EFFECTS OF TWO PROTEIN LEVELS ON THE GROWTH PATTERN AND FEED EFFICIENCY OF GUINEA PIGS FROM DIFFERENT INBRED LINES

by

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INTRODUCTION

The importance of protein and its relation to the growth of an animal and to the quality of the carcass has long been recognized. It has been known for quite a long time that all monogastric animals must receive at least a certain minimum amount of protein in their food. During the early 20th century the protein content of the ration was considered most important in the diet of man and animals. However, more recent investigations have shown that for man, swine, poultry, rats, and dogs the quality and kind of protein are fully as important as the amount. The importance of the general requirements of protein for various body functions such as maintenance, growth, reproduction, fattening, and the production of milk, work, and meat is generally understood.

Some recent experiments have shown that there is no physiological harm caused by feeding farm animals a considerably larger amount of protein than they actually need. In spite of this proof, it must be recognized that protein fed to the animal in excess of what the body can utilize tends to be wasteful as far as its specific function is concerned since the amount of protein that can be stored in the body is very limited. In some experiments it has been shown that an excess of protein may cause harmful effects to the metabolism of the animal by throwing an increased load on the liver and kidneys which must excrete the surplus nitrogen (Maynard and Loosli, page 106, 1956). The harmful effect caused by the feeding of an excess of protein is noted especially in the case of feeding specific amino acids. In young animals that are growing and fattening, the feeding of an excess of protein may tend to make them grow more rangy and to deposit less fat than if fed rations lower in protein (Morrison 1948). There is evidence that the body can metabolize a rather high level of protein in a complete diet for a long period without showing any harmful effects on growth or on the body itself. In an Ohio experiment, pigs remained healthy and made normal growth when fed for 13 weeks on a ration containing 42 per cent of protein (Morrison 1948). In an Illinois test, all the pigs remained normal when fed a ration containing 30 per cent protein from weaning time on (Morrison 1948). Lieb and Tolstoi (1929) also reported a study involving two Eskimos who ate meat exclusively for eleven months without showing any defect.

It is generally accepted now that the quality of protein is more important than the amount of protein fed. The minimum intake which proves adequate for a specific combination of proteins will neither be adequate nor optimum for a combination of lower biological value. Thus to better understand the effect of proteins upon the growth of different animals and the protein level required, the biological value of proteins must first be recognized. After Thomas (1909) "the biological value of protein has been defined as the fraction of the absorbed protein nitrogen that is retained in the body".

The purpose of the present investigation was to study the effects of two different protein levels on the growth pattern and feed efficiency of guinea pigs from different highly inbred lines.

REVIEW OF LITERATURE

The first scientific experiments conducted to investigate the effect of different levels of protein upon the growth of animals can probably be attributed to the nutritionists of the 19th century. Maynard and Loosli (page 105, 1956) reported that Liebig who mistakenly believed that protein was a source of muscular energy, advocated the "maximum protein principle" which was later rejected by Chittenden (1904). Rubner (1902) advanced the concept that protein is the dominant factor responsible for the dynamic effect of the animal diet. He and his immediate associates obtained the results during short time observations with dogs or humans when they used a food component (protein, fat or carbohydrate) which was fed to an experimental subject maintained in a basal or fasting condition just prior to the feeding test. They reported that protein produced a greater dynamic effect than did an equicaloric amount of carbohydrate or fat. But this concept has now been revised and the greater dynamic effect produced by protein depends mostly on the quality and the level of protein for the different species of animals. This concept was rejected by Forbes et al. (1935a, 1935b, 1938, 1939, 1940, 1944, 1946) and Black, Maddy and Swift (1950). In an extensive series of experiments with albino rats during 70 days feeding periods, Black and his associates (1950) reported that the relationship between protein level and heat production influences the gains of the animals. Black and his associates also showed conclusively that there was a decrease in heat production as the protein content of equicaloric diets increased from 6 to 45 per cent. As the per cent of protein increased from 6 to 25 per cent, the successive smaller amounts of heat produced were accompanied by increasing gains of body tissues. Black (1950) reported that at higher protein levels (from 25 to 45 per cent) as heat production decreased the gain also decreased. This decrease in body gain was greater than the decrease in heat production. Thus, in this case they concluded that a protein level of more than 25 per cent was undesirable.

Black (1950) reported an increase in weight and fat when there was an increase in the percentage of protein. In that diet he used low levels of proteins such as 6, 8, and 10 per cent.

Commer and Sherman (1936) reported that increasing the protein content of a rat diet from 14 to 18.8 per cent caused more rapid growth and an increased rate of calcification in young rats, though these differences had disappeared by 180 days of age. An increase of protein up to 25 per cent caused a further increase in growth which was not improved by raising the protein content to 40 per cent.

Harte, Travers and Sarich (1948) worked with weanling rats fed diets containing a constant quality of protein at different levels. Control groups received diets averaging 7, 10, and 18 per cent casein ad libitum with the level of protein alternated daily between 5 and 9 per cent, 5 and 15 per cent, and 10 and 30 per cent levels of protein respectively. With 20 per cent the constant level, controls grew faster than the experimental groups which alternated between 10 to 30 per cent and their efficiency was greater but the difference was not highly significant. Daily alternation of both quality and quantity of dietary protein resulted in significantly poorer growth response, but not significantly lower protein efficiency.

In a study of the effect of three low protein levels on rat weights, Costa (1950) working with rats reported that the low protein (2%) group at a level of 48.6 calories per day lost more weight than those receiving the low protein (4.6%) ration high in mineral group at a level of 37.7 calories, while the "low caloric" high protein (18.6%) group when given at a level of 39 calories lost least. In a study of protein and amino acid requirements of young guinea pigs, Heinicke _et al_. (1955, 1956) reported that levels of casein of 25 per cent or less were inadequate for young, rapidly growing guinea pigs, while a diet containing 35 per cent of casein seemed to be somewhat superior. The very striking responses obtained when arginine was added to the diets containing the lower levels of casein indicated that the casein was limited in arginine for the young pigs. He also reported that guinea pigs grew very well on diets of natural materials which contain only 20 per cent of protein.

Leveille and Sauberlich (1961) in a study on the influences on dietary protein levels reported that the serum protein concentration is influenced by the dietary protein level in growing chicks. They noted that the serum proteins and cholesterol can be altered by protein levels above that required for maximum growth. They reported that the protein requirement for maximum growth was between the two highest protein levels fed and was calculated as 20.5 per cent of the diet. The growth rate was higher at higher levels corresponding to the high serum protein. In a study of nitrogen balance, Emman et al. (1945) reported that in maintaining the body tissue, priority should be given to protein rather than caloric intake. They observed that positive nitrogen balance could be maintained on a low caloric intake when sufficient protein was provided. In other words, with a restricted diet consisting purely of carbohydrate and protein a better metabolic and physiological result will follow when the proportion allotted to carbohydrate is reduced and that allotted to protein is increased in contrast to the normal distribution in a well balanced diet. Barnes et al. (1946), as the result of a study on the growth and maintenance utilization of whole egg (99% biological value), Soybean No. 1 (67% B.V.), Soybean No. 2 (64% B.V.) and wheat glutten (35% B.V.), reported that when the level of protein intake was increased there was a decline in the fraction of absorbed protein that was utilized for maintainance. At the same time the fraction utilized for growth rose to a maximum and then declined. The net result of the changes was a fall in the observed biological value. The relative participation of growth and maintenance in making up the biological value varied markedly depending upon the quantity and the nutritive quality of protein that was ingested.

Bosshardt (1946a, 1946b, 1948, 1949), in a series of experiments on the caloric restriction and protein metabolism in the growing mouse reported that restriction of the caloric intake by decreasing the consumption of fat and carbohydrates while holding protein, vitamin and mineral intake constant in growing mice resulted in (1) a decrease in growth rate, (2) a decrease in the efficiency of protein and caloric utilization for growth and (3) a decrease in energy expenditure. He observed that extra quantities of dietary protein caused increased growth to approximately the same extent in mice receiving an adequate caloric intake as in those receiving a caloric intake restricted to about one half the adequate level. With low caloric intakes, extra calories in the form of protein caused a much greater growth response than equivalent calories supplied as fat or carbohydrates. Sherman and Pearson (1946, 1947, 1948) in a series of experiments designed to investigate the nutritional life history as influenced by dietary enrichment reported that a group of male and female rats given the supplemented diet from weaning gained weight more rapidly than litters on the control basal diet. They also reported that female rats on the higher protein diet reproduced earlier and produced more and heavier young than litter mates in the control on the basal diet. Ross _et al_. (1951) found that low protein diets resulted in a decrease in lactic and niccinic dehydrogenases in the liver within 30 days with both young and adult rats.

Hamilton (1935) reported that for rats and pigs the better balanced a ration is with respect to protein (so long as the per cent does not exceed the minimum required for maximum growth rate) the greater is its growth promoting value. The gains made by animals receiving rations of higher protein levels contained more protein and less fat and they gained faster than comparable animals fed equicaloric amounts of a lower protein ration.

Mitchell and Smuts (1932) showed by the paired feeding technique that the minimum percentage of meat protein capable of supporting maximum growth rate in rats was between 18 and 20 per cent. In studying the protein efficiency of diets, Morrison and Campbell (1960) reported that in using adequate diets containing 7, 10 and 15 per cent protein supplied by casein or by a mixture of plant protein the grams of gain per gram of protein consumed (PER) were calculated at weekly intervals for ten weeks. They reported that female rats tended to give maximal PER values at lower dietary protein levels than the males. The PER values found with both sexes dropped as the experiment progressed but the decline was much greater with the animals fed casein than with those fed plant protein. In both sexes the protein level required for maximal PER tended to decline as the experiment progressed.

Lushbough (1960) reported that for a diet based on casein, sucrose and lard or corn oil fed ad libitum, the rate of body weight gain and the caloric efficiency of feed utilization increased with progressive increases in protein. In a study of the effect of two different levels of protein and their relationship to fat, Barnes _et_ _al_. (1959) reported that four groups of weanline pigs were fed rations that were either high or low in protein and fat, and that protein malnutrition was most marked in the low protein high fat group. These animals showed signs of a disease similar to that in human infants called "Kwashiorkor". Low protein intake also resulted in an increase in serum cholesterol. The cholesterol values reached a peak between the 4th and 8th weeks and then declined slowly. The low protein high fat did not decline as rapidly as the other, and caused the greater severity of protein malnutrition. Hogan and Piltcher (1933) reported that in diets varying in protein from 7 to 33 per cent, rats on the high protein diet made better gains than rats on the lower protein diets even though both diets furnished the same amount of metabolizable energy. Hogan, Johnson and Ashworth (1935) compared 10 and 26.2 per cent of protein in the diet and found that rats on the higher protein diet made greater gains and contained more water protein and energy but less fat than their litter mates on the lower protein diet.

Forbes et al. (1935b) found when feeding rats equicaloric amounts of diets containing respectively 10, 15, 20 and 25 per cent of protein that with increased protein up to at least 20 per cent there was an increase in total gains, an increase in protein stored, and a decrease in fat gain per unit of protein gained. Forbes et al. (1935a, 1935b) reported that albino rats receiving the same energy but different protein levels of 10, 15, 20 and 25 per cent made different gains though the energy intake was constant. The increase in per cent of protein led to greater increase in body weight. The increment in percentage of protein from 10 to 15 per cent lead to a greater increase in body gain than the one from 15 to 20 per cent, while the 20 to 25 per cent increase was negligible.

Osborne et al. (1919) reported that the level of the test protein in the diet at which the maximum PER is obtained varies with different proteins. The data indicated that proteins of poor quality must be fed at a relatively high level to obtain a maximal protein efficiency ratio.

Weimer and Nishihara (1959) used the rat depletion-repletion method to study the influence of the protein levels of the diet on the concentration and distribution of the serum glycoproteins. It was found that following depletion significant decreases occured in all serum constituents with the exception of the protein bound carbohydrate of the albumin fraction. Diets containing 17 per cent or more of casein were adequate to restore glycoprotein and globulin polysaccharide levels to their normal range. With the exception of the eight per cent level of casein, all other repletion diets were not only adequate for the restoration of the total serum, but also elicited marked increases in the elevation of the serum globulins.

