation of fibrous diets is facilitated by the habit of coprophagy.

In the present study, the differences in dry matter digestibility between phases, dietary treatments as well as interaction (Table 4 c) were highly significant ($P < 0.01$). Mahajan and Sastry (1982) also observed significant differences in dry matter digestibility when ration contained various proportions of roughage to concentrate ratios. Further, they found that the efficiency of dry matter utilisation decreased with the advancement of age. The higher digestibility of dry matter in rabbits fed pellets containing 40 per cent lucerne hay at 36 weeks of age in the present investigation may be due to coprophagy resulting in higher utilisation of fibrous diet.

The organic matter digestibility followed a similar trend as that of dry matter digestibility. The results of phase I and II were quite comparable while those of phase III were lower (Table 5, 5 a and 5 b). Analysis of variance revealed a significant difference (P< 0.01) between treatments, between phases and interaction between treatments and phases (Table 5 c).

The crude protein digestibility coefficient, particularly with lucerne level at 20 and 40 per cent in the diet, was slightly higher in phase II (Table 6 a) as compared to phase I (Table 6), while with 30 per cent lucerne in the diet, a reverse trend was observed. During phase III, an increasing trend in the crude protein digestibility coefficient was observed with increase in the level of lucerne in the diet from 20 to 40 per cent (Table 6 b), though the values were lower than those at phases I or II (Table 6 and 6 a). Correlating these findings with average daily gain and feed efficiency (Table 15) the results obtained during phase I however were superior than phase II suggesting that older rabbits in comparison to younger stock seem to inefficiently retain and utilise crude protein, thus resulting in poorer weight gains. However, the protein digestibility values in this study (Table 6, 6 a and 6 b) were lower than those observed by Rigoni et al. (1980) who reported that apparent protein digestibility was as high as 72.86 per cent in New Zealand white rabbit

Spreadbury (1978) stated that a concentration above 180 g/kg diet, the amount of dietary protein apparently retained was almost constant.

The mean digestibility coefficients of ether extract during phase I, II and III were maximum in rabbits fed 20 per cent lucerne hay (Table 7, 7 a and 7 b), followed by those fed 40 and 30 per cent, respectively in phase I and III only. Whereas, in phase II the digestibility coefficient of ether extract in rabbits fed 30 and 40 per cent lucerne was comparable. The differences in digestibility coefficients of ether extract were highly significant ($P < 0.01$) between treatments and phases (Table 7 c). The higher ether extract digestibility when the ration contained 20 per cent lucerne hay component, during all the three phases, could be due to increased proportion of concentrate in the diet. Similar results were reported by Das Gupta (1968), Lassiter et al. (1957), Putnam (1958), Putnam and Loosli (1959) in ruminants. However, the values obtained in the present study (Table 7, 7 a and 7 b) with regard to ether extract digestibility were lower than those reported by Rigoni et al. (1980) wherein the digestibility was of the order of 76.86 per cent.

The differences in crude fibre digestibility between ration treatments and phases as well as interaction were not significant (Table 8 c). The values obtained in the present study (Table 8, 8 a and 8 b) are approximately 1 to 2 per cent lower than those observed by Rigoni et al. (1980), irrespective of the level of incorporation of lucerne hay component. Carregal (1980) concluded that rabbit fed 7, 10 and 13 per cent crude fibre in the diet did not have any effect on the digestibility of crude fibre but with increase in the crude fibre levels there was a concomitant decrease in digestibilities of protein and nitrogen-free extract. Owen (1981) observed that the digestion in hind gut is a superior adaptation for dealing with high fibre herbage, hence the insignificant difference in crude fibre digestibilities with varying levels of crude fibre intake. On the contrary, Partridge (1981) observed that high fibre diet decreased dry matter and neutral detergent fibre digestibility.

The apparent digestibility coefficient of nitrogen-free extract was higher with diet 3 containing 40 per cent lucerne, followed by diet 1 and 2 having 20 and 30 per cent lucerne respectively in all the phases (Tables 9, 9 a and 9 b). However, between the phases, the results are quite comparable indicating that digestion of soluble carbohydrates might not be much affected by differences in age of the rabbits. There was a highly significant difference ($P < 0.01$) in nitrogen-free extract digestibility between treatments unlike phases and interaction between treatments and phases was not significant (Table 9 c).

These results are in partial consonance with the findings of Ledin (1982) who reported that the digestibility coefficient of nitrogen-free extract was higher in diet containing 18 per cent dehydrated alfalfa than 27 per cent.

The differences in nitrogen balance between various ration treatments were not significant (Table 10 c). Between phases, the differences were highly significant (P<0.01). All the experimental rabbits showed positive nitrogen balance (Table 10, 10 a and 10 b). The nitrogen retention is expected to vary with increase in the level of lucerne hay in cattle (McCullough, 1970) as a result of decreased urinary nitrogen excretion; the present study indicates that the proportion of roughage to concentrate in rabbits had no effect on either the urinary excretion of nitrogen or nitrogen balance. Spreadbury (1978) while studying the distribution of dietary nitrogen observed that in rabbits getting over 180 g crude protein/kg diet, the protein retention was fairly constant and was not reflected in nitrogen balance. In the present study, the rabbits in different treatments were receiving over 180 g of crude protein per kg diet and the insignificant differences in nitrogen balance during each phase was perhaps due to this factor.

All the rabbits were in positive calcium and phosphorus balance during all the phases (Table 11, 11 a, 11 b; 12, 12 b and 12 c). The differences in calcium and phosphorus balances between ration treatments as well as between phases were highly significant (P ∠ 0.01) (Table 11 c) and 12 c).

Since a specific requirement for minerals is not known, poultry mineral mixture was provided in the diet as indicated by Lang (1981 a). Yoshida et al. (1968) observed that germ free rabbits excreted a higher percentage of ingested calcium and phosphorus in urine than conventionally fed rabbits, whereas, it was the opposite in case of faeces. In the present study, higher percentage of calcium and phosphorus was excreted in faeces than in urine since a conventional ration was fed to rabbits.

5.2 PLANE OF NUTRITION

5.2.1 Digestible Crude Protein (DCP)

The digestible crude protein intake increased slightly when the ration contained 30 per cent lucerne hay as compared to those containing 20 and 40 per cent lucerne hay (Table 14). However, the differences between ration treatments as well as phases were not significant (Table 14 a). A slightly higher DCP intake in rabbits fed ration containing 30 per cent lucerne hay coincided with increased body weight gains (Table 15) at the end of 20 weeks. The DCP intake was lower in rabbits fed diet containing 40 per cent lucerne hay than those fed

20 per cent during phase I. In phase II and III the DCP intake was higher in animals fed 40 per cent lucerne than those fed 20 per cent (Table 14).

N.R.C. (1966) suggested a requirement of 11 g DCP for a live weight ranging from 1.80 to 4.00 kg for normal growth and 12 g for a live weight ranging from 1.80 to 3.20 kg for normal growth and fattening when the crude protein percentage in the diet is about 16. The mean digestible crude protein intake in rabbits fed diets containing 20, 30 and 40 per cent lucerne hay during different phases was comparable with N.R.C. suggestion, except for a higher intake of 15.42 and a lower intake of 10.18 g noted in phase II and III in rabbits fed diet containing 30 and 20 per cent lucerne hay, respectively. This deviation however was not reflected appreciably in terms of proportionate increase or decrease in growth rate but the TDN and energy intake seemed to play a role in determining the growth performance. The results indicated that DCP intake was more influenced as the animals reached maturity age (phase II) than slaughter age (phase I) and least at adulthood (phase III).

5.2.8 Total Digestible Nutrient (TDN)

Even though the total digestible nutrient intake increased markedly when the ration contained 30 per cent lucerne hay, when compared to diets containing 20 and 40 per cent, during all phases (Table 14), the differences between ration treatments as well as phases were insignificant (Table 14 b). As in the case of DCP intake (Table 14), higher TDN intake in rabbits fed diet containing 30 per cent lucerne hay coincided with increased body weight gains at the end of 20 weeks (Table 18).

N.R.C. (1966) suggested a requirement of 60 g of TDN for a live weight ranging from 1.80 to 4.00 kg for normal growth and 65 g for a live weight ranging from 1.80 to 3.20 kg for normal growth and fattening when the crude protein percentage in the diet is 16. The mean TDN intake in animals fed diets containing 20 and 40 per cent lucerne hay at different phases was quite comparable while higher values than suggested by N.R.C. were noted in animals fed diet containing 30 per cent lucerne hay at all phases with a commensurate hike noted in the DM intake. This could be due to higher dry matter intake in animals fed diet containing 30 per cent lucerne hay at all phases. Further, the dry matter consumption was comparatively higher with animals reaching maturity age (20 weeks) than at slaughter age (14 weeks) and lowest at adulthood (26 weeks) (Table 14).

5.2.3 Intake of Digestible and Metabolizable Energy

An adequate supply of energy is recognized to be of primary importance in maintaining optimum performance in all farm livestock. Energy requirements for rabbits have been expressed in a multiplicity of ways, which make comparisons difficult. Recent work using metabolizable energy (ME) or net energy (NE) would seem to be a satisfactory basis for assessing the requirements (Lang, 1981 a).

The calculated digestible energy intake ranged from 276.5 to 366.8 kcal in different groups in phase I when the animals average body weights ranged from 3.12 to 3.20 kg, from 382.9 to 401.0 kcal in different groups of phase II when the average body weight ranged from 4.55 to 4.81 kg and from 269.4 to 297.7 kcal in different groups of phase III when the average body weights ranged from 3.65 to 3.98 kg. N.R.C. (1977) suggested a DE requirement of 2500 kcal for growth and 2100 kcal for maintenance of rabbits fed _ad libitum_.

The intake of DE was comparatively higher in all the treatments and phases (Table 14) than suggested by N.R.C. (1977). Spreadbury and Davidson (1978) stated that rabbits have been clearly shown to adjust feed intake to maintain a constant level of energy intake. However, Lang (1981 a) opined that caecal volatile fatty acid production may contribute a substantial portion of energy requirements but the importance of the process in rabbits of different ages and on varying diets has not been investigated.

The calculated metabolisable energy intake ranged from 236.8 to 282.6 kcal in different groups in phase I, from 238.0 to 292.8 kcal in phase II and from 220.9 to 264.1 kcal in phase III.

The ratio of digestible crude protein to total digestible nutrients exhibited a wider ratio (1:5.38 to 1:5.81) in rabbits fed ration containing 20 and 30 per cent lucerne hay in phase II (Table 14). Similar ratios (1:5.88 to 1:6.29) in animals fed 20 and 30 per cent lucerne hay in phase I and (1:5.70 to 1:6.01) in rabbits fed 20, 30 and 40 per cent lucerne hay in phase III suggest that DCP was lower in these respective diets than could meet the animal's requirement. However, the DCP utilization required more energy in 20 per cent lucerne hay feed in phase I and II while in phase III it may be seen with 20 per cent lucerne hay.

De Blas *et al.* (1981) studied the effect of diet on feed intake and growth of rabbits from weaning to slaughter at different ages and weights. They reported a significant ($P < 0.01$) energy to protein ratio (kcal DE/gram DCP) and stated that this was related to growth traits. The relationship between growth rates and DE intake reached a maximum at an energy : protein ratio (E : P) of about 23.8 kcal DE : g DCP. However, in this study the E : P ratio was quite comparable in some instances while higher in others (Table 14).

5.3 GROWTH STUDIES

In the first experiment the average daily gain in body weight during the 14 weeks trial period, that is, 7 to 20 weeks of age ranged from 27 to 43, 30 to 48 and 29 to 46 g, in rabbits fed diet containing 20, 30 and 40 per cent lucerne hay, respectively (Table 15). At 12 weeks of age the animals attained an average body weight of 2.558, 2.686 and 2.641 kg in the three above mentioned dietary treatments, respectively. Thereafter, a declining trend was observed in the average daily weight gain in all the treatments as age advanced though the animals continued to gain in body weight. Rabbits fed diet containing 30 per cent lucerne hay responded with better weight gains as compared to those fed diets containing 40 and 20 per cent lucerne hay, respectively (Table 15). Analysis of variance showed that there was a significant difference ($P < 0.01$) in average daily gain between dietary treatments and also between weeks (Table 15 a).

These results are in agreement with those of Pote _et al._ (1980) who reported superior average daily gains with 30 per cent lucerne hay in diets than diets containing 20 or 40 per cent lucerne. They are in partial agreement with results of Rigoni _et al._ (1980) and Schlolaut (1981) who observed daily weight gains of 42.86 and 37.40 g respectively in New Zealand whites when the animals attained 2.5 kg, but are higher than these stated by Sastry and Mahajan (1981) who reported an average daily gain of 32.84 g in New Zealand White rabbits fed concentrate for 7 to 13 weeks old and 24.55 g from 13 to 20 weeks old.

However, Cheeke and Patton (1978 c and 1981) observed better average daily gain with 20 per cent lucerne hay in diet than those receiving 40 or 30 per cent respectively, while Ledin (1982) found no difference in average daily gain in rabbits fed diets containing 18 and 37 per cent alfalfa hay.

There was a declining trend in average daily gain after 12 weeks of age (Figure 1). This is in agreement with the findings of Mahajan _et al._ (1980) who concluded that young rabbits (7 to 13 weeks of age) gained more weight than adults (13 to 20 weeks of age) as the rate of gain declined after 12 weeks of age indicating that young rabbits were more efficient in utilising the dry matter (unit feed consumed/day/unit daily weight gain) than the older ones, thus revealing that the ability to utilise the feed decreases with the increase in age in meat type rabbits.

However, Lang (1981 b) stated that after 8 weeks, growth rate begins to diminish and at 10 to 12 weeks of age the growth curve plateaus. Further, when the rabbit has passed this active phase of growth, changes occur in the proportion of

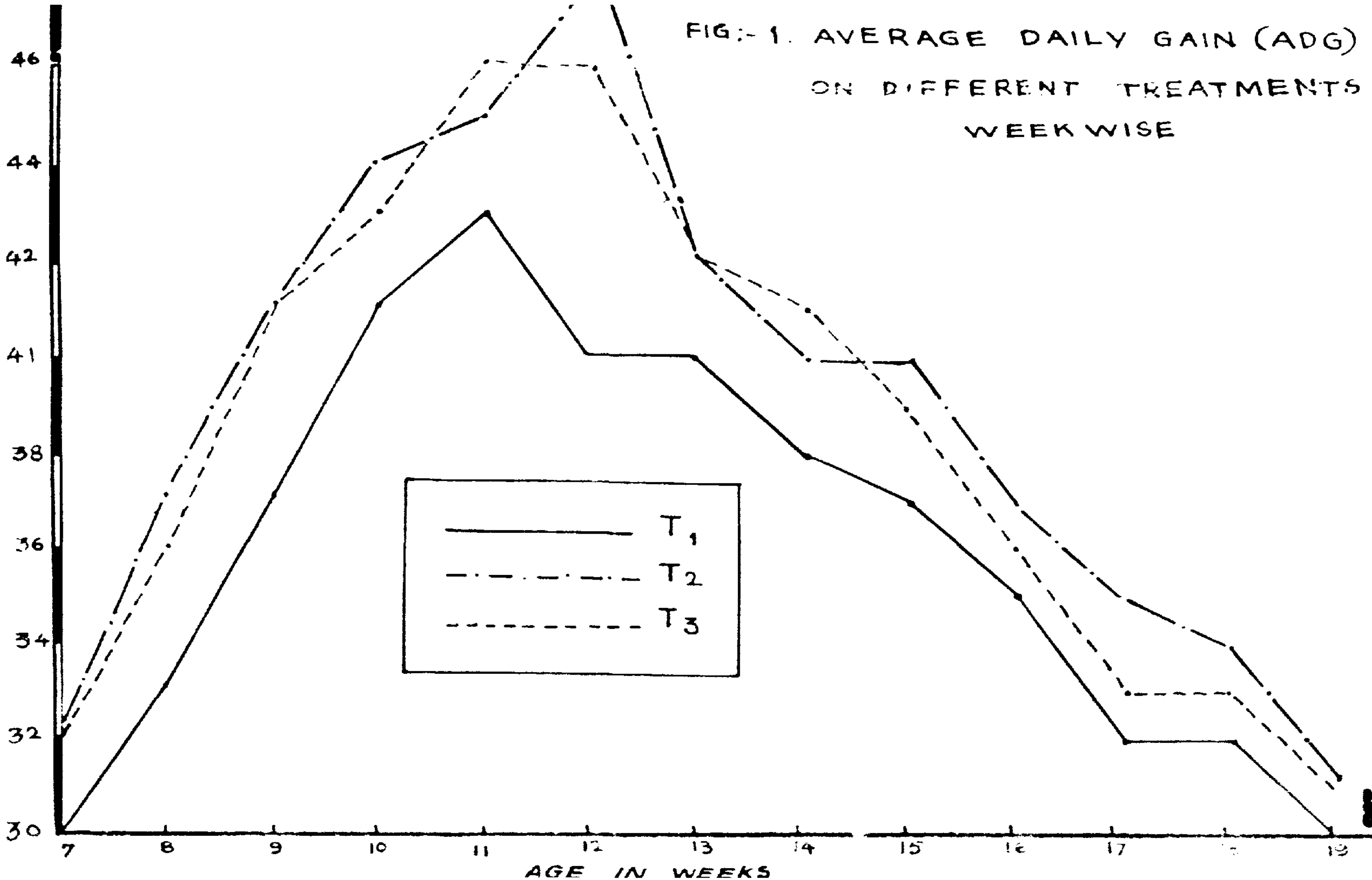


FIG:- 1. AVERAGE DAILY GAIN (ADG) ON DIFFERENT TREATMENTS WEEKWISE fat and in the moisture content of the live weight gain so that more energy is needed per unit of gain than at younger age.