Rao _et al_. (1960) reported that the protein level increased from 7.2 to 14.9 per cent by the addition of a nonessential amino acid mixture, a maximum growth rate of five grams per day was obtained with nine per cent protein. The minimum requirement of protein for maximum nitrogen retention of 143.7 mg/day was ten per cent of the diet, whereas for the maximum growth of 5.1mg/day it was only 8.8 per cent of protein.

Hamilton (1939) in a study concerning growth activity and composition of rats fed diets balanced and unbalanced with respect to protein reported that increasing the percentage of protein from 4 to 16 per cent in the diet of growing animals increased the growth promoting value of the diet. Diets containing between 16 and 30 per cent of a good quality protein were of equal growth promoting value and as the protein percentage increased above 30 per cent the growth promoting value decreased. It was also noted that the appetites of rats consuming diets containing less than 16 per cent or more than 22 per cent protein were adversely affected.

Coles (1960) reported the results obtained from seven female kittens from three litters which had been weaned to a stock diet containing 50 per cent protein and transferred at ten weeks of age to a diet with 20 per cent protein. Kittens from all litters lost weight rapidly during the first two weeks on the experimental diet. However, kittens from one litter then gained weight slowly while the others continued to lose at a slower rate.

Cunningham (1960) reported that in a study of protein storage male pigs of about 50 kg. were self-fed on a diet containing 14.5 per cent protein until they reached weights of from 74 kg. to 97 kg., then they were divided into three groups and given diets containing 16, 26 and 33 per cent protein in amounts calculated to maintain body weight. Pigs given 16 per cent gained an average of 42 kg. and retained 108 g. Nitrogen in six weeks. Pigs given 26 per cent protein lost an average of 1.2 kg. and retained 200 g. Nitrogen and those given 33 per cent protein gained an average of 0.6 kg. and retained 241 g. Nitrogen.

Most of the literature cited above has involved crossbred animals. Up to the present time there have been very few studies pertaining to the effect of different protein levels upon growth in inbred animals. Fenton and Carr (1951) were probably the first to make an extensive study of the effect of protein level upon the growth of inbred mice. In an experiment with 250 mice of four different strains synthetic diets containing 10, 30 and 90 per cent of casein and diets in which 85 to 90 per cent of casein was replaced by lactalbumin and in which 3 or 10 gr. $NaHCO_3$ was added to 100 gr. of the 90 per cent casein diet were tested. The 90 per cent casein diet was not readily eaten and caused reduced growth in all four strains, but this effect was greatly reduced by $NaHCO_3$ supplements or the substitution of lactalbumin. Weight gains of the C_3H and A strains were much the same whether the diet contained 10 or 30 per cent casein. On the other hand the C_{57} and I strains (high incidence of spontaneous tumor) grew faster on a diet containing 30 per cent casein than with the 10 per cent casein.

Fenton and Marsh (1956) reported that two strains of mice highly susceptible to nutritionally induced obesity were found to have a higher caloric requirement for the utilization of a low protein diet than a strain which was moderately susceptible and one that was completely resistant. They also reported that the deposition of excess fat was accompanied by an increase in the fat free components - protein, ash and water - and there were differences in growth rates when rations of low protein content were fed. Fenton and Carr (1951) in a study of the response of four strains of mice to diets differing in fat content reported that when the diet increased in fat, there were only two strains that increased in weight. The efficiency of food utilization for body weight gain increased with rising dietary fat levels regardless of the effect on growth.

EXPERIMENTAL PROCEDURES

The animals used in this study were part of the Kansas State University guinea pig colony consisting of several different highly inbred lines. Inbreeding coefficients ranged from 25 to 76 per cent.

All guinea pigs were weaned at three weeks of age and were put in the experiment. First, the young guinea pigs were ear-tagged for positive identification, weighed, and assigned to individual cages which measured $8\frac{1}{2}$" x 12" x 10". Two guinea pigs from the same inbred litter were then randomly assigned to the two different rations; one was a high protein ration of approximately 23 per cent crude protein, the other a low protein ration which contained approximately 14 per cent of crude protein.

Feed Mixture for the Experimental Animals

The rations used for the tested animals were prepared before the first pair of experimental animals was put on test. The ingredients of the two rations, one low protein and one high protein, were the same as those in the regular colony ration which contains approximately 17 per cent crude protein.

To avoid the effect of too drastic change in nutrients upon the growth and health of the young guinea pigs, the rations were computed in such a way that all the requirements for the tested guinea pigs were met (based on the recommendations of M. E. Reid of the National Institutes of Health, 1958).

The guinea pigs of the colony were fed concentrates and roughages separately which allowed the animals to select feed according to their individual tastes and requirements; but such freedom in selecting of feed could not be permitted in research. Therefore, the problem was to prepare uniform rations of concentrates and roughages which would not allow the pigs to select different ingredients of the rations. Roughages and concentrates were mixed together and made into pellets of 3/16" diameter by the University's feed and milling department. Pelleting the feeds prevented the pigs from choosing only certain portions of the ration and minimized the amount of feed that was wasted.

The rations used in this study were:

I. - The high protein ration which included the following ingredients:

1 - Dehydrated Alfalfa meal	175	lbs.
2 - Ground Oats	205	"
3 - Soybean oil meal	55	"
4 - Meat scraps	60	"
5 - Bonemeal	5	"
6 - B-Complex (Merck's 58-A)	1	" Total 501 lbs.

II. - The low protein ration which included the following ingredients:

1 - Dehydrated Alfalfa meal	175	lbs.
2 - Ground Oats	305	"
3 - Soybean oil meal	2.5	"
4 - Meat scraps	2.5	"
5 - Bonemeal	15	"
6 - B-Complex (Merck's 58-A)	1	" Total 501 lbs.

Based on the tables of average chemical composition of feed ingredients, the content of each ingredient in protein, fat, fiber, calories, vitamins and minerals of the two rations was estimated (Tables 1 and 2). According to the computation, the total digestible nutrients of the high and low protein rations were 69.54 and 71.71 per cent, and the nutritive ratios were 1:2.5 and 4.2, respectively. This is approximately the proportion of nutrients commonly recommended for guinea pigs.

A sample of each ration was sent to the biochemical service laboratory for chemical analysis. It was found that all nutrients of both rations were nearly the same except the protein content. The crude protein content of the high ration was 23.44 per cent and 17.25 per cent for the low ration (Table 5). The actual crude protein content of the low ration was much higher than the one previously computed (Table 2). The moisture content of low protein ration was also higher than that of the high protein ration.

The Requirement of Vitamin C by Guinea Pigs

Dry feeds contain very little vitamin C. Since guinea pigs have a high requirement for this vitamin and since dry feeds were being fed most of the time, it was necessary to supplement the guinea pigs with this vitamin by feeding ascorbic acid to the tested animals in the pure crystalline form.

In this study, the guinea pigs were fed 6 mg. of ascorbic acid daily, regardless of size. The extra amount was given to make sure that all the tested animals received an adequate supply of vitamin C.

A definite amount of ascorbic acid was dissolved in a cup of water which was enough to give to all the animals on test. The solution was administered to the tested animals two times each week, an average of .1 ml. per pig per day, Mondays and Thursdays, by using a medicine dropper. At first some difficult was experienced in administering the vitamin, but after a few days nearly all of the pigs readily accepted the vitamin.

To supplement for vitamin C, and to supply succulence, head lettuce was fed from the beginning of the experiment to the end of April. After this date, the guinea pigs were given green alfalfa as a source of vitamin C and A until the end of the study. About 30 gms. of head lettuce or green alfalfa were given per animal per day. This amount was readily consumed by all the guinea pigs on test, but was beleived not to contain enough vitamin C for the guinea pigs.

An ascorbic acid deficiency has long been associated with disturbances in protein metabolism, particularly the formation of an intercellular cementing substance. Sealock and Silberstein (1939) were probably the first workers to connect this deficiency with the metabolism of specific amino acids. The fact that normal metabolism of specific amino acids was disturbed in scorbutic guinea pigs and immature infants was reported by Gordon, Levin and Maples (1941) and Christensen and Lynch (1948). Administration of ascorbic acid in large amounts often restores normal metabolism. In the experiments conducted by Sammuel (1948), he attempted to determine whether ascorbic acid metabolism could be influenced in the rat by increasing protein metabolism while maintaining a constant caloric intake. He reported that a high protein diet led to a decrease in the concentration of ascorbic acid in tissues such as the liver, kidney, and muscles which metabolize considerable amounts of amino acids. It is thought that the results are best explained by an increased utilization of ascorbic acid in those tissues able to metabolize large amounts of amino acids.

Weighing and Feeding

The guinea pigs were put on test at 21 days of age, after being weaned from their mothers. Two litter mates, regardless of sex, were assigned, one to each individual cage, and one was fed the higher protein ration and the other the lower protein ration. Each animal was weighed at the beginning of the test and weekly thereafter as long as it was on the experiment. The weighing of the experimental animals was done most of the time in the early morning immediately before feeding so as to avoid as nearly as possible the error due to the presence of the undigested feed in the alimentary tract. All weighings including the feed were made on a laboratory metric balance which could be read accurately at 1/10th of a gram.

Enough pellets were made to last during the entire feeding period of three months. The feed was put in feed containers two times a week. Each time 100 gms. of pellets were given to each animal beginning at the time the animal went on test. The reason for feeding the animals two times a week was to avoid the waste of feed by the guinea pigs. When the animals required more feed, 200 gms. were put into the container each time. At the end of each week the feed remaining in the containers and that recovered from dropping trays was weighed. The amount remaining at the end of the week was subtracted from the amount given each animal at the beginning of the week. This difference was the amount of feed consumed by each animal for the week. The same process was continued as long as the animal remained in the experiment.

Fresh water was given daily, and a saltspool was accessable to each pig throughout the study. Each week the trays were emptied and lined with clean newspapers. Lambert (1923) reported difficulties caused by guinea pigs getting into the feeders and fouling the feed to the extent, according to his report, that it was impossible for him to measure feed consumption accurately. Martin (1942) also reported the same problem, but he overcame it by using narrow feeders so that it was impossible for the guinea pigs to lie and rest inside the feeder. In this study, feeders which had two small compartments were used thus this problem was completely overcome. In order to prevent the pigs from wetting the feed, waterers of two sizes were used. During the first two weeks small waterers were used and later, after the animals had increased in size, larger ones were used.

Laboratory Conditions

During the experiment, controlling the temperature of the room was difficult, but by the use of steam heat in the winter and an air conditioner and electric fans for cooling during the summer, fluctuations of temperature were reduced to some extent. The temperature of the room during the experiment varied from 70 to 80°F depending on the season. Season also affected the

the reproduction rate of the guinea pigs in the colony and the number of weanling guinea pigs available for the experiments. During the winter the number of young guinea pigs born and weaned at 21 days of age was very small.

Statistical Analysis

The method used in analyzing these data was the analysis of variance (Snedecor 1959). Determination of the differences in weekly and total feed consumption, weekly and total gain, feed efficiency during the 12 week trial, feed efficiency from the first through the fourth week, from the fifth through the eighth week, and from the ninth through the 12th week due to lines, rations, sex, first and second order interactions were made. The reason in choosing the odd weeks in analyzing the data for weekly feed consumption and weekly gain was that these odd weeks seemed to be fairly representable of all weeks. The feed consumption and gain of the pigs in these weeks were apparently very variable. During the first week most of the pigs lost weight and consumed very little feed. At the fifth week, many weak pigs had died. The remaining animals adapted well to the rations.

Table 1. The calculated composition of the high protein ration (23% protein).