5.3.1 Feed Consumption

The average daily feed consumption increased from 91, 96 and 97 g to 265, 256 and 260 g from 7 to 20 weeks of age in animals fed 20, 30 and 40 per cent lucerne, respectively (Table 15). The average daily feed consumption noted in this study during ages 7 to 9 weeks (91 to 139 g) partially tally with the findings of Lang (1981 b) who stated that New Zealand White rabbits consumed 100 to 140 g of pelleted feed during this period.

On live weight basis Schlolaut (1982) observed that the daily feed consumption ranged from 100 to 125 g for body weights 1100 to 1480 g. In this study, viewing the 3 dietary treatments, the feed consumption was however of lower order ranging from 91 to 112 g for body weights 1266 to 1496 g (Table 15).

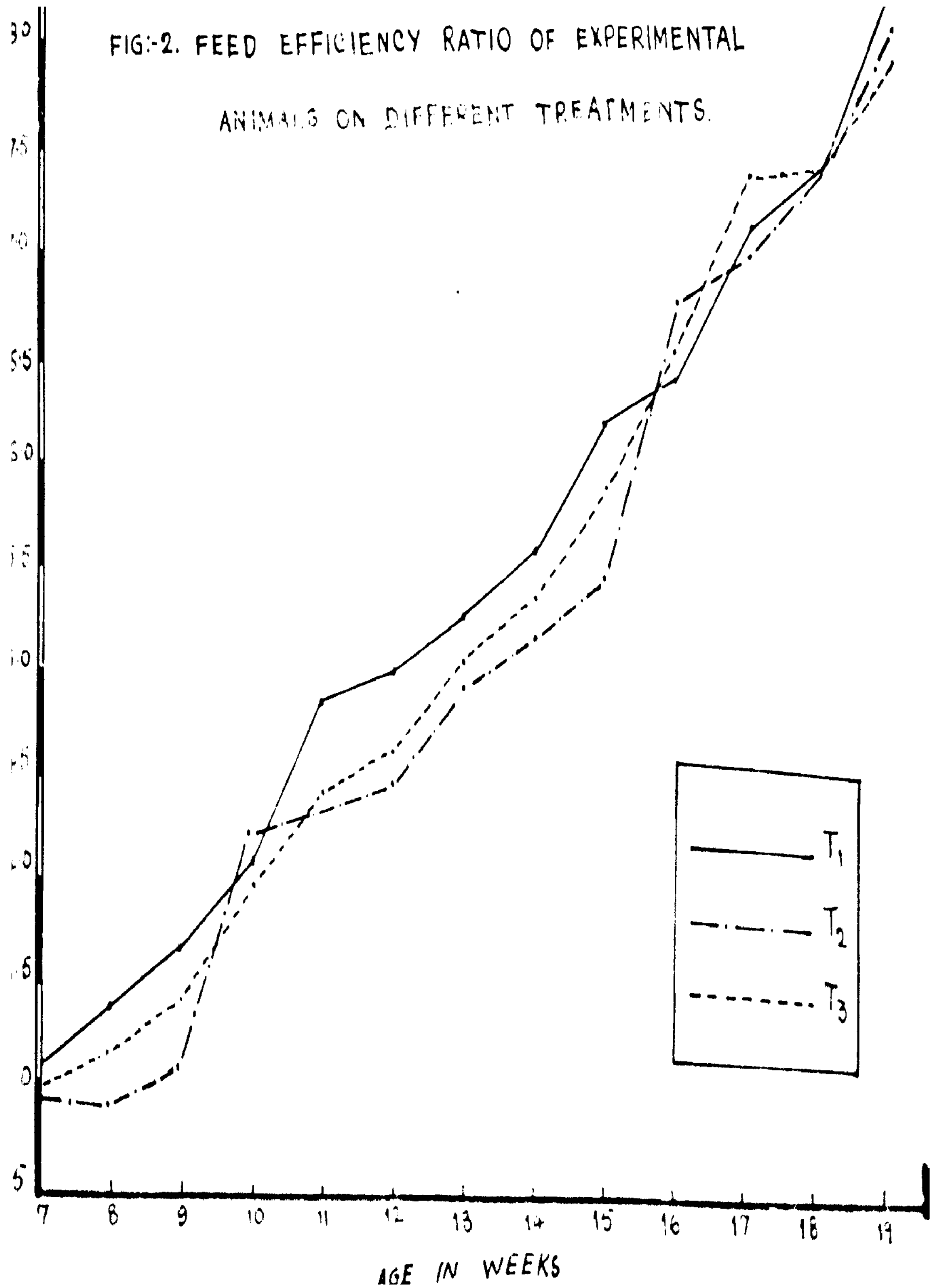
The daily feed intake in percentage of body weight in the 3 dietary treatments ranged from 7.17 to 5.46 from 7 to 20 weeks of age (Table 15). Taking all the treatments into account the percentage ranged from 7.09 to 8.15 during weeks 9 to 12 when the body weights ranged from 1.711 to 2.065 kg.

Thereafter, the percentages declined as the animals aged and grew. These findings are in near agreement with Mauslich (1966) who correlated body weight with daily feed intake and found that for body weights 1.8, 2.2, 2.7 and 3.2 kg, the daily feed intake in percentage of body weight was 8.0, 7.8, 7.0 and 6.7 respectively for normal growth and fattening. It may be concluded that as the animals grew, the daily feed intake in percentage of body weight declined. However, Lang (1981 b) reported that after weaning, feed intake increased until dry matter intake was about 5.5 per cent of live weight and this level is maintained until maturity.

5.3.2 Feed Efficiency

From the graphical presentation in Figure 2 of the 3 dietary treatments, it may be noted that feed efficiency decreased with the age, that is from 7 to 20 weeks, which ranged from 2.97 to 8.81. A feed conversion ratio range from 4.42 to 5.00 was observed when the animals attained about 2.5 kg (slaughter weight) at about 11 to 12 weeks of age in the treatments. Thereafter, it decreased from 13th week onwards as the animals grew and also the average daily gains declined in all the treatments (Table 15). Between the ages 7 to 9 weeks the feed efficiency ranged between 2.97 to 3.46 when the animals attained a weight of about 1.7 kg, and 4.02 to 5.00 between the ages 10 to 12 weeks when the animals

FIG:-2. FEED EFFICIENCY RATIO OF EXPERIMENTAL ANIMALS ON DIFFERENT TREATMENTS.



attained a body weight of about 2.6 kg. Statistically the results were significant ($P \leq 0.01$) between treatments and between weeks (Table 15 b).

The results observed in this study are in close agreement with the findings of Douglas (1981) who stated that the food conversion ratio from 8 to 9 weeks was 3.46:1 and from 9 to 10 weeks was 4.80:1. The results are also in conformity with Lang (1981 a) who stated that food conversion ratio was about 3:1 at 8 weeks old and thereafter deteriorated to 4:1 at 10 weeks and 5:1 or more at 12 weeks old. It was opined that a meat rabbit should attain 2.5 kg live weight at about 10 weeks old, but poorer food conversion and slower growth towards the end of this period results in the last few grams of body weight being achieved at greater cost than the earlier growth. The results also have a semblance with those of Harris (1978) and Gehl (1978) who stressed that in New Zealand whites, after an approximate weight of 2.5 kg, the feed efficiency declined, while the Ministry of Agriculture, Fisheries and Food, U.K. (1978) stated that food conversion ratio deteriorated after 10 weeks of age.

However, the results presented here are in contrast to that reported by Sastry and Mahajan (1981) who found a food conversion ratio of 2.87 in New Zealand White rabbits from 7 to 13 weeks old and 4.17 in 13 to 20 weeks old.

5.2.3 pellet size

As the rabbits in this study were housed in cages with wire floors, they were fed complete pellets to prevent selection and consequent wastage of feed. Observation of rabbits indicated that they prefer pelleted diet to one in a meal from (N.R.C., 1977 and Harris *et al.*, 1983).

Several workers (Braunlich, 1966; N.R.C., 1966; NRDA, 1972; Ministry of Agriculture, Fisheries and Food, U.K., 1979; Schlolaut, 1982 and Harris *et al.*, 1984) opined that rabbit pellets should be 5 mm thick (range 3 to 8) with the length exceeding the diameter to avoid excessive abrasion waste.

In this study however steamed pellet of diameter 6 mm x 1/2 inch length (i.e., 6 x 12.5 mm) was used.

Sastry and Mahajan (1981) fed the same diet in two different pellet sizes - 3 and 6 mm diameter, to New Zealand White rabbits of 6 and 12 weeks age respectively, and found significant (P< 0.01) efficiency of dry matter utilization in both the groups. Harris *et al.* (1984) compared the diets which had pellet diameters 3/16 inch and length 1/4 inch (i.e., 5 x 6.5 mm) and 3/16 inch and 1/2 inch (i.e., 5 x 12.5 mm) and found that the rabbits preferred the latter size than the former.

When Lebas (1970) compared pellets with diameter 5 and 7 mm, better daily weight gains were reported with 5 mm diameter pellet (33.7 g) than 7 mm diameter pellet (31.9 g).

In this study though the pellet size was uniform in all the dietary treatments, the average daily gains were variable, probably due to the different levels of lucerne incorporated in the diets (Table 15).

5.4 LEVEL OF DRY MATTER INTAKE ON GROWTH RATE

In the second experiment an attempt was made to study the effect of level of intake of dry matter (90, 100 and 110% N.R.C.) on growth performance during active growth phase. The average daily gains were superior in rabbits fed diet containing 30 per cent lucerne hay followed by those fed 40 and 20 per cent lucerne hay, respectively. In rabbits fed diet containing 30 and 40 per cent lucerne hay the average daily gains increased with the increase in level of feeding, while the reverse was observed with rabbits fed 20 per cent lucerne hay, that is, rabbits fed 90 per cent N.R.C. level exhibited better average daily gains followed by those fed 100 and 110 per cent N.R.C. level, respectively. An increasing average dry matter intake per animal per day was observed as the level of feeding increased from 90 to 110 per cent N.R.C. in rabbits fed diet 20 and 30 per cent lucerne while in animals fed 40 per cent lucerne, higher average dry matter intake per animal per day was noted at 100 per cent followed by 110 and 90 per cent N.R.C.level, respectively (Table 16, 16 a and 16 b).

The average dry matter intake per kg live weight also increased with the level of feeding in rabbits fed 20 per cent lucerne. However, no such trend was observed with rabbits fed 30 and 40 per cent lucerne. The dry matter intake per kg live weight gain was lower and hence superior in rabbits fed diet containing 40 per cent lucerne than those fed 30 and 20 per cent lucerne, respectively. Dry matter intake per kg live weight gain was comparable within the levels of feeding ranging from 2.54 to 2.84 kg and 2.98 to 3.16 kg in rabbits fed 40 and 20 per cent lucerne respectively, whereas a wider range was observed from 2.87 to 3.26 kg in those fed 30 per cent lucerne (Table 18, 18 a and 18 b).

Lowest total feed consumption by experimental animals was observed in rabbits fed 40 per cent lucerne followed by those fed 20 and 30 per cent lucerne respectively, but the consumption increased as the level of feeding increased in all the 3 dietary treatments (Table 18, 18 a and 18 b). When the total feed consumption and cost of feed per kg live weight were correlated with average daily gain, it was seen that higher consumption as well as higher cost resulted in higher average daily gain in rabbits fed 30 per cent lucerne. In rabbits fed 40 per cent lucerne, the total consumption was lowest but animals exhibited better average daily gains in comparison to those fed 20 per cent lucerne, while the cost of feed was higher for diet containing 40 per cent lucerne than 20 per cent lucerne incorporated (Table 18, 18 a and 18 b).

The feed efficiency was superior with rabbits fed 40 per cent lucerne followed by those fed 20 and 30 per cent lucerne, respectively (Table 18, 18 a and 18 b).

With regard to rabbits fed 20 per cent lucerne, it may be said that better average daily gains, lower cost of feed per kg live weight gain and a better feed efficiency was noticeable at 90 per cent N.R.C. level of feeding, while in rabbits fed 40 per cent lucerne better average daily gain, lower cost of feed per kg live weight gain and a very appreciable feed efficiency was evinced at 110 per cent N.R.C. level of feeding. In rabbits fed 30 per cent lucerne, though the average daily gain was better than rabbits fed diet containing 20 and 40 per cent lucerne, the cost of feed was comparatively higher with feed efficiency comparable with that of diet containing 20 per cent lucerne.

Statistically there was no significant difference in the average daily gain between the treatments and between the levels (Table 17 c), but significant ($P < 0.01$) differences were found pertaining to the cost of feed per kg live weight gain (Table 18 c). The overall mean for various parameters including the dressing percentage among the three dietary treatments generally increased with an increase in plane of nutrition (Table 24).

5.5 CARCASS CHARACTERISTICS

The mean body weights at slaughter ranged from 2.18 kg in rabbits fed 20 per cent lucerne at 90 per cent N.R.C. level of feeding to 2.66 kg in rabbits fed 40 per cent at 110 per cent N.R.C. level of feeding when the animals were 14 weeks of age (Table 20, 20 a and 20 b). This range is in agreement with the opinion of Newstead et al. (1978) who suggested that the slaughter weight of the rabbit should be 4 1/2 to 5 lb (2.04 to 2.27 kg) minimum, while the upper limit recommended for slaughter was about 2.5 kg by Zupin et al. (1979). However, Owen (1978) stressed that the slaughter must be at a fixed live weight (approximately 2.5 kg) rather than a fixed age.

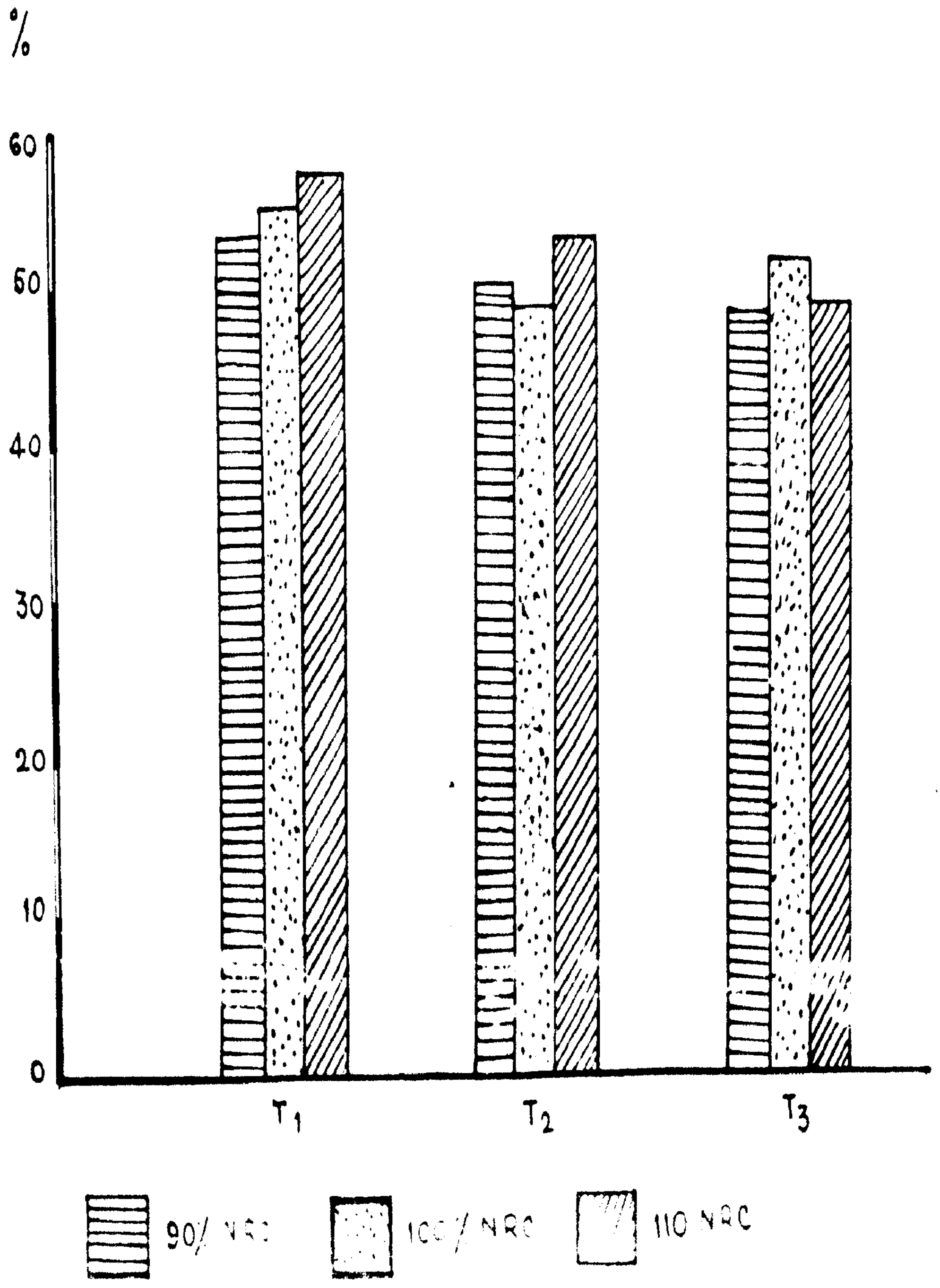
The warm carcass dressing percentages ranged from 48.84 at 90 per cent N.R.C. level of feeding in rabbits fed 40 per cent lucerne to 56.28 at 110 per cent N.R.C. level of feeding in rabbits fed diet containing 20 per cent lucerne (Table 20, 20 a and 20 b). While there was a significant ($P < 0.01$) difference in hot carcass dressing percentage between dietary treatments, no significant differences were found between the levels of feeding and interaction between dietary treatments and levels. The same was true with regard to the percentage of chilled carcasses also (Table 20 c and 20 d).