	Dehydrated Alfalfa Meal	Ground Oats	Soybean oil meal (Solvent)	Meat Scraps	Bonemeal	Total
Pounds	35.00	41.00	11.00	12.00	1.00	100.00
Protein	5.95	4.92	4.95	7.20	0.07	23.09
Fat	0.700	1.435	0.055	0.960	0.010	3.160
Fiber	8.75	4.92	0.71	0.36	0.01	14.75
Calories	22.40	49.61	11.44	-	0.92	84.37
Riboflavin	245.00	16.40	14.30	12.00	0.50	288.20
Pantothenic acid	490.00	143.50	60.50	13.20	1.00	708.20
Niacin	490.00	205.00	99.00	216.00	2.30	1012.30
Choline	14.00	17.43	13.20	12.00	-	56.63
Calcium	0.525	0.041	0.028	0.720	0.241	1.555
Phosphorus	0.070	0.148	0.072	0.360	0.108	0.758
Dry matter	31.675	37.228	9.966	11.172	0.968	91.009
Digestible protein	4.410	5.904	4.664	6.180	-	21.158
Total digestible nutrients	15.225	37.474	8.635	8.208	-	69.542
Nutritive ratio 1:	2.4	5.3	0.8	0.3	-	2.5

Table 2. The calculated composition of the low protein ration (14% protein).

	Dehydrated Alfalfa Meal	Ground Oats	Soybean oil meal (Solvent)	Meat Scraps	Bonemeal	Total
Pounds	35.00	61.00	0.50	0.50	3.00	100.00
Protein	5.95	7.32	0.23	0.30	0.21	14.01
Fat	0.700	2.135	0.003	0.040	0.030	2.908
Fiber	8.75	7.32	0.03	0.02	0.03	16.15
Calories	22.40	73.81	0.52	-	2.76	99.49
Riboflavin	245.00	24.40	0.65	0.50	1.50	272.05
Pantothenic acid	490.00	213.50	2.80	0.60	3.00	708.90
Niacin	490.00	305.00	4.50	9.00	3.00	811.50
Choline	14.00	25.96	0.60	0.50	6.90	47.96
Calcium	0.525	0.061	0.001	0.030	0.723	1.340
Phosphorus	0.070	0.220	0.010	0.020	0.324	0.644
Dry matter	31.675	55.388	0.453	0.466	2.904	90.886
Digestible protein	4.410	8.784	0.211	0.258	-	13.693
Total digestible nutrients	15.225	55.754	0.393	0.342	-	71.714
Nutritive ratio 1:	2.4	5.3	0.8	0.3	-	4.2

Table 3. The reported chemical analysis of the two test rations.

Nutrients	High Protein Ration %	Low Protein Ration %
Protein	23.44	17.25
Ether Extract	3.85	3.81
Crude Fiber	13.27	13.52
Moisture	7.50	8.05
Ash	10.49	7.53
N-Free Extract	41.45	49.84
Carbohydrates	54.72	63.36

RESULTS AND DISCUSSION

Effect of Different Levels of Protein on Total and Weekly Feed Consumption.

Ration. Many experiments have been designed to investigate the effects of differences in food intake and to determine the mechanisms underlying these effects. Strominger and his associates (1953) suggested that food intake varies inversely with the protein level, thus with the specific dynamic action of the diet, and they found that food intake was high at a low protein level.

Fenton (1957) reported that a group of adult mice was fed a 30 per cent protein diet. Food intake was measured as soon as the body weight was stabilized. Thereafter the dietary protein level was reduced successively to 15, 10, 5 and 3.5 per cent. Food intake was highest at the low protein levels and least with the 30 per cent diet. In another experiment the mice were stabilized on a 15 per cent protein diet and later received in succession, 10, 5 and 3.5 per cent protein diets. The mice were maintained at each protein level for a considerable period of time; in contrast to the preceding experiment in which the animals were kept on one diet for only a week. The food intake increased as the protein level decreased. However, it was observed that when the 3.5 per cent level was reached the food intake dropped sharply. Fenton (1957) attributed this result to the fact that this level was at a deficiency level.

In this study, the results were in accordance with Strominger's (1953) hypothesis, who postulated that a low protein ration (at a certain limit depending on the species) stimulated higher feed consumption. The result showed there was a highly significant difference ($P < .01$) between rations in total feed consumption (Table 3). When two rations were fed, one high with 23 per cent of protein, and low with 14 per cent of protein, the guinea pigs receiving the low protein ration consumed 1878 grams, while those on the high protein ration consumed only 1773 grams during the 12 week feeding period.

Analysis of the weekly feed consumption records (Tables 4, 5, 6, 7, 8 and 9) indicated that there was a highly significant ($P < .01$) difference due to rations during the 5th, 7th, 9th and 11th weeks.

Table 3. Analysis of variance of total feed consumption.

Source of Variations	Degrees of Freedom	Sums of Squares	Mean Squares
Total	154	18413020.05	
Rations	1	565577.22	565577.22**
Lines	11	3314665.07	301333.19**
Sex	1	940319.07	940319.07**
L x R	11	2466252.11	224204.74**
L x S	11	1473083.46	133916.68**
R x S	1	1897117.90	1897117.90**
L x R x S	11	3921660.54	356514.59**
Within	107	3834344.64	35834.99

**highly significant ($P < .01$)

The guinea pigs which received the low protein ration consumed 80, 114, 146, 172, 189 and 199 grams; while those receiving the high ration consumed 76, 103, 130, 149, 161 and 169 grams during the 1st, 3rd, 5th, 7th, 9th and 11th weeks respectively.

<u>Lines</u>. Accumulated evidence indicates that an individual

inherits a characteristic metabolic pattern just as he inherits the color of skin, hair and eyes. The objective of this portion of the present study was to find if there was a differential response by guinea pigs of different lines to different levels of protein. The results showed that there was a highly significant difference ($P < .01$) between lines (Table 3). The averages for total feed consumption for the 12 lines ranked from the highest to the lowest were as follows: Y:2007, S:1993, A:1862, G:1848, T:1828, B:1822, D:1798, I:1751, R:1729, X:1625, U:1559 and Z:1518 grams. The results were similar to the findings of Fenton and Carr (1951) who reported a significant difference in response to diets of different protein levels among the four strains of mice C57, I, C3H and A. Mice in strains C57 and I had a higher protein requirement than those in the A and C3H strains. Fenton and March (1956) in a study of two strains of mice which were highly susceptible to nutritionally induced obesity reported that they had a higher caloric requirement for the utilization of a low protein diet than a strain which was moderately susceptible, and one that was completely resistant.

As far as weekly feed consumption was concerned (Tables 4, 5, 6, 7, 8 and 9) there were highly significant ($P < .01$) differences between lines during the 9th and 11th weeks and the differences between lines during the 5th week was significant ($P < .05$). In general, there were significant or highly significant differences in feed consumption among the different lines.

Table 4. Analysis of variance in feed consumption during the 1st week.

Source of Variations	Degrees of Freedom	Sums of Squares	Mean Squares
Total	181	91911.57	
Rations	1	1853.45	1853.45*
Lines	11	15827.47	1438.86**
Sex	1	718.17	718.17
L x R	11	1946.73	176.97
L x S	11	226.92	20.63
R x S	1	-216.30	-216.30
L x R x S	11	23888.07	2171.64
Within	134	47667.06	355.72

**highly significant ($P < .01$)
* significant ($P < .05$)

This finding could have been due to the fact that each individual and especially the individuals in different lines had different genetic makeups which could have resulted in a different metabolic pattern. It must be remembered that each inbred line in this study had a different origin and inbreeding coefficients were probably higher in some than others. Because of the large number of animals involved in this study, the writer did not compute the individual inbreeding coefficient for each guinea pig in the test. However, the inbreeding coefficients ranged from about 25 to 76 per cent. The response of different individuals within the same line to different levels of protein may be insignificant, but these data clearly demonstrate that there was a significant difference in response to the two levels of protein by the 12 lines included in the study.

<u>Sex</u>. Differences in feed consumption between male and female guinea pigs were considered in this study since important differences between the sexes have been observed in other species.

In the portion of the study concerning total feed consumption, in which 90 males were compared with 65 females, males consumed significantly ($P < .01$) (Table 3) more feed than females (an average of 1839 grams as compared to 1681 grams). Similar results were reported by Brooks (1933) who worked with Bronze turkeys, a breed in which the male is much larger than the female. He reported that males consumed more feed and made more efficient use of the feed they consumed than the females. Jull and his associates (1928) earlier found similar results with chickens. Similar results were also observed in rats by Morris and co-workers (1933) and in the mouse by Thompson (1926) and by Beard (1926) and by Hess, Byerly and Jull (1941).

Table 5. Analysis of variance of feed consumption during the 3rd week.

Source of Variations	Degrees of Freedom	Sums of Squares	Mean Squares
Total	174	148512.82	
Rations	1	4707.76	4707.76**
Lines	11	26167.11	2378.83**
Sex	1	6128.64	6128.64**
L x R	11	3718.24	338.02
L x S	11	13619.75	1238.15*
R x S	1	163.80	163.80
L x R x S	11	21274.20	1934.00**
Within	127	72733.32	572.70

**highly significant ($P < .01$)
* significant ($P < .05$)

In an analysis of the weekly feed consumption (Tables 4, 5, 6, 7, 8 and 9) data revealed that there were highly significant ($P < .01$) differences during the 3rd, 7th, 9th and 11th weeks and significant ($P < .05$) differences during the 5th week (Table 6). The males consumed an average of 81g, 114g, 144g, 166g, 183g and 190g while the females consumed an average of 78g, 101g, 131g, 150g, 165g and 172g during the 1st, 3rd, 5th, 7th, 9th and 11th weeks respectively.

Table 6. Analysis of variance of feed consumption during the 5th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	167	211799.40	
Rations	1	10389.37	10389.37**
Lines	11	18412.53	1673.86*
Sex	1	5564.34	5564.34*
L x R	11	17403.40	1582.12*
L x S	11	24647.93	2240.72**
R x S	1	1377.39	1377.39
L x R x S	11	36020.96	3274.63**
Within	120	97983.48	816.53

**highly significant ($P < .01$)
* significant ($P < .05$)

<u>Line x Ration Interaction</u>. In this portion of the study, the objective was to determine if pigs in different lines exhibited different responses to the two rations. The results showed that there was a highly significant ($P < .01$) difference due to line x ration interaction for total feed consumption (Table 3). Fenton and Carr (1951) demonstrated that each of four lines of mice gave a different response to a special ration. There were two lines, C57 and I, which required a higher protein per cent in the diet than lines A and C3H. Food intake of strain I mice

diminished with increasing protein level, while the mice in strain C3H showed little change. Similar results were found by Fenton (1957) who reported that when strains A and I were pair-fed a high fat content diet, for a period of 48 days following weaning, more fat was deposited in mice of strain A than in those of Strain I.

As far as weekly feed consumption was concerned (Tables 4, 5, 6, 7, 8 and 9) There were significant differences ($P < .05$) during the 5th week and highly significant differences ($P < .01$) during the 11th week due to line x ration interaction. The variation in results for different weeks may have been caused by the large individual variations in weekly feed consumption and the large variation in number of animals in each line.

Line x Sex Interaction. It was reported above that the females consumed less feed than the males and that the lines responded differently to the two types of rations. The writer was unable to find any published information pertaining to line x sex interaction in feed consumption. In the case of total feed consumption (Table 3), there was a highly significant difference ($P < .01$) due to line x sex interaction.

Table 7. Analysis of variance of feed consumption during the 7th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	160	238528.19	
Rations	1	18132.65	18132.65**
Lines	11	33522.37	3047.48**
Sex	1	8889.87	8889.87**
L x R	11	9190.90	835.53
L x S	11	14029.67	1275.42
R x S	1	2718.49	2718.49
L x R x S	11	16439.82	1494.52
Within	113	135604.42	1200.04

*highly significant ($P < .01$)

There was a differential response by the two sexes from line to line for weekly feed consumption (Tables 4, 5, 6, 7, 8 and 9) during the 5th, 11th ($P < .01$) and 3rd weeks ($P < .05$).

Ration x Sex Interaction. Sherman and Pearson (1947, 1948 and 1950) in a series of experiments designed to investigate the nutritional life history as influenced by dietary enrichment reported that a group of male rats fed a supplemental diet consumed more feed and gained weight faster than those on control basal diets. They also reported that females on a high protein diet reproduced earlier and produced heavier offspring than litter mates on the control basal diet.

There was a significant difference ($P < .01$) in total feed consumption (Table 3) due to ration x sex interaction.

Table 8. Analysis of variance of feed consumption during the 9th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	155	207671.24	
Rations	1	27445.80	27445.80**
Lines	11	40578.78	3688.98**
Sex	1	11623.65	11623.65**
L x R	11	13330.37	1211.85
L x S	11	11311.42	1028.31
R x S	1	278.61	278.61
L x R x S	11	29502.48	2682.04**
Within	108	73600.13	681.48

**highly significant ($P < .01$)

As far as weekly feed consumption was concerned (Tables 4, 5, 6, 7, 8 and 9) there was a significant ration x sex interaction only during the 11th week when the difference was highly significant (P $<$.01). It was observed that in some tables (Tables 4, 11, 14, 15, 16, 17, 18 and 19) on the difference due to ration x sex interaction the sums of squares were negative. These negative sum of squares were due to the fact that there was a large difference in number of males and females among both rations.

Line x Ration x Sex Interaction. The second order interaction, line x ration x sex, for total feed consumption (Table 3) was highly significant, indicating that the interactions between ration and sex differed among the lines. The line x ration s sex interaction for weekly feed consumption was highly significant (P $<$.01) during all weeks except the 7th week which was significant (P $<$.05).

Table 9. Analysis of variance of feed consumption during the 11th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	154	247375.77	
Rations	1	35103.31	35103.31**
Lines	11	54754.23	4977.65**
Sex	1	12452.73	12452.73**
R x L	11	72634.21	6603.11**
L x S	11	25242.42	2294.76**
R x S	1	2105.75	2105.75**
L x R x S	11	27170.76	2470.09**
Within	107	17912.36	167.41

**highly significant (P $<$.01)

Effect of Different Levels of Protein on Total and Weekly Gain

Ration. In this study, there was a highly significant advantage in total gain (Table 10) by the pigs receiving the lower protein ration. The average total gain for pigs on the higher ration was 273 grams and the average total gain for pigs on the lower ration was 358 grams. These results differed from the findings of Hogan and Piltcher (1933) who reported that with diets varying in protein levels from 7 per cent to 38 per cent, rats gained more weight on the higher protein ration than the low protein ration. Similar results were found by Hogan and associates (1933, 1935), Forbes et al. (1935, 1936), Osborne et al. (1919) and Hamilton (1939). Lushbough (1960) also reported that the rate of body weight gain and caloric efficiency of feed utilization increased with progressive increases in protein. However, Cunningham (1960) working with pigs reported results similar to those obtained in this study. He found that pigs given a 16 per cent protein ration gained an average of 42 kg. and retained 108 grams of Nitrogen in six weeks, whereas, pigs given 26 per cent protein lost an average of 1.2 kg. and retained 200 grams of Nitrogen. Those given 33 per cent gained an average of 0.6 kg. and retained 241 grams of Nitrogen. Fenton and Carr (1951) also reported that inbred mice on a low ration had a greater gain than those on the high protein ration. The different findings among these authors may be due to the fact that each worker used a different species of animals.

In weekly gains (Tables 11, 12, 13, 14, 15 and 16), the difference between rations was significant ($P < .05$) during the 9th week, was highly significant ($P < .01$) during the 1st, 7th and 11th weeks, and was non-significant during the 3rd and 5th weeks. For the weeks studied, the average weekly gains for guinea pigs on the high protein ration were 8g, 27g, 29g, 21g, 23g and 16g and the average weekly gains for those on the low protein ration were 14g, 27g, 32g, 31g, 28g and 25g. In general, there were significant differences in weekly gains between the different levels of protein.

Table 10. Analysis of variance of total gain during the 12 weeks of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	154	1281324.73	
Rations	1	278870.42	278870.42**
Lines	11	229701.08	20881.92**
Sex	1	99552.28	99552.28**
L x R	11	39853.39	3623.04
L x S	11	51732.87	4702.99
R x S	1	25650.81	25650.81*
L x R x S	11	122712.60	11155.69**
Within	107	433251.28	4049.08

**highly significant ($P < .01$)
* significant ($P < .05$)

The results concerning weekly feed consumption were in accord with those published by Cunningham (1960) and Fenton (1951). But the present results differed from those reported by several authors such as Forbes (1935) and Lushbough (1960). The present results possibly can be attributed to the fact that in this experiment highly inbred guinea pigs were used, while in previous studies different species of non-inbred animals were used. Another contributing factor could be the fact that the levels of protein used in this study were not as extreme, 23 per cent and 14 per cent, as levels used by the above authors since the protein level in their rations ranged from 6 to 90 per cent of of protein or casein. The normal dietary protein level for guinea pigs is about 17 per cent. Also, in the discussion of feed consumption, it was brought out that the lower protein ration stimulated feed consumption. It may be expected that gains also increased in the case of the lower protein ration where feed consumption was greater.

Table 11. Analysis of variance of gain during 1st week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	181	53291.23	
Rations	1	2142.86	2142.86**
Lines	11	6209.46	564.49*
Sex	1	1216.49	1216.49*
L x R	11	1691.62	153.78
L x S	11	3603.20	327.56
R x S	1	-286.84	-286.84
L x R x S	11	7893.01	717.54**
Within	134	30821.43	230.01

**highly significant (P < .01)
* significant (P < .05)

Lines. The result showed that there was a highly significant difference among lines as far as total gain was concerned. The average total gain for the 12 lines ranked from the highest to the lowest were as follows: Y:374g, B:361g, A:348g, G:338g, I:337g, S:326g, X:312g, T:308g, U:291g, R:263g, D:261g and Z:206g. Fenton and Carr (1951) also found a significant line difference in a study with inbred mice. They observed that animals in some lines grew better than others when fed the same ration. It was believed that each metabolic aspect studied was controlled by a separate set of multiple factors. Fenton (1956) demonstrated that different strains of mice responded differently to a to per cent fat diet. With such high caloric density, the C3H, C57 and A strains consumed enough extra calories to become obese at three months of age. Only the strain I remained normal under this condition.

In weekly gains (Tables 11, 12, 13, 14, 15 and 16), there existed a highly significant difference during the 9th and 11th weeks, and a significant difference during the 1st and 3rd weeks but the differences during the 5th and 7th weeks were non-significant.

Table 12. Analysis of variance of gain during 3rd week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	174	74204.56	
Rations	1	19.37	19.37
Lines	11	7764.33	705.84*
Sex	1	462.70	462.70
L x R	11	4355.84	395.98
L x S	11	4510.03	410.00
R x S	1	838.82	838.82
L x R x S	11	14376.75	1306.97**
Within	127	41876.72	329.73

**highly significant ($P < .01$)
* significant ($P < .05$)

<u>Sex</u>. The results of the portion of this study concerning total gain showed there was a highly significant difference ($P < .01$) between sexes. The males made significantly larger total gain of 336 grams than the females which had an average of 289 grams (Table 12). The difference in weekly gains (Tables 11, 12, 13, 14, 15 and 16) were non-significant during the 3rd, 9th and 11th weeks but were significant ($P < .05$) during the 1st and 7th weeks,

and were highly significant during the 5th week.

The average weekly gains of males and females were 13g, 29g, 34g, 28g, 26g, 22g and 8g, 25g, 25g, 23g, 24g and 20g for the 1st, 3rd, 5th, 7th, 9th and 11th weeks of the experiment respectively. Results did not show a significant difference during the 3rd, 9th and 11th weeks as Martin (1942) reported in a study using guinea pigs. In his study males grew more rapidly than females after the 3rd week of the experiment. The difference in results may be attributed to the fact that more females than males which were underweight died during the first six weeks of the experiment. This left only the heavyweight females with the light and heavyweight males after the sixth week.

Table 13. Analysis of variance of gain at the 5th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	167	48974.51	
Ration	1	326.91	326.91
Lines	11	3006.78	273.34
Sex	1	3471.63	3471.63**
L x R	11	2419.51	219.95
L x S	11	1759.25	159.93
R x S	1	355.98	355.98
L x R x S	11	6309.80	573.61*
Within	120	31324.65	261.04

**highly significant ($P < .01$)
* significant ($P < .05$)

The non-significant differences during the 3rd, 9th and 11th weeks were also in contrast to the findings of Jull and his associates (1928) who found in chickens that during the first six weeks the males and females had the same gain, then the males outweighed the females. However Castle (1916) working with guinea pigs found that during the first 50 days on test the males had a slower growth than females, after which time the males outgrew the females.

Line x Ration Interaction. The results of the total gain indicated that the line x ration interaction was non-significant. The only significant line x ration interaction for weekly gain was during the 9th week (Table 17).

Table 14. Analysis of variance of gain during 7th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	160	56423.42	352.65
Rations	1	3030.80	3030.80**
Lines	11	4165.49	378.68
Sex	1	1156.54	1156.54*
L x R	11	3102.35	282.03
L x S	11	5500.39	500.03*
R x S	1	-122.07	-122.07
L x R x S	11	10644.56	967.68**
Within	113	28945.36	256.15

**highly significant ($P < .01$)
* significant ($P < .05$)

Line x Sex Interaction. The line x sex interaction involving total gain (Table 10) was non-significant. In weekly gain, the only significant difference due to line x sex interaction were those for the 7th week (Table 14) and the 9th week (Table 15). These results differed from those reported by Martin (1942). He reported that the males gained faster and utilized feed more efficiently than the females. However, in comparing the gain of larger size with smaller size guinea pigs, he found that larger animals, either males or females, tended to gain faster than the smaller animals, but more feed was consumed.

Table 15. Analysis of variance of gain during 9th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	155	45933.12	
Rations	1	1045.57	1045.57*
Lines	11	6194.48	563.13**
Sex	1	453.06	453.06
L x R	11	3460.26	314.56*
L x S	11	4868.74	442.61**
R x S	1	-20.37	-20.37
L x R x S	11	12691.55	1153.77**
Within	108	17239.83	159.63

**highly significant ($P < .01$)
* significant ($P < .05$)

Ration x Sex Interaction. The results of the portion of this study involving total gain (Table 10) indicated that there was a significant ($P < .05$) ration and sex interaction but there was no significant ration x sex interaction during any of the weeks included in the analyses.

Line x Ration x Sex Interaction. There was a highly significant difference in total gain (Table 10) due to line x ration x sex interaction and the second order interaction was highly significant for all weekly gains except for the 5th week (Table 13) which was significant.

Table 16. Analysis of variance of gain during 11th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	154	40418.53	
Rations	1	3382.13	3382.13**
Lines	11	6874.00	624.90**
Sex	1	11.62	11.62
L x R	11	2920.67	265.51
L x S	11	3122.02	283.82
R x S	1	-2.36	-2.36
L x R x S	11	6355.67	577.78**
Within	107	17754.78	165.93

**highly significant ($P < .01$)

Effect of Different Levels of Protein on Total Feed Efficiency and Feed Efficiency Four-week Intervals.

Ration. Feed efficiency is considered important in nutritional research because it affects the economy of gain. In practical farm operations the ratio of feed to gain and to the ratio of feed cost to the value of gain are always considered. Many farmers generally realize that, other things being equal, the animal which makes the higher rate of gain consuming a relatively smaller amount of feed is more profitable.

In this study of total feed efficiency, there was a highly significant ($P < .01$) difference in rations, the average of gain in grams per gram of feed consumed was 0.17 for the high protein and 0.19 for the lower diet. As far as feed efficiency for intervals of four weeks was concerned, there was a significant ($P < .05$) difference in rations during the first 4-week interval (Table 18). The average feed efficiency during the first 4-week period was 0.22 for pigs receiving the high protein ration and 0.26 for those on the lower ration. There was also a highly significant ($P < .01$) ration difference during the 5th through the 8th week interval (Table 21). The average feed efficiency was 0.12 for pigs on the high protein and 0.15 for those on the low diet. However, during the third 4-week period (9th through the 12th week), there was no significant difference in ration. The average feed efficiency during the third 4-weeks period (Table 20) was 0.07 for the high protein diet and 0.09 for the low ration.