The results are in close agreement with the observations of Lang (1981 b) who stated that animals weighing 2.1 to 2.7 kg have a killing out percentage of 50 to 55; with those of Braunlich (1968) who expressed that a yield of 50 to 60 per cent is normal, and also 50 to 54 per cent (less the head and feet) as reported by Karne (1978).

The observations of this study were higher than found by Rao *et al.* (1978) who reported that the mean dressed carcass ranged from 45.6 to 50.3 per cent of live weight; 47.72 to 47.33 in 14 week old rabbit carcasses that were fed diets containing 18 and 37 per cent alfalfa, respectively (Ledin, 1982), and Schlolaut (1981 b) who concluded that the slaughter weight should not exceed 60 per cent of the weight of the animal. However, the results were lower than observed by Schlolaut (1982) who found that the average dressed carcass was 59, 56 and 56 per cent for *ad libitum*, 80 per cent and 60 per cent level of feeding, respectively.

It may be noted from figure 3 that best results were recorded with diet having 20 per cent lucerne, with an increasing trend in the dressing percentage in direct relation to the increasing plane of nutrition. Similar tendency with diet having 30 per cent lucerne was also noted though the dressing percentages were lower as compared to diet having 20 per cent lucerne. While the dressing percentages of animals fed 40 per cent lucerne were quite close to those fed 30 per cent, better killing out percentage was noticed with 100 per cent followed by 110 and 90 per cent N.R.C. level of feeding, respectively. However, from the overall results it may be concluded that better dressing percentage could be attributed to the increase in level of feeding which is in conformity with similar findings of Schlolaut (1982) who found increased dressing percentages with the increase in level of feeding.

BY PLANE OF NUTRITION



Regarding shrinkage, no definite trend was observed. It ranged from a minimum of 3.43 per cent in rabbits fed 20 per cent lucerne to a maximum of 5.78 per cent in rabbits fed 40 per cent lucerne at 80 per cent N.R.C. level, 4.44 per cent in carcasses of rabbits fed 40 per cent lucerne to 4.96 per cent in carcasses of rabbits fed 20 per cent lucerne at 100 per cent N.R.C. level and 4.06 in carcasses of rabbits fed 30 per cent lucerne to 5.74 per cent in carcasses of rabbits fed 20 per cent lucerne at 110 per cent N.R.C. level (Table 20, 20 a and 20 b). It may be surmised that the shrinkage percentages were comparatively close in carcasses of animals fed 100 per cent N.R.C. level in all the 3 dietary treatments than in carcasses at other levels of feeding and dietary treatments.

Lange and Schlolaut (1981) slaughtered New Zealand white rabbits at 16 weeks of age when the animals attained 2.6 kg live weight and found the mean hot carcass yield to be 56 per cent and the cold carcass yield to be 54.6 per cent with a mean shrinkage of 1.86 per cent.

With regard to various cuts viz., the fore, mid and hindquarter, no definite trend as influenced by various diets and plane of nutrition was observed (Table 21, 21 a and 21 b). Except for the statistical significance ($P < 0.01$) of forequarter found between treatments (Table 21 c), there were no significant differences found in the mid and hindquarter either between levels of feeding or interaction between treatments and levels. The percentage of forequarter ranged from 25.647 to 27.800, 25.143 to 26.730 and 24.288 to 26.047 in rabbits fed 20, 30 and 40 per cent lucerne, respectively. The midquarter percentage ranged from 34.347 to 35.897, 36.410 to 37.517 and 36.497 to 37.803 in carcasses of rabbits fed 20, 30 and 40 per cent lucerne, respectively. The percentages noted for hindquarters ranged from 36.803 to 38.688 in rabbits fed 20 per cent lucerne, 26.883 to 27.660 in rabbits fed 30 per cent lucerne and 27.450 to 28.120 in rabbits fed 40 per cent lucerne. Comparatively better results were noticed for forequarter cuts in rabbits fed diet containing 20 per cent lucerne, followed by those fed diet containing 30 and 40 per cent lucerne, respectively. While the midquarters were comparable of rabbits fed 30 and 40 per cent lucerne, the results of those fed 20 per cent lucerne were poorer. As for the hindquarters it was interesting to note that the percentages declined with the increase in the level of feeding in diet containing 30 and 40 per cent lucerne,, respectively. However, in rabbits fed 20 per cent lucerne, better percentage was obtained with 100 per cent followed by 110 and 90 per cent N.R.C. level of feeding, respectively (Table 21, 21 a and 21 b).

The results obtained were higher than those observed by Lange and Schlolaut (1981 b) who found in rabbits 16 weeks of age when they attained 2.6 kg live weight, the per cent yields of fore, mid and hindquarter were 28.0, 32.5 and 30.0, respectively. The results are in agreement with Schlolaut (1982) who reported the yields as 21.6, 37.8 and 38.4 per cent in fore, mid and hindquarter, respectively. According to Mahajan and Sastry (1983) no uniform trend was observed in the percentage proportion of various physical cuts in the carcasses of New Zealand white rabbits fed on roughage alone, concentrate + roughage (1/3 : 2/3) and concentrate alone to 12 and 20 weeks old. Results indicated that the mid and the hind quarter together comprised more than 60 per cent of the dressed weight which was in contrast to the statement of Kellogg et al. (1940) who expressed that these two cuts comprised 60 per cent.