Table 17. Analysis of variance of total feed efficiency during the 12 weeks of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	154	0.29528935	
Rations	1	0.02574399	0.02574399**
Lines	11	0.05470784	0.00497344**
Sex	1	0.00433599	0.00433599
L x R	11	0.00734115	0.00066738
L x S	11	0.01286835	0.00116985
R x S	1	-0.00348711	-0.00348711
L x R x S	11	0.04239786	0.00385435**
Within	107	0.14789417	0.00138219

**highly significant ($P < .01$)

These results differed from those found by Hogan <u>et al</u>. (1936) who, working with rats, reported that feed efficiency was greater in a high protein ration (26.2 per cent) than in a low protein ration (10 per cent). Similar results were obtained by Lushbough (1960). However, several authors have reported results similar to that found in this study. Catron <u>et al</u>. (1952), Hoefer <u>et al</u>. (1952), Becker <u>et al</u>. (1955), Jensen <u>et al</u>. (1955)

and Meade (1956) reported that growing-finishing pigs will gain weight rapidly and efficiently when fed a ration containing less protein than previously recommended, provided that the ration is adequate in non-protein dietary constituents.

The difference between the findings of Hogan (1933) and those in this study was possibly due to the fact that the levels of protein in the present experiment were not too extreme (the difference was only 9%) while those used by Hogan ranged from 10 per cent to 26.2 per cent. It was observed that feed efficiency for animals on both rations decreased rapidly beginning at the intervals of the 5th through 8th weeks and the 9th through the 12th week.

Table 18. Analysis of variance of feed efficiency during first 4 weeks of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	170	2.63803301	
Rations	1	0.06689168	0.06689168*
Lines	11	0.14707752	0.01337068
Sex	1	0.09813815	0.09813815*
L x R	11	0.06009712	0.00546337
L x S	11	0.07968438	0.00724403
R x S	1	-0.00584087	-0.00584087
L x R x S	11	0.23195197	0.02108654
Within	123	1.96003306	0.01593523

*significant ($P < .05$)

Lines. There were highly significant ($P < .01$) differences in total feed efficiency due to lines (Table 17), as well as during the 5th through the 8th week interval (Table 19). At the end of the first four week (Table 18) and during the last four weeks

(Table 20), there was no significant effect of lines on feed efficiency. Generally these results were in accord with those of Hoefer <u>et</u> <u>al</u>. (1952), Wahlstrom (1954), Hanson <u>et</u> <u>al</u>. (1955), Jensen <u>et</u> <u>al</u>. (1955) and Meade (1956) who reported no large difference in feed efficiency due to the levels of protein. the highly significant differences during the second four weeks may be attributed in genetic background of the inbred lines. Similar results were also obtained by Aunan <u>et</u> <u>al</u>. (1960) who reported highly significant differences in the rate of gain and feed efficiency in pigs.

<u>Sex</u>. There were no significant differences in total feed efficiency due to sex. The average feed efficiencies for the males and females were 0.18 and 0.17, respectively (Table 19). There were, however, significant ($P < .05$) differences in feed efficiency due to sex during the first four weeks (Table 20). The average feed efficiencies for males and females during this period were 0.26 and 0.21, respectively. During the 5th through the 8th week (Table 19), there was a highly significant ($P < .01$) difference in feed efficiency due to sex. The average feed efficiencies of males and females during this period were 0.14 and 0.12. But during the 9th through the 12th week there was no significant difference in feed efficiency due to sex (Table 20). The average feed efficiency for both males and females during the last four week period was 0.08. In general, the males had higher feed efficiencies than the females.

The results involving total feed efficiency among sex was contrary to those reported by Martin (1942) who observed sex differences in the economy of feed utilization of guinea pigs. The males had a higher feed efficiency than the females beginning at the sixth week. Morris (1933) also observed sex differences in favor of males in the economy of feed utilization. Morrisson and Campbell (1960) using gram of protein instead of gram of feed, reported that the female rats tended to give maximal "gram of gain per gram of protein" or PER values at lower dietary protein levels than the males. In both sexes the protein level required for maximal PER tended to decline as the experiment progressed, indicating that as the animals matured a larger portion of the ration was utilized for maintenance.

Table 19. Analysis of variance of feed efficiency from 5th week through 8th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Total	157	.54348796	
Rations	1	.01856614	0.01856614**
Lines	11	.05470122	0.00497283**
Sex	1	.02068235	0.02068235**
L x R	11	.05132420	0.00466583*
L x S	11	.03471011	0.00315546
R x S	1	-.00006378	-0.00006378
L x R x S	11	.15169734	0.01379066**
Within	110	.21187038	0.00192609

**highly significant ($P < .01$)
* significant ($P < .05$)

<u>Line x Ration Interaction</u>. The line x ration interaction for total feed efficiency was non-significant (Table 17). During the four week intervals, the only significant line x ration interaction for feed efficiency was during the 5th through the 8th week period.

Line x Sex Interaction. There were no significant differences in total feed efficiency due to line x sex interaction (Table 19). Analysis of variance of feed efficiency during each of the four week intervals of the experiment revealed that there were also no significant differences due to line x sex interaction during any of specific intervals.

Table 20. Analysis of variance of feed efficiency from 9th week through 12th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Square
Total	154	0.59801271	
Rations	1	.00836933	0.00836933
Lines	11	.07423384	0.00674853
Sex	1	.00022964	0.00022964
L x R	11	.04633524	0.00421229
L x S	11	.01546379	0.00140579
R x S	1	.00107290	0.00107290
L x R x S	11	.07370609	0.00670055*
Within	107	.37860188	0.00353834

*significant ($P < .05$)

Ration x Sex Interaction. The ration x sex interaction, indicating a differential response by the two sexes to the different rations, was non-significant (Table 17). This was also true during each of the four week intervals of the feeding trial (Tables 20, 21 and 22).

Line x Ration x Sex Interaction. Table 17, the analysis of variance of total feed efficiency, showed that there was a highly significant ($P < .01$) difference due to the line x ration x sex interaction. In table 18, the analysis of variance for the first four week indicated that there was no significant difference due to this type of interaction. Table 19, including the analysis for the 5th through the 8th week for feed efficiency showed there was a highly significant ($P < .01$) difference due to line x ration x sex interacrion. During the last four weeks there was a significant ($P < .05$) difference in feed efficiency (Table 20) due to line x ration x sex interaction. The results were generally expected because in analyzing the variation in gains due to line x ration x sex interaction, it was found to be either significant or highly significant and gains increased as feed consumption increased.

To further study the effect of two protein levels on the growth of guinea pigs belonging to various inbred lines, hierarchial subdivisions and the analysis of variance of Snedecor (1959) were used to investigate the differences between lines within rations and between sexes within lines and rations.

Table 21. Analysis of variance of total feed consumption for the 12 weeks of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	565577.22	565577.22**
Lines:Rations	22	5780917.43	262768.97**
Sexes:Lines:Rations	24	2395727.25	99821.96
Within	107	9671798.15	90390.64

**highly significant ($P < .01$)

There were highly significant ($P < .01$) differences between lines within ration as far as total feed consumption was concerned (Table 21); but the effect of sex within lines within rations

(Table 21) was non-significant. The difference between lines within a particular ration, either high or low in protein, had a direct effect upon feed consumption, and some lines consumed significantly more feed than others.

Table 22. Analysis of variance of the 1st week in feed consumption.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	1853.45	1853.45*
Lines:Rations	22	18774.20	853.37**
Sexes:Lines:Rations	24	22659.51	944.14**
Within	134	49624.41	370.33

**highly significant ($P < .01$)
* significant ($P < .05$)

In studying feed consumption during the first week (Table 22) there was a highly significant difference due to lines within rations and to the variation within lines within rations. These results were in accord with the findings of Fenton (1960) who reported that each line had a different metabolic pattern in the consumption of rations, which were varied in protein levels. The sex differences were generally expected. Most previous studies had demonstrated that males consumed and utilized feed more economically than the females.

There was a significant ($P < .05$) difference in feed consumption during the third week due to line differences within rations but no significant difference due to the effect of sex within lines within rations.

Table 23. Analysis of variance of feed consumption during the 9th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	27445.80	27445.80**
Lines:Rations	22	53909.15	2450.41**
Sexes:Lines:Rations	24	27795.76	1158.15
Within	108	98520.53	912.23

**highly significant ($P < .01$)

During the 5th and 7th weeks there were no significant differences due to lines within rations or to sex within lines within rations.

As far as feed consumption of guinea pigs during the 9th week was concerned (Table 23) there was a highly significant ($P < .01$) difference due to line effect within rations but the difference between pigs within lines within rations was non-significant.

Table 24. Analysis of variance of feed consumption during 11th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	35103.31	35103.31**
Lines:Rations	22	127388.44	5790.38**
Sexes:Lines:Rations	24	66989.28	2791.22**
Within	107	17894.74	167.24

**highly significant ($P < .01$)

There was a highly significant difference ($P < .01$) in feed consumption during the 11th week (Table 24) due to lines within rations and to sex within lines within rations.

In testing differences in total gain (Table 25) due to lines within rations and sex within lines within rations, it was observed that there was a highly significant difference ($P < .01$).

Table 25. Analysis of variance of total gain during 12 weeks of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	278870.42	278870.42**
Lines:Rations	22	274554.47	124797.48**
Sexes:Lines:Rations	24	177411.49	73921.45**
Within	107	550488.35	5144.75

**highly significant ($P < .01$)

The results concerning weekly gain revealed that there were no significant differences due to sex or to line effects during the 1st, 3rd, 5th, 7th or 9th week. There was a highly significant line difference in gain but no significant sex difference during the 11th week (Table 27).

Table 26. Analysis of variance of feed efficiency from 5th week through the 8th week.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	0.01856614	0.01856614*
Lines:Rations	22	0.10602542	0.00481934*
Sexes:Lines:Rations	24	0.12105549	0.00504397*
Within	110	0.29784091	0.00270764

*significant ($P < .05$)

The analysis of variance of total feed efficiency indicated that there was no significant difference due to lines within rations or to sex within linex within rations.

The differences in feed efficiency during the first four weeks and the last four weeks due to lines within rations or due to sex within lines within rations were non-significant; however, there were significant differences in feed efficiency during the 5th through the 8th week due to lines within rations and sex within lines within rations (Table 26).

Table 27. Analysis of variance of gain during 11th week of the experiment.

Source of Variation	Degrees of Freedom	Sums of Squares	Mean Squares
Rations	1	3382.13	3382.13**
Lines:Rations	22	9794.67	445.21**
Sexes:Lines:Rations	24	5232.76	218.03
Within	107	22008.97	205.69

**highly significant ($P < .01$)

SUMMARY

The objective of this investigation was to study the effects of two different protein levels on the growth pattern and feed efficiency of guinea pigs from different inbred lines.

Data from 182 individually fed animals were used to determine the differences in total and weekly feed consumption, total and weekly gain, feed efficiency during the 12 week trial and feed efficiency from the 1st through the 4th week, 5th through the 8th week and from the 9th through the 12th week among guinea pigs from different lines. The method used in analyzing these data was the analysis of variance (Snedecor 1959).

There was a highly significant $(P < .01)$ difference in total feed consumption due to rations, lines and sexes. The pigs receiving the ration containing the lower protein level consumed more feed than those on the higher protein ration. The males consumed more feed than the females. The lines x ration, line x sex, ration x sex and line x ration x sex interactions were highly significant.

It was found that there were highly significant differences in total gain $(P < .01)$ due to lines, rations and sex but the only highly significant interaction was the line x ration x sex $(P < .01)$. The ration x sex interaction was statistically significant $(P < .05)$.

Highly significant differences $(P < .01)$ in weekly feed consumption due to rations were obtained during all weeks except the 1st week and the 3rd week when the differences were only significant $(P < .05)$. The line differences were also highly significant $(P < .01)$ during all weeks except the 5th when the differences

were significant. Differences in weekly feed consumption due to sex were highly significant during the 3rd, 7th, 9th and 11th weeks and significant during the 5th week. The line x ration interaction was found to be non-significant during all weeks except the 5th when it was significant. The results also indicated there were highly significant line x sex and ration x sex interactions during the 11th week. There were highly significant line x ration x sex interactions during all weeks except the 7th week when the interaction was only significant.

There were large differences in weekly gain due to line, ration and sex, and to their interactions during all weeks. The results indicated that there was a highly significant ($P < .01$) difference in weekly gain due to rations for the 1st, 7th and 11th weeks and a significant ($P < .05$) difference at the 9th week. There was a highly significant line effect during the 9th and 11th weeks and a significant line effect during the 1st and 3rd weeks; highly significant influence of sex on weekly gain was observed at the 5th week and the sex influence was significant during the 1st and 9th weeks.

In studying weekly gain the line x ration x interaction was found to be non-significant during all weeks except the 9th when it was significant. The line x sex interaction involving weekly gain was significant during the 7th ($P < .05$) and 9th weeks ($P < .01$). A highly significant variation caused by line x ration x sex interaction was obtained during all weeks except the 5th ($P < .05$).

There was a highly significant difference in feed efficiency during the 12 week trial, due to the effects of rations and lines but there were no significant effects due to sex. The lower protein ration (feed efficiency was 0.19) was slightly superior to the high protein ration (feed efficiency 0.17). In computing the feed efficiency the gain was used as the numerator and the feed consumption as the denominator; therefore, the higher the feed efficiency the better the ration. For feed efficiency, the interactions between line x ration, line x sex, and ration x sex were not significant, but the line x ration x sex interaction was highly significant.

The differences between rations in feed efficiency during the first four weeks were significant, the lower protein ration with a feed efficiency index of .26 was superior to the higher protein ration (.22). Effects due to lines were non-significant but a significant ($P < .05$) difference was due to sex. The feed efficiency of the females (.21) was less than that of the males (.26). There were no significant interactions involving feed efficiency during the first four weeks.

For feed efficiency during the 5th through the 8th week period, highly significant differences due to ration, line, sex and line x ration x sex interaction were found. The line x ration interaction was significant. The lower protein ration had a higher feed efficiency than the high protein ration and the males had a higher feed efficiency than the females.

For feed efficiency during the 9th through the 12th week, there were no significant differences due to line, ration or sex or first order interactions; however, the second order interaction, line x ration x sex, was significant.

In general, the differences between the low and high protein rations were statistically significant. The lower ration appeared superior to the higher ration in feed efficiency and the animals on the lower protein ration gained more weight but consumed more feed. The animals on the lower protein ration were apparently stimulated to eat more than those on the higher ration. There were also significant differences in response to rations by guinea pigs from different lines. The average for total gains of different lines due to rations during the 12 weeks of the experiments ranked from the highest to the lowest were as follows: low ration, Y 414g, G 398g, A 388g, B 385g, I 383g, S 378g, D 355g, X 354g T 338g, U 325g R 282g, Z 280g; and high ration, Y 335g, B 33 g, A 317g I 292g, T 283g, S 273g, G 271g, X 270g U 259g, R 245g, Z 232g and D 186g. The results also showed there was a significant difference between sexes; the males ate more, gained faster and utilized the feed more efficiently than the females.

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APPENDIX

Table 1. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"A".												
F 49.2	252.5	283.0	318.0	355.0	378.0	417.0	450.5	456.0	491.5	499.1	510.6	522.0
*234.0	156.5	143.5	158.0	198.5	179.0	172.0	193.0	188.0	195.0	188.5	182.5	199.0
M 50.1	167.2	179.0	219.0	255.8	302.2	330.7	362.0	384.1	439.1	504.4	518.0	546.7
*163.0	58.5	100.0	120.5	133.0	169.0	174.0	168.0	172.0	191.0	216.0	226.0	208.0
F 53.1	199.6	222.0	267.5	300.5	351.7	390.0	404.6	433.0	450.0	463.8	478.0	490.0
*199.0	62.0	92.0	109.0	134.0	160.0	172.0	172.0	173.0	182.0	185.0	186.0	182.0
F 54.1	251.3	289.5	292.7	326.0	349.6	403.4	436.0	480.3	498.3	520.0	538.3	547.7
*246.2	95.5	119.0	117.0	144.0	172.0	185.0	182.0	188.0	189.0	195.0	186.0	194.0
F 55.1	154.9	171.2	224.0	268.3	301.6	315.8	329.6	351.7	375.7	411.0	443.5	455.5
*154.5	38.0	58.0	70.0	80.0	84.0	100.0	102.0	112.0	110.0	174.0	161.0	165.0
M 56.2	194.2	196.5	204.1	215.5	249.5	294.8	362.4	418.8	462.3	521.0	550.0	568.0
*204.5	49.0	54.0	62.0	72.0	77.0	99.0	135.0	153.0	176.0	202.0	214.0	226.0
M 57.1	245.8	288.6	337.5	385.7	422.8	470.0	490.6	516.1	533.6	565.3	600.0	635.4
*234.5	70.0	84.0	92.0	120.0	160.0	170.0	190.0	220.0	220.0	225.0	226.0	228.0
F 58.1	210.0	226.3	241.4	261.5	318.2	346.3	363.5	379.8	383.0	400.0	409.5	407.0
*199.1	72.0	78.0	84.0	120.0	135.0	110.0	140.0	167.0	152.0	154.0	170.0	150.0
M 46.1	157.0	165.0	149.0	-	-	-	-	-	-	-	-	-
*152.0	73.5	118.0	106.0	-	-	-	-	-	-	-	-	-
TOTALS	1832.5	2021.1	2253.2	2368.3	2673.6	2968.0	3199.2	3419.8	3633.5	3884.6	4047.9	4172.3
*1786.8	675.0	846.5	918.5	1001.5	1136.0	1182.0	1282.0	1373.0	1415.0	1539.5	1551.5	1552.0
MEAN	203.61	224.56	250.36	296.04	334.20	371.00	399.90	427.48	454.19	485.58	505.99	521.54
*198.53	75.00	94.06	102.06	125.19	142.00	147.75	160.25	171.63	176.88	192.44	193.94	194.00

F-female
M-male
*initial weight

Table 2. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"A"												
F 49.1	210.0	190.0	183.0	171.0	152.0	-	-	-	-	-	-	-
*241.0	76.0	59.0	77.5	80.0	64.0	-	-	-	-	-	-	-
M 50.3	163.5	177.5	209.2	232.3	243.4	269.6	338.6	385.8	434.8	473.1	516.1	553.3
*167.0	56.0	76.5	101.0	122.0	117.0	133.0	162.5	220.2	228.0	240.0	232.0	251.0
M 53.2	201.0	241.4	309.1	347.6	409.1	461.8	494.3	530.0	550.0	509.5	558.0	580.0
*199.4	85.0	123.0	143.0	157.5	182.0	198.0	213.0	222.0	224.0	180.0	217.0	241.0
M 54.2	278.2	310.9	347.0	400.0	426.8	475.8	518.6	545.6	560.0	606.0	643.3	661.7
*251.1	110.5	142.0	175.0	187.0	205.0	210.0	223.0	200.0	196.0	210.0	210.0	216.0
F 55.3	156.5	185.6	218.2	238.6	256.9	275.5	297.2	310.1	348.5	373.5	393.5	419.7
*129.1	80.0	84.0	91.0	101.0	105.0	120.0	135.0	120.0	135.0	160.0	180.0	186.0
M 56.3	249.9	300.6	338.8	396.7	445.5	491.2	554.0	590.6	601.9	630.0	662.6	689.0
*215.2	84.0	91.0	94.0	99.0	120.0	180.0	210.0	210.0	210.0	220.0	215.0	221.0
F 57.2	228.1	289.9	340.1	380.2	416.2	447.8	466.2	492.8	515.5	554.0	580.5	605.8
*217.5	84.0	91.0	91.0	160.0	170.0	170.0	190.0	220.0	190.0	220.0	220.0	230.0
F 58.2	121.0	141.1	153.1	179.0	185.7	195.4	193.5	208.0	210.2	216.1	-	-
*149.6	72.0	74.0	84.0	120.0	110.0	160.0	160.0	147.0	154.0	163.0	-	-
M 46.3	-	-	-	-	-	-	-	-	-	-	-	-
*125.5	-	-	-	-	-	-	-	-	-	-	-	-
M 46.4	144.0	128.0	-	-	-	-	-	-	-	-	-	-
*148.0	66.0	52.0	-	-	-	-	-	-	-	-	-	-
*												
TOTALS	1752.2	1965.0	2098.5	2345.4	2535.5	2617.1	2862.4	3062.9	3220.9	3362.2	3353.7	3509.5
1843.4	713.5	792.5	856.5	1026.5	1073.0	1171.0	1293.5	1339.0	1337.0	1393.0	1274.0	1345.0
MEAN	194.69	218.33	262.31	293.18	316.94	373.87	408.91	437.55	460.13	480.30	558.95	584.92
*184.34	79.29	88.06	107.06	128.31	134.13	167.29	184.79	191.29	191.00	199.00	212.33	264.17

F-female
M-male
*initial weight

Table 3. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"B"												
F 68.1	184.2	240.0	267.3	317.0	353.3	359.5	394.2	386.8	424.4	462.4	493.6	501.1
*172.2	68.5	111.0	126.0	138.0	159.0	169.0	172.5	173.0	127.5	166.5	187.0	179.0
F 69.2	195.0	200.7	256.1	289.8	300.0	326.2	332.5	360.0	392.2	385.0	401.2	412.1
*166.4	41.0	55.5	101.0	114.5	126.5	138.0	150.0	154.0	169.0	143.0	176.5	176.0
F 71.1	216.1	193.1	201.1	176.7	-	-	-	-	-	-	-	-
*212.0	58.0	69.0	83.0	68.0	-	-	-	-	-	-	-	-
M 72.2	212.8	239.5	263.0	278.6	314.8	340.5	381.6	406.3	418.7	455.2	468.4	499.9
*215.6	78.0	106.0	107.0	113.0	136.0	154.0	152.0	146.0	140.0	142.0	169.0	182.0
F 74.2	144.6	162.3	181.9	195.3	202.1	189.2	190.0	167.5	-	-	-	-
*161.5	49.0	51.0	62.0	80.0	82.0	80.0	107.0	50.0	-	-	-	-
F 75.3	221.0	239.2	290.0	315.0	348.9	373.7	396.6	421.0	445.3	481.0	515.0	549.2
*202.7	72.0	82.0	84.0	84.0	90.0	100.0	147.0	143.0	145.0	177.0	182.0	184.0
M 76.2	196.5	232.8	291.7	348.0	401.2	454.0	483.1	504.1	552.7	590.8	611.0	627.1
*167.4	94.0	102.0	107.0	128.0	160.0	175.0	188.0	176.0	196.0	201.0	205.0	215.0
TOTALS	1370.2	1507.6	1751.1	1920.4	1920.3	2043.1	2178.0	2245.7	2233.3	2374.4	2489.2	2589.4
1297.8	460.5	576.5	670.0	725.5	753.5	816.0	916.5	842.0	777.5	829.5	919.5	936.0
MEAN	195.74	215.23	250.16	274.29	320.05	340.52	363.00	374.28	446.66	474.88	497.84	517.88
*185.40	65.79	82.36	95.71	103.64	125.58	136.00	152.75	140.33	155.50	165.90	183.90	187.20