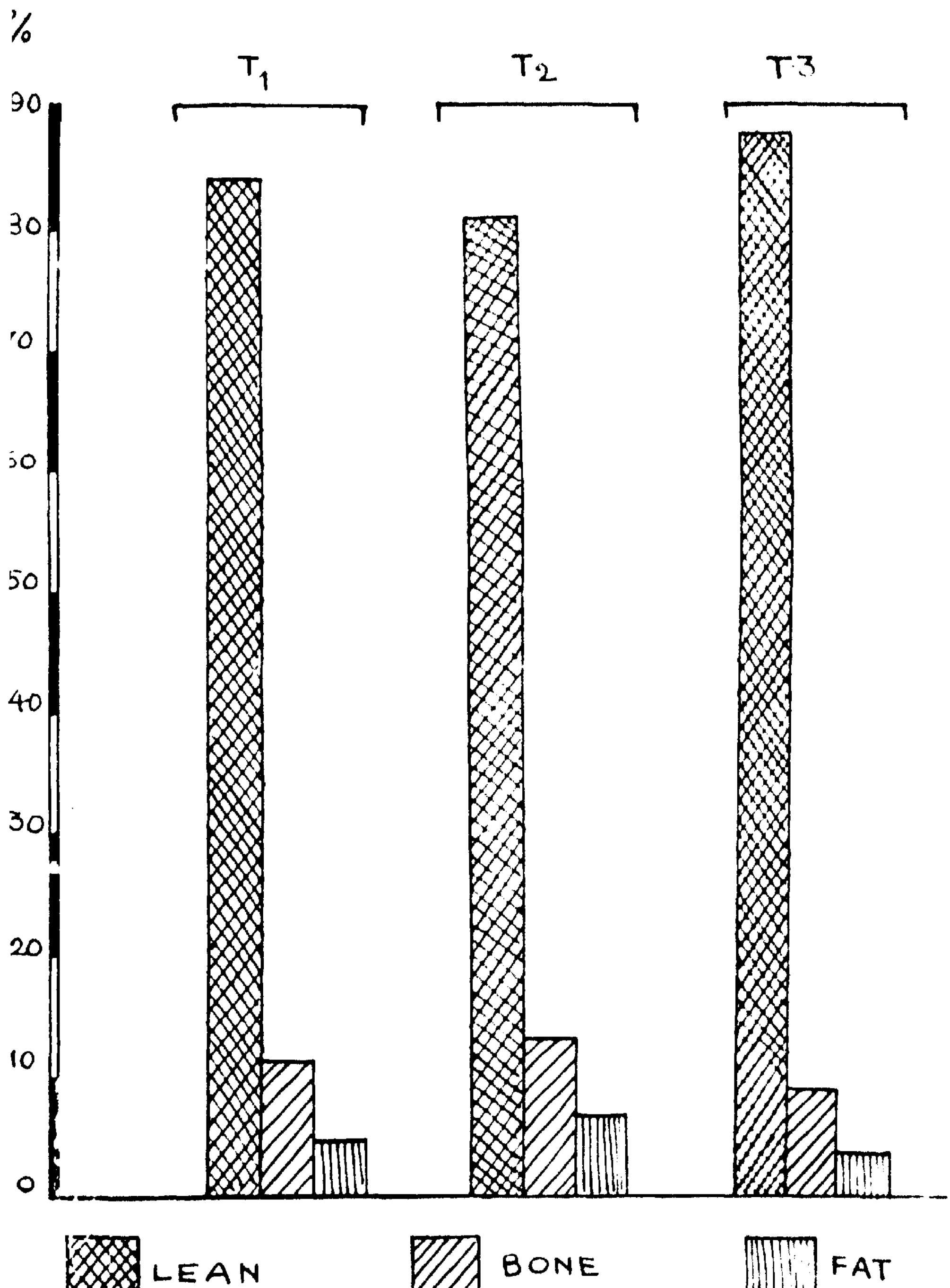
Higher proportion percentage of lean, that is, 85.46 to 87.26 per cent, was clearly discernible in carcasses of rabbits fed 40 per cent lucerne followed by carcasses of rabbits fed 20 per cent lucerne, that is, 84.21 to 85.28 per cent and lastly 78.96 to 81.28 per cent in carcasses of rabbits fed 20 per cent lucerne (Table 22, 22 a and 22 b). Consequently, the proportion percentage of bone was lowest in rabbits fed 40 per cent lucerne in diet followed by those fed 20 and 20 per cent lucerne, respectively. Thus the meat : bone ratio was commensurate, being highest in carcasses of rabbits fed diet containing 40 per cent lucerne, followed by carcasses of rabbits fed diet having 20 per cent lucerne, and lowest in the carcasses of rabbits fed diet having 20 per cent lucerne. However, the proportion percentage of fat was comparatively found lower in carcasses of rabbits fed diet containing 20 per cent lucerne followed by carcasses of rabbits fed diet containing 40 per cent lucerne and highest in carcasses of rabbits fed diet containing 20 per cent lucerne (Table 22, 22 a and 22 b). The results indicated that there was a highly significant (P ∠ 0.01) difference for lean, bone, fat and meat: bone ratio between dietary treatments while differences between levels and interaction between treatments and levels were non significant (Table 22 c, 22 d, 22 e and 22 f).

Delavena (1981) stated that there was a decline in the muscular per cent in forequarter, a steady increase in the midquarter, while not much variation in the hindquarter in 4 to 26 weeks old rabbits. However, there was an increasing trend in the percentage of muscle and fat while a decreasing pattern in the bone was observed.

The results observed in this experiment (Figure 4, 5 and 6) were better than those reported by Schlolaut (1982) who reported an average percentage of meat, bone and fat in rabbit carcasses to be 65.2, 12.9 and 11.6, respectively. Lang (1981 b) stated that fat content of the rabbit carcasses increased with age but was low in the 8 to 12 week old animals, since at this stage the rate of muscle cell hyperplasia which is rapid in the young rabbit begins to decline.

The percentage of edible organs increased with the increase in plane of nutrition in rabbits fed diets containing 20 and 40 per cent lucerne respectively while it was not so in

FIG. 4. EFFECT OF 90% NRC LEVEL OF FEEDING ON THE PERCENTAGE OF LEAN, BONE AND FAT IN DIFFERENT TREATMENTS



ON THE PERCENTAGE OF LEAN, BONE AND FAT IN DIFFERENT TREATMENTS.

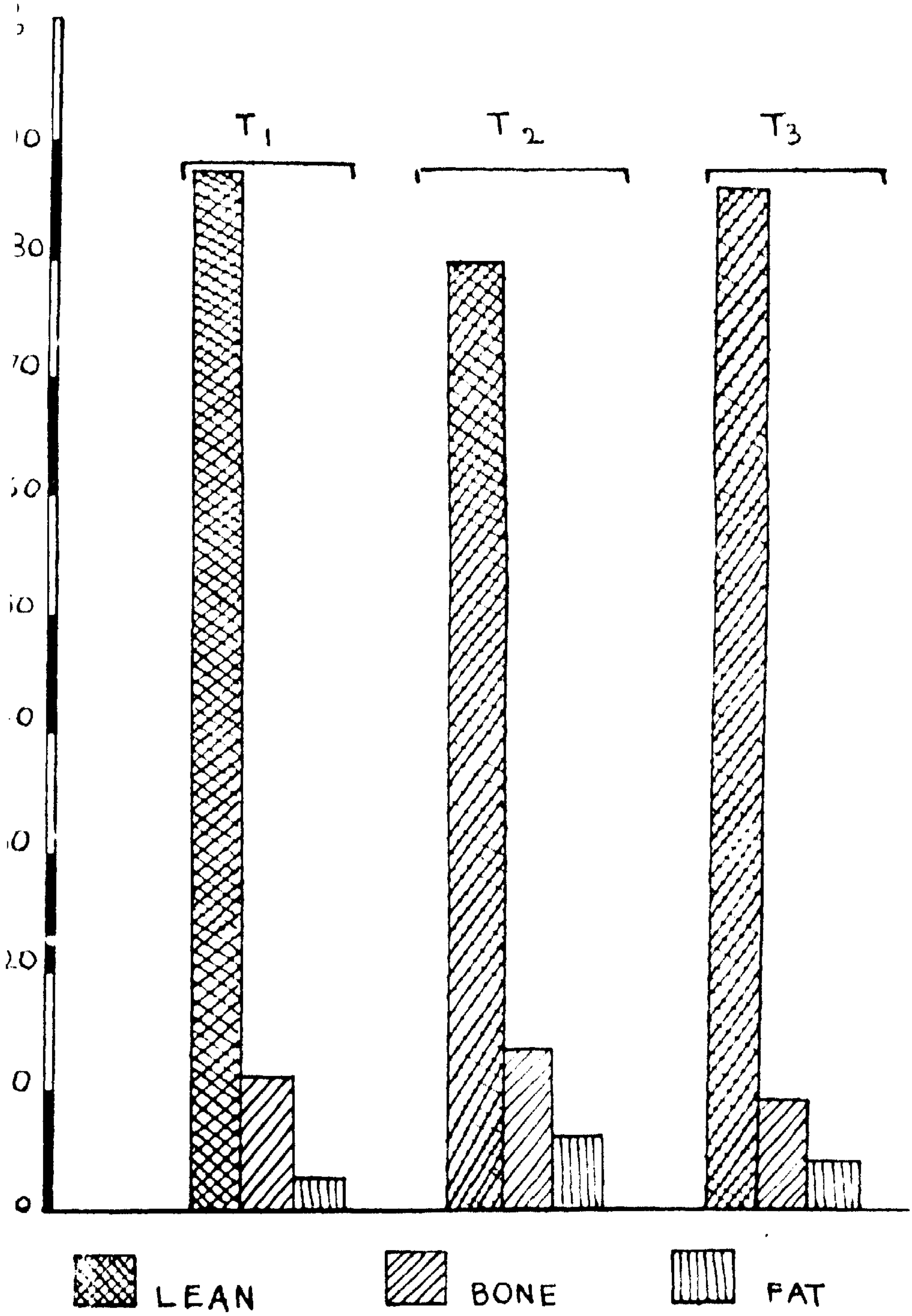


FIG. 6 :- EFFECT OF 110% NRC LEVEL OF FEEDING ON THE PERCENTAGE OF LEAN, BONE AND FAT IN DIFFERENT TREATMENTS.