F-female
M-male
*initial weight

Table 4. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"B"												
F 68.2	173.6	217.5	224.4	293.4	312.5	322.8	356.6	390.0	412.1	467.8	500.0	534.3
*181.0	52.0	86.0	101.0	111.0	140.0	153.5	158.0	194.0	171.0	199.0	210.5	218.0
F 69.1	227.8	224.6	263.0	289.0	297.7	345.5	376.3	419.4	479.2	491.2	524.3	543.0
*232.3	55.5	66.0	105.0	116.5	125.0	127.5	141.0	183.0	195.5	214.5	228.0	224.0
M 71.2	261.5	261.8	285.8	347.5	393.5	438.5	490.5	518.5	566.7	601.8	629.0	640.0
*246.7	91.0	110.5	130.0	150.0	176.0	198.0	211.0	215.0	217.0	218.0	228.0	235.0
M 72.1	258.3	293.3	343.5	390.0	410.0	463.4	511.0	534.3	568.1	599.9	626.2	681.6
*244.5	122.5	147.0	160.0	180.0	200.0	210.0	214.0	211.0	211.0	218.0	227.0	238.0
M 74.1	141.5	173.4	162.1	185.1	194.8	207.7	204.8	187.5	-	-	-	-
*146.0	70.0	70.5	70.0	82.0	93.0	96.0	82.0	73.0	-	-	-	-
F 75.1	194.0	216.3	265.0	298.1	345.8	397.5	438.7	461.7	491.3	539.3	561.7	586.0
*177.2	78.0	91.0	91.0	95.0	104.0	140.0	160.0	180.0	190.0	195.0	215.0	225.0
M 76.1	186.6	225.8	268.3	331.7	385.1	430.7	466.5	496.4	530.5	564.5	541.0	540.0
*134.3	84.0	88.0	97.0	113.0	144.0	161.0	177.0	185.0	190.0	196.0	170.0	200.0
TOTALS	1443.3	1612.7	1812.1	2134.8	2339.4	2606.1	2844.4	3007.8	3047.9	3264.5	3382.2	3524.9
*1362.0	553.0	665.0	754.0	847.5	982.0	1086.0	1143.0	1241.0	1174.5	1240.5	1278.5	1340.0
MEAN	206.19	230.39	258.89	304.97	334.20	372.30	406.34	429.69	507.98	544.08	563.70	587.48
*194.57	79.00	95.00	107.70	121.07	140.29	155.14	163.29	177.29	195.75	206.67	213.08	218.33

F-female
M-male
*initial weight

Table 5. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"C"												
M 17.2	219.0	193.0	183.0	166.5	184.5	200.0	207.0	225.7	246.0	265.3	279.5	295.0
*201.0	91.0	104.5	90.0	83.5	90.5	100.0	94.0	105.0	98.0	114.0	111.5	115.0

F-female
M-male
*initial weight

Table 6. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"C"												
M 17.1	131.5	-	-	-	-	-	-	-	-	-	-	-
*187.0	61.5	-	-	-	-	-	-	-	-	-	-	-

F-female
M-male
*initial weight

Table 7. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"D"												
M 71.2	262.0	306.0	318.0	348.5	401.0	432.0	440.5	479.2	498.5	533.8	544.0	554.2
*241.0	102.5	148.0	184.0	196.5	197.0	213.0	210.0	181.0	198.0	196.0	198.5	195.0
F 73.1	239.5	279.0	319.5	324.7	354.0	418.4	464.3	477.3	498.5	508.8	480.0	500.0
*228.5	90.5	147.0	164.0	191.0	213.0	218.5	227.5	226.0	226.5	228.5	202.0	174.0
F 76.2	169.0	156.4	181.1	192.1	211.4	233.9	253.5	277.5	318.7	352.7	388.0	412.0
*169.8	75.0	65.0	79.0	92.0	108.0	119.0	126.0	134.0	143.0	147.0	149.0	152.0
M 79.2	198.5	226.1	238.5	242.3	253.0	282.8	251.3	241.0	203.0	205.2	194.9	202.0
*207.5	70.0	70.0	74.0	89.0	94.0	95.0	65.0	49.0	67.0	89.0	43.0	90.0
F 80.1	165.8	188.6	203.5	218.7	227.1	237.1	245.5	258.6	262.8	276.3	283.6	290.0
*181.2	91.0	98.0	80.0	66.0	70.0	82.0	65.0	85.0	87.0	96.0	100.0	104.0
TOTALS	1034.8	1156.1	1260.6	1326.3	1446.5	1604.2	1655.1	1733.6	1781.5	1876.8	1890.2	1958.2
1028.0	429.0	528.0	581.0	634.5	682.0	727.5	693.5	675.0	721.5	756.5	692.5	715.0
MEAN	206.96	231.22	252.12	265.26	289.30	320.84	331.02	346.72	356.30	375.36	378.04	391.64
*205.6	85.80	105.60	116.20	126.90	136.40	145.50	138.70	135.00	144.30	151.30	138.50	143.00

F-female
M-male
*initial weight

Table 8. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"D"												
M 71.1	291.5	324.5	356.0	408.5	436.5	464.5	487.8	601.0	621.6	628.0	659.5	668.5
*272.5	85.0	129.5	147.0	165.0	185.5	214.5	223.0	231.0	234.0	236.0	240.0	242.0
F 73.3	241.0	256.0	279.5	318.1	332.0	395.2	434.5	427.5	452.3	472.7	489.2	537.1
*218.0	108.0	144.0	146.0	190.0	207.5	211.0	216.0	224.0	222.0	224.0	230.5	233.0
F 76.1	292.8	276.4	265.5	279.9	294.3	333.2	379.2	418.0	465.8	489.1	504.1	516.7
*275.3	101.0	130.5	107.0	122.0	122.0	113.0	138.0	163.0	181.0	189.0	189.0	199.0
M 79.3	218.5	275.8	308.6	351.4	384.5	452.8	497.4	525.4	538.0	569.3	607.7	641.5
*177.1	84.0	92.0	96.0	96.0	156.0	180.0	180.0	170.0	215.0	210.0	210.0	215.0
M 80.3	188.7	-	-	-	-	-	-	-	-	-	-	-
*181.3	80.0	-	-	-	-	-	-	-	-	-	-	-
TOTALS	1232.5	1132.7	1209.6	1357.9	1447.3	1645.7	1798.9	1971.9	2077.7	2159.1	2260.5	2363.8
*1124.2	458.0	496.0	496.0	573.0	671.0	718.5	757.0	788.0	852.0	859.0	869.5	889.0
MEAN	246.50	283.18	302.40	339.48	361.83	411.43	449.73	492.98	519.43	539.78	565.13	590.95
*224.84	91.60	124.00	124.00	143.25	167.75	179.63	187.50	197.00	213.00	214.75	217.38	222.25

F-female
M-male
*initial weight

Table 9. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"G"												
M 59.1	206.3	265.4	294.4	345.4	386.8	433.5	471.6	494.0	490.0	442.9	411.5	358.9
*215.6	38.0	58.0	106.0	135.0	172.0	183.0	187.0	168.0	160.0	135.0	90.0	66.0
F 61.1	104.2	108.6	-	-	-	-	-	-	-	-	-	-
*113.3	37.0	69.0	-	-	-	-	-	-	-	-	-	-
F 63.1	126.0	-	-	-	-	-	-	-	-	-	-	-
*125.0	32.0	-	-	-	-	-	-	-	-	-	-	-
F 64.2	120.0	129.0	146.0	185.0	205.0	206.4	260.0	262.0	285.0	299.0	319.0	340.6
*124.0	51.0	62.0	80.0	107.0	116.0	126.0	124.0	144.0	126.0	131.0	140.0	154.0
M 65.2	180.0	205.0	236.5	258.3	289.0	311.0	338.0	376.5	417.0	463.0	480.0	503.7
*171.0	90.0	91.0	105.0	111.0	115.0	129.0	146.0	154.0	178.0	198.0	204.0	196.0
M 67.3	217.2	270.7	304.6	339.7	397.4	427.0	473.6	526.7	552.0	554.2	571.5	610.2
*198.7	94.0	125.0	154.0	166.0	182.0	192.0	200.0	210.0	198.0	195.0	175.0	188.0
M 69.1	292.0	279.0	310.0	352.0	382.0	405.0	414.0	399.0	410.0	424.0	458.4	487.7
*283.0	101.0	101.0	130.0	151.0	159.0	164.0	144.0	136.0	143.0	143.0	163.0	178.0
F 70.1	160.0	158.0	164.0	149.0	151.0	-	-	-	-	-	-	-
*187.6	65.0	73.0	81.0	75.0	74.0	-	-	-	-	-	-	-
M 72.2	238.5	251.7	238.4	219.4	181.0	-	-	-	-	-	-	-
*227.5	112.0	127.0	95.0	71.0	64.0	-	-	-	-	-	-	-
M 74.2	226.0	263.0	296.0	356.6	389.0	422.5	440.8	468.6	489.8	528.7	545.5	501.1
*184.0	126.0	133.0	137.0	155.0	161.0	161.0	185.0	193.0	196.0	200.0	187.0	159.0
M 78.1	190.0	245.0	268.0	320.8	344.0	367.1	395.8	435.3	473.3	510.0	536.2	524.0
*168.0	101.0	112.0	116.0	136.0	142.0	150.0	154.0	154.0	190.0	204.0	208.0	205.0
F 79.3	158.2	192.2	238.2	284.0	312.0	346.0	393.0	423.0	453.0	480.0	466.4	488.7
*145.0	70.0	73.0	93.0	106.0	112.0	126.0	140.0	160.0	140.0	160.0	150.0	178.0
M 80.2	188.5	211.0	225.0	206.0	215.1	230.6	178.0	-	-	-	-	-
*181.0	59.0	67.0	90.0	80.0	91.0	120.0	72.0	-	-	-	-	-
M 83.1	142.0	195.3	220.8	237.0	246.5	256.7	230.7	250.0	258.0	252.5	260.0	278.1
*168.4	62.0	72.0	80.0	110.0	97.0	117.0	90.0	135.0	140.0	167.0	180.0	192.0
M 84.2	150.0	-	-	-	-	-	-	-	-	-	-	-
*153.4	45.0	-	-	-	-	-	-	-	-	-	-	-

Continued

Continued

Table 9. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"G"												
TOTALS	2668.9	2773.9	2941.9	3252.9	3498.8	3425.4	3595.5	3634.5	3828.1	4154.1	4048.5	4093.0
*2645.5	1083.0	1163.0	1267.0	1403.0	1485.0	1468.0	1442.0	1454.0	1471.0	1533.0	1497.0	1516.0
MEAN	177.93	213.38	245.16	271.08	291.57	342.54	359.55	403.83	425.34	461.57	449.83	454.78
*176.37	72.20	89.46	103.92	116.92	123.75	146.80	144.20	161.55	163.44	170.33	166.33	168.44

F-female
M-male
*initial weight

Table 10. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"G"												
M 59.2	214.0	259.2	296.5	324.2	368.5	419.1	451.5	506.2	526.3	562.3	597.1	614.5
*220.5	63.0	82.0	113.0	141.0	167.0	172.0	184.0	196.0	207.0	213.0	211.0	213.0
F 61.2	145.2	162.5	212.0	238.0	280.3	310.7	346.9	371.1	414.8	450.0	471.4	481.0
*142.8	55.0	75.0	103.0	135.0	155.0	163.0	174.0	182.0	198.0	221.0	231.0	225.0
F 63.3	202.3	234.2	247.2	290.5	321.5	353.8	377.3	410.0	425.1	456.9	471.9	520.4
*180.2	60.0	104.0	135.0	156.0	162.0	169.0	183.0	194.0	193.0	199.0	211.0	224.0
M 64.1	170.0	203.4	238.0	271.9	306.8	339.0	392.0	414.0	435.6	457.5	494.2	548.0
*168.7	80.0	106.0	124.0	140.0	144.0	163.0	177.0	196.0	221.0	217.0	213.0	227.0
M 65.1	196.1	237.1	289.2	323.6	357.6	411.3	466.3	484.1	512.4	549.1	563.2	574.4
*187.9	82.0	94.5	136.0	150.0	177.0	200.0	211.0	202.0	190.0	206.0	195.0	190.0
M 67.2	226.0	284.0	310.0	346.0	388.0	422.0	464.0	534.7	580.0	598.0	643.0	686.0
*197.0	90.0	141.0	156.0	184.0	175.0	177.0	202.0	211.0	217.0	227.0	227.0	228.0
M 69.2	312.2	359.5	391.8	451.7	495.2	563.7	588.0	595.5	607.7	587.0	607.2	619.1
*299.2	100.0	154.0	182.0	211.0	219.0	230.0	234.0	245.0	238.0	224.0	224.0	239.0
M 70.2	178.3	211.2	246.7	288.3	302.6	261.6	231.7	-	-	-	-	-
*195.1	75.0	91.0	113.0	138.0	147.0	118.0	84.0	-	-	-	-	-
M 72.1	182.8	231.8	285.0	304.0	324.0	381.4	-	-	-	-	-	-
*169.5	70.0	80.0	104.0	114.0	139.0	143.0	-	-	-	-	-	-
M 74.3	186.8	236.5	275.1	335.0	354.0	377.0	416.0	461.0	492.6	538.0	592.0	618.0
*153.2	95.0	123.0	156.0	166.0	160.0	168.0	192.0	196.0	200.0	210.0	224.0	237.0
M 78.3	152.0	192.0	232.0	290.0	332.0	383.0	438.8	504.4	566.0	600.0	636.0	670.0
*155.5	72.0	77.0	98.0	120.0	126.0	147.0	150.0	154.0	195.0	220.0	220.0	230.0
F 79.1	165.0	185.0	217.0	267.0	298.5	362.0	410.0	441.3	466.1	476.0	484.0	490.0
*140.0	73.0	78.0	88.0	97.0	99.0	105.0	140.0	145.0	155.0	150.0	150.0	160.0
M 80.1	176.0	155.5	130.0	-	-	-	-	-	-	-	-	-
*183.4	52.0	45.0	37.0	-	-	-	-	-	-	-	-	-
M 83.2	170.8	162.0	-	-	-	-	-	-	-	-	-	-
*167.1	70.0	60.0	-	-	-	-	-	-	-	-	-	-
M 84.3	160.0	138.0	-	-	-	-	-	-	-	-	-	-
*157.0	46.0	31.0	-	-	-	-	-	-	-	-	-	-