those fed 30 per cent lucerne in the diet, especially in rabbits fed 110 per cent N.R.C. level of feeding which was lowest compared to 100 and 90 per cent N.R.C. level respectively. Further, higher percentages were found in rabbits fed 40 per cent than 20 and 30 per cent lucerne in the diets, respectively (Table 23, 23 a and 23 b).

Lower non-edible organ weights were evident in rabbits fed 20 per cent lucerne followed by rabbits fed 40 and 30 per cent lucerne, respectively. In rabbits fed 30 per cent lucerne in the diet, they were quite comparable at 3 different levels of feeding.

The weights of edible organs in rabbits of 14 weeks of age were heavier than the mean reported of about 84 g at 12 weeks of age by Fischer (1981). This may be due to as suggested by Ledin (1982) that growth of the viscera is linked to age and only secondly to weight. However, Rao *et al.* (1978) stated that organ weights decreased with increasing slaughter age. In the present study the edible organ weights in 14 week old rabbits ranged from 95 g in rabbits fed 20 per cent lucerne at 90 per cent N.R.C. level of feeding to 165 g in rabbits fed 40 per cent lucerne at 110 per cent N.R.C. level. Treatment-wise, taking all the levels of feeding into account, the average weight of edible organs worked out to be 121.30, 121.20 and 142.67 g in rabbits fed 20, 30 and 40 per cent lucerne, respectively. These weights are however heavier than mean edible organ weight of 101.5 g as reported by Schlolaut (1981) in rabbits of 16 weeks of age. The yields of both edible and non-edible organs were significant ($P < 0.01$) between treatments but not within levels and interaction of treatment and levels.

5.6 FEED COST PER UNIT LIVE WEIGHT GAIN

Since the ultimate goal of broiler rabbit raising is the rabbit meat production, higher dressing percentages were observed in rabbits whose diet contained 20 per cent lucerne followed by those fed 30 and 40 per cent lucerne in the diet, respectively. Taking the feed cost per unit live weight gain into account, it may be suggested that feeding rabbits a diet having 20 per cent lucerne at 110 per cent N.R.C. level might be quite satisfactory since cost of kg saleable meat worked out was Rs 6.13 with a feed efficiency of 3.72 and a mean dressing percentage of 55.25 (Table 24). This cost of kg saleable meat was however more than that at 100 per cent level (Rs 5.97), the feed efficiency ratio was also higher than that at 90 and 100 per cent level (3.15 and 3.33) and yet a higher dressing per cent yield (55.53) was obtained with 110 per cent feeding level than that at 90 and 100 per cent (53.12 and 54.65). Correlating the cost of kg saleable meat with that of feed efficiency (cost of kg saleable meat : feed efficiency ratio), 110 per cent N.R.C. level of feeding

Table 84. Feed cost of meat production (cost in Rs/kg of dressed meat + edible organs)

	20% lucerne hay			30% lucerne hay			40% lucerne hay		
	90% N.R.C.	100% N.R.C.	110% N.R.C.	90% N.R.C.	100% N.R.C.	110% N.R.C.	90% N.R.C.	100% N.R.C.	110% N.R.C.
Live weight at slaughter (kg)	2.18	2.31	2.30	2.23	[illegible]	2.40	2.35	2.41	[illegible]
Dressing percentage	53.12	[illegible]	56.85	49.80	60.41	52.30	48.24	51.98	[illegible]
Saleable meat (kg)	1.205	1.264	1.415	1.310	[illegible]	[illegible]	1.356	[illegible]	[illegible]
Feed cost per group during experimental period (Rs)	54.39	[illegible]	60.66	80.88	[illegible]	92.10	61.15	70.81	73.37
Feed cost/animal during experimental period (Rs)	7.77	8.00	8.67	11.55	12.65	13.41	8.74	10.12	10.47
Cost of kg saleable meat (Rs)	6.19	5.87	6.13	8.31	[illegible]	9.43	6.31	7.23	7.05
Feed conversion ratio	3.15	3.29	2.72	3.23	[illegible]	3.42	2.80	3.12	[illegible]
Ratio of cost of kg saleable meat : Feed conversion	1.97	1.78	1.65	2.53	2.79	2.75	2.38	2.33	2.50

with 20 per cent lucerne in diet was economical (1:1.[illegible]) than at [illegible] and 100 per cent (1:1.[illegible] and 1:1.[illegible]). Further, N.R.C. level of feeding was economical in comparison to ad libitum feeding (Table 16, 18, 18 a and 18 b) in relation to average dry matter intake per animal per day, average dry matter intake per kg live weight gain, cost of feed per kg live weight gain, total feed consumption and feed efficiency.

SUMMARY

CHAPTER VI

SUMMARY

Two experiments were conducted. Three experimental diets in pellet form - 6 mm diameter were prepared in accordance with the recommendation of N.R.C. (1977) for growing rabbits. Diets 1, 2 and 3 contained lucerne hay at 20, 30 and 40 per cent level respectively as a roughage source. These diets were nearly isocaloric and isonitrogenous and were fed to rabbits in experiment I and II.

In experiment I, 30 New Zealand white rabbits weaned at 6 weeks of age were randomly distributed into three groups of 10 animals each. The experimental period was divided into 3 arbitrary phases.

Phase I - 14 weeks of age (slaughter age)

Phase II - 20 weeks of age (age at maturity)

Phase III - 36 weeks of age (adults).

The animals were fed *ad libitum*. Daily feed intake and weekly body weight gains were recorded. Metabolism trials were conducted at 3 different phases (ages) viz., 14, 20 and 36 weeks to determine the digestibility coefficients and nutrient balances in rabbits fed diets having different roughage to concentrate ratios.

In experiment II, 60 New Zealand white rabbits weaned at 6 weeks of age were randomly allotted to 3 dietary treatment

groups of 21 animals each. Each group was subdivided into 3 sub-groups of 7 animals each. These sub-groups were fed 90, 100 and 110 per cent N.R.C. level of pellets containing 20, 30 and 40 per cent lucerne hay to assess feed consumption and body weight gains. Three representative animals from each sub-group were slaughtered at the end of 8 weeks growth trial to study the carcass characteristics.

In experiment I, the average dry matter intake of animals was 130.21, 124.62 and 122.76 g in phase I (14 weeks); 182.87, 177.04 and 186.40 g in phase II (20 weeks) and 114.88, 121.34 and 115.29 g in phase III (26 weeks). There was a significant ($P < 0.01$) difference in dry matter intake between phases. When the 3 phases were compared, it was discernible that the average dry matter consumption was significantly ($P < 0.01$) higher in rabbits of phase II followed by phase I and III, respectively. The differences were, however, insignificant between dietary treatments and interaction between treatments and phases as well.

The mean dry matter digestibility coefficients were 66.25, 68.45 and 67.27 in phase I, 66.46, 68.38 and 65.94 in phase II and 60.98, 64.08 and 65.10 in phase III, respectively. The differences in dry digestibility between phases, dietary treatments as well as interaction between treatments and phases were highly significant ($P < 0.01$).

The mean coefficients of digestibility of organic matter were 65.44, 64.68 and 67.48 in phase I, 65.72, 63.23 and 67.11 in phase II and 61.77, 55.59 and 65.18 in phase III, respectively. Statistically the organic matter digestibility followed a similar trend as that of dry matter digestibility.

The mean coefficients of crude protein in animals fed diets 1, 2 and 3 were 60.09, 59.08 and 62.00 in phase I, 61.48, 54.46 and 62.45 in phase II and 53.10, 54.71 and 59.80 in phase III, respectively. Highly significant ($P \angle 0.01$) differences between treatments, phases and interaction between treatments and phases were observed in crude protein digestibility. Correlating these findings with average daily gain and feed efficiency the results obtained during phase I were superior than phase II suggesting that older rabbits in comparison to young stock seemed to inefficiently retain and utilise crude protein thus resulting in poorer weight gains.

The mean coefficients of ether extract digestibility in rabbits were 69.02, 64.28 and 67.00 in phase I, 68.74, 66.88 and 66.64 in phase II and 66.88, 61.60 and 68.48 in phase III, respectively. Significant ($P \angle 0.01$) differences in ether extract digestibility were noted between dietary treatments and phases only. The higher ether extract digestibility with diet containing 30 per cent lucerne hay during all the phases could be due to increased proportion of concentrate in the diet.

The average crude fibre digestibility coefficient in animals fed diet, 1, 2 and 3 were 18.23, 15.84 and 18.46 in phase I, 16.97, 16.80 and 17.71 in phase II and 16.88, 17.78 and 18.40 in phase III, respectively. However, the differences in crude fibre digestibility between treatments and phases as well as interaction between treatments and phases were insignificant.

The average NFE digestibility coefficients were 65.15, 64.51 and 67.61 in phase I, 64.58, 62.90 and 68.17 in phase II and 62.59, 61.56 and 69.25 in phase III, respectively. There was a highly ($P < 0.01$) significant difference in NFE digestibility between treatments, whereas, the differences were insignificant between phases and interaction between treatment and phases. Between phases, the results were quite comparable indicating that digestion of soluble carbohydrates might not be much affected by the differences in age of rabbits.

The average daily nitrogen retention was 1.716, 1.648 and 1.652 g in phase I, 2.778, 2.286 and 1.887 g in phase II and 1.826, 1.646 and 1.605 g in phase III, respectively. Significant ($P < 0.01$) differences were observed between phases only.

The mean retention of calcium in animals was 0.160, 0.220 and 0.186 g in phase I, 0.151, 0.283 and 0.180 g in phase II and 0.129, 0.127 and 0.167 g in phase III, respectively. Calcium retention was highly significant ($P < 0.01$) between treatments, phases and interaction between treatments and phases.

The mean retention of phosphorus was 0.037, 0.049 and 0.030 g in phase I, 0.0[illegible], 0.068 and 0.044 g in phase II and 0.041, 0.038 and 0.034 g in phase III, respectively. There was a highly significant ($P < 0.01$) difference in phosphorus retention between treatments and phases only.

All the animals were in positive nitrogen, calcium and phosphorus balance.

The mean daily intake of DCP were 12.23, 12.69 and 11.66 g in phase I at body weights 3.12, 3.30 and 3.26 kg; 11.96, 16.42 and 12.34 g at body weights 4.56, 4.85 and 4.75kg in phase II and 10.18, 11.86 and 11.24 g at body weights 3.74, 3.82 and 3.66 kg in phase III, respectively. There were no significant differences in DCP intake per day between the treatments as well as between the phases. N.R.C. (1977) suggested a requirement of 11 g DCP for a live weight ranging from 1.80 to 4.00 kg for normal growth and 12 g for a live weight ranging from 1.80 to 3.20 kg for normal growth and fattening when the crude protein percentage in the diet is about 16. The mean DCP intake in rabbits fed 20, 30 and 40 per cent lucerne hay during different phases was comparable with the N.R.C. recommendations.

The mean TDN intake was 67.20, [illegible].00 and 62.25 g in phase I 64.29, [illegible].12 and 66.28 g in phase II and 61.22, 67.26 and 64.09 g in phase III, respectively. There was no significant difference in TDN intake per day between treatments and phases. N.R.C.(1977) suggested a requirement of 60 g of TDN for a live weight ranging from 1.80 to 4.00 kg for normal growth and 65 g for a live weight ranging from 1.80 to 3.20 kg for normal growth and fattening when the crude protein percentage in the diet is 14. The mean TDN intake in animals fed diets containing 20 and 40 per cent lucerne hay at different phases was quite comparable while higher values than suggested by N.R.C. was noted in animals fed 30 per cent lucerne hay with a commensurate hike noted in the DE intake which could be attributed to higher dry matter intake in these animals.

The average daily gain in experiment I during the 14 week trial period, that is, 7 to 20 weeks of age, ranged from 27 to 48 30 to 43, 30 to 48 and 29 to 46 g in animals fed 20,30 and 40 per cent lucerne hay *ad libitum*. At 12 weeks of age, the animals attained an average body weight of 2.858, 2.656 and 2.641 kg in the above dietary treatments, respectively. Thereafter, a declining trend was observed in the average daily weight gain in all the three treatments as the age advanced though the animals continued to gain in body weight. Analysis of variance showed that there was a significant ($P < 0.01$) difference in average daily gain between treatments and also between weeks.

The average daily feed consumption increased from [illegible], [illegible] and 97 g to [illegible], 285 and [illegible] g from 7 to 20 weeks of age in the three ration groups, respectively.

The feed efficiency decreased with the age, that is from 7 to 20 weeks, which ranged from 2.97 to [illegible] in all the three dietary treatments. A feed conversion ratio of 4.48 to 5.00 was observed when the animals attained about 2.5 kg(slaughter weight) at about 11 to 12 weeks of age. Thereafter, it decreased from 13th week onwards as the animals grew and the average daily gain declined in all treatments. Between the ages 7 to 9 weeks, the feed efficiency ranged between 2.97 to 3.65 when the animals attained a weight of about 1.7 kg and 4.08 to 5.00 between the ages 10 to 12 weeks when the animals attained a body weight of about 2.6 kg. The results were significant ($P < 0.01$) between treatments and between weeks.

In experiment II, an attempt was made to study the effect of level of intake of dry matter (90, 100 and 110% N.R.C.) on growth performance and carcass characteristics during active growth phase.

The average daily gains were superior in rabbits fed 30 per cent lucerne hay followed by those fed 40 and 20 per cent, respectively. The average daily gain increased with an increase in level of feeding in rabbits fed 30 and 40 per cent lucerne while the reverse was observed with 20 per cent lucerne. An increase in average dry matter intake was observed as the level of feeding increased from 90 to 110 per cent N.R.C. in rabbits fed 20 and 30 per cent lucerne while in animals fed 40 per cent, higher average dry matter intake was noted at 100 per cent followed by 110 and 90 per cent, respectively. Dry matter intake per kg weight gain was comparable within the levels of feeding ranging from 2.54 to 2.84 kg and 2.98 to 3.16 kg in rabbits fed 40 and 30 per cent, whereas, a wider range was observed from 2.87 to 3.36 kg in rabbits fed 20 per cent lucerne. Lowest feed consumption and better feed efficiency was observed with rabbits fed 40 per cent lucerne followed by those fed 20 and 30 per cent, respectively. Statistically there was no significant difference in average daily gain between the treatments and between the level but significant ($P < 0.01$) differences were found pertaining to cost of feed per kg live weight gain.

Regarding the slaughter studies, there was a significant ($P < 0.01$) difference in hot carcass dressing percentage between dietary treatments; no significant differences were found between levels of feeding and interaction between treatments and levels. The same trend was observed regarding the chilled carcass percentages also. Better dressing percentages were noticed with an increase in the level of feeding.

The shrinkage percentages were comparatively close in carcasses of animals fed 100 per cent N.R.C. level in all the three treatments than in carcasses at other levels of feeding and dietary treatments.

Except for the statistical difference ($P < 0.01$) of fore-quarter found between treatments, there was no significant difference found in the mid and hindquarter either between the levels of feeding or interaction between treatments and levels.

Generally a higher proportion of lean with consequent decrease in bone resulting in better meat : bone ratio was observed in rabbits fed 40 per cent lucerne followed by those fed 20 and 30 per cent lucerne, respectively. The results indicated that there was a highly significant ($P < 0.01$) difference for lean, bone, fat and meat : bone ratio between treatments, while differences between levels and interaction between treatments and levels were non-significant.

The yields of both edible and non-edible organs were significant ($P < 0.01$) between treatments but not within levels and interaction between treatments and levels.

The cost of kg saleable meat with that of feed efficiency (cost of saleable meat : feed efficiency ratio), 110 per cent N.R.C. level of feeding with 20 per cent lucerne in diet was economical (1:1.66) than at 90 and 100 per cent N.R.C. (1:1.67 and 1:1.70).

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V I T A

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