Continued

Continued

Table 10. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"G"												
TOTALS	2837.5	3251.9	3370.5	3730.2	4129.0	4584.6	4581.7	4722.3	5026.6	5274.8	5558.0	5821.4
*2717.1	1083.0	1341.5	1545.0	1752.0	1870.0	1955.0	1931.0	1921.0	2014.0	2087.0	2106.0	2173.0
MEAN	189.17	216.73	274.65	310.85	344.08	382.05	416.53	472.23	502.66	527.48	555.80	582.14
*181.14	72.20	89.43	118.85	146.00	155.83	162.92	175.45	192.10	200.40	208.70	210.60	217.30

F-female
M-male
*initial weight

Table 11. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"I"												
F 10.2	175.0	184.0	230.0	268.0	296.0	321.0	346.0	356.2	381.0	376.4	370.4	375.3
*143.0	61.0	81.0	97.5	121.0	142.5	149.5	150.0	142.5	154.0	162.5	155.5	165.0
M 12.3	236.0	261.0	275.0	310.0	345.3	372.7	424.7	400.8	391.3	420.0	432.0	461.8
*219.8	105.0	120.0	133.0	140.0	150.0	154.0	182.0	178.0	154.0	182.0	188.0	196.0
M 15.2	254.5	276.0	323.7	361.8	395.8	432.3	442.5	467.0	507.0	495.5	515.0	559.0
*240.7	72.0	78.0	84.0	102.0	106.0	135.0	140.0	145.0	150.0	140.0	160.0	200.0
F 16.2	228.9	269.9	314.6	353.5	379.5	408.0	447.5	465.7	488.5	504.0	536.1	576.5
*201.5	76.0	84.0	80.0	120.0	141.0	150.0	160.0	172.0	170.0	150.0	170.0	119.0
TOTALS	894.4	990.9	1143.3	1293.3	1416.6	1534.0	1660.7	1689.7	1767.8	1795.9	1853.5	1912.6
*1005.0	314.0	363.0	394.5	483.0	539.5	588.5	632.0	637.5	628.0	634.5	673.5	680.0
MEAN	223.60	247.73	285.83	323.33	354.15	383.50	415.00	422.43	441.98	448.98	463.38	478.15
*251.25	78.50	90.75	98.58	120.75	134.88	147.13	158.00	158.38	157.00	158.63	168.38	170.00

F-female
M-male
*initial weight

Table 12. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"I"												
M 10.1	218.0	233.6	283.0	332.5	379.5	429.0	465.3	501.3	546.2	564.6	588.5	620.0
*201.0	42.0	51.5	86.0	149.0	167.5	177.0	183.0	197.0	210.5	220.5	233.0	236.0
M 12.2	182.3	231.6	270.0	297.0	337.6	378.3	406.4	445.1	491.7	513.1	531.8	552.1
*154.3	98.0	118.0	140.0	150.0	159.0	167.0	170.0	192.0	196.0	196.0	206.0	210.0
M 15.1	263.4	289.2	338.0	392.6	448.1	504.5	530.8	557.3	585.6	602.2	615.5	578.5
*223.8	101.0	108.0	112.0	114.0	126.0	180.0	190.0	190.0	190.0	185.0	190.0	200.0
F 16.3	235.6	271.8	295.6	327.3	368.0	405.5	434.8	454.8	485.0	530.0	561.0	562.5
*203.8	84.0	91.0	80.0	80.0	120.0	140.0	170.0	180.0	180.0	154.0	160.0	163.0
TOTALS	899.3	1026.2	1186.6	1349.4	1533.2	1717.3	1837.3	1958.5	2108.5	2209.9	2296.8	2313.1
*782.9	325.0	368.5	418.0	493.0	572.5	664.0	713.0	759.0	776.5	755.5	789.0	809.0
MEAN	224.83	256.55	296.65	337.35	383.30	429.33	459.33	489.63	527.13	552.48	574.20	578.28
*195.73	81.25	92.13	104.50	123.25	143.00	166.00	178.25	189.75	194.13	188.88	197.25	202.25

F-female
M-male
*initial weight

Table 13. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"R"												
M 85.1	208.0	230.5	250.0	284.5	320.0	371.0	391.2	481.0	517.7	534.7	552.2	580.8
*216.0	108.0	107.0	146.0	151.5	157.0	206.5	219.0	227.5	217.5	220.0	222.5	241.0
M 87.2	223.3	233.7	275.7	305.3	350.0	382.7	405.3	442.3	497.4	539.0	558.0	598.0
*218.5	100.0	92.0	114.0	126.5	145.0	172.0	175.0	186.0	197.0	207.0	199.0	200.0
M 90.2	206.0	223.0	263.5	304.6	343.4	382.7	393.0	432.4	470.0	485.3	473.1	412.0
*214.4	86.0	91.0	108.0	144.0	160.0	175.0	181.0	182.0	182.0	196.0	196.0	169.0
F 91.2	187.2	211.7	195.1	224.5	236.2	196.5	191.5	178.4	166.0	175.5	192.0	220.0
*198.0	45.0	55.0	73.0	77.0	66.0	56.0	55.0	49.0	56.0	56.0	60.0	63.0
F 92.1	193.0	223.4	275.0	288.7	320.0	335.5	367.8	387.0	409.2	438.0	455.4	509.0
*172.1	108.0	115.0	128.0	156.0	175.0	182.0	197.0	202.0	208.0	206.0	218.0	224.0
F 93.4	235.7	266.0	290.5	304.0	324.6	348.1	382.8	406.5	421.4	407.0	362.8	321.8
*199.6	99.0	103.0	105.0	111.0	125.0	128.0	140.0	160.0	180.0	120.0	100.0	80.0
M 94.1	267.4	305.3	320.0	361.0	398.7	434.0	472.0	508.0	524.4	538.7	490.4	435.0
*209.3	97.0	112.0	126.0	126.0	136.0	160.0	180.0	190.0	190.0	198.0	120.0	82.0
M 95.2	210.0	252.4	278.6	305.1	330.0	348.2	369.3	390.0	405.6	426.2	438.1	463.2
*164.7	91.0	105.0	105.0	110.0	120.0	136.0	130.0	146.0	159.0	178.0	178.0	190.0
TOTALS	1730.6	1946.0	2148.4	2377.7	2622.9	2798.7	2972.9	3225.6	3411.7	3544.4	3522.0	3539.8
*1592.6	734.0	780.0	905.0	1002.0	1084.0	1215.5	1277.0	1442.5	1389.5	1381.0	1293.5	1249.0
MEAN	216.33	243.25	268.55	297.21	327.86	349.84	371.61	403.20	426.46	443.05	440.25	442.48
*199.08	91.75	97.50	113.13	125.25	135.50	151.94	159.62	180.31	173.69	172.63	161.69	156.13

F-female
M-male
*initial weight

Table 14. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"R"												
M 85.2	180.5	205.0	224.5	193.3	188.0	169.2	175.0	201.7	190.5	206.0	187.0	205.0
*194.0	93.0	95.0	96.0	67.0	68.0	66.0	95.0	99.0	98.0	102.0	94.0	119.0
M 87.1	250.0	276.1	321.1	343.7	389.8	429.0	478.6	511.0	573.0	605.0	617.3	633.7
*236.0	118.5	128.5	147.5	173.0	199.5	216.0	226.0	220.0	227.0	249.0	215.0	225.0
F 90.1	255.2	281.1	306.6	332.0	376.1	406.1	438.8	460.5	472.5	499.7	517.3	530.0
*214.8	117.5	157.0	156.0	164.0	168.0	158.0	180.0	182.0	182.0	196.0	202.0	208.0
F 91.3	186.4	218.7	243.1	274.7	302.5	319.9	346.5	383.0	399.1	425.7	462.9	491.3
*151.2	98.0	115.0	121.0	137.0	140.0	140.0	144.0	157.0	160.0	161.0	169.0	175.0
M 92.2	178.7	210.1	274.2	304.6	361.5	397.7	437.0	456.6	405.0	414.5	422.3	400.0
*158.2	108.0	135.0	151.0	161.0	178.0	183.0	196.0	196.0	172.0	166.0	152.0	140.0
M 93.3	235.3	261.8	301.8	332.0	377.0	398.7	421.6	447.5	480.6	502.0	522.8	527.8
*194.2	94.0	105.0	119.0	122.0	196.0	138.0	144.0	160.0	160.0	180.0	190.0	214.0
M 94.2	211.5	243.0	262.4	293.8	338.6	386.4	416.8	449.4	475.3	487.0	517.2	525.0
*174.3	49.0	64.0	84.0	86.0	89.0	91.0	140.0	150.0	160.0	175.0	180.0	200.0
F 95.3	209.8	255.1	278.3	298.6	312.8	349.4	383.0	398.3	403.3	419.5	434.7	441.9
*178.8	84.0	105.0	105.0	105.0	120.0	130.0	135.0	150.0	150.0	159.0	160.0	169.0
TOTALS	1707.4	1950.9	2212.0	2372.7	2646.3	2856.4	3097.3	3308.0	3399.3	3559.4	3681.5	3754.7
* 1501.5	762.0	904.5	979.5	1015.0	1158.5	1122.0	1260.0	1314.0	1309.0	1378.0	1362.0	1450.0
MEAN	213.43	243.75	276.50	296.59	330.79	357.05	387.16	413.50	424.91	444.93	460.19	469.34
*187.69	95.25	113.06	122.44	126.88	144.81	140.25	157.50	164.25	163.63	172.25	170.25	181.25

F-female
M-male
*initial weight

Table 15. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"S"												
M 31.2	158.5	184.0	230.5	275.0	289.5	348.2	392.3	397.8	409.0	437.3	441.0	453.3
*125.0	70.5	92.5	113.0	150.0	140.0	167.5	174.5	172.5	166.5	163.5	177.5	175.0
F 32.3	173.3	237.1	276.7	283.0	311.2	329.5	352.0	380.4	386.0	406.5	425.0	425.4
*181.0	103.0	100.0	126.0	146.0	148.0	150.5	152.5	173.5	189.0	192.0	193.0	194.0
F 33.1	261.6	281.6	315.3	319.8	352.2	400.8	392.4	430.9	455.0	467.5	481.8	487.5
*251.1	86.0	115.0	124.5	146.0	168.0	179.0	174.0	199.0	211.0	211.0	179.0	193.0
F 35.1	160.4	163.6	176.0	201.1	262.3	287.0	300.5	321.0	360.2	375.7	392.5	425.6
*185.4	64.0	73.0	82.0	108.0	126.0	143.0	161.0	167.0	174.0	168.0	170.0	180.0
F 37.1	244.5	285.7	310.0	351.0	387.7	408.3	428.3	454.7	494.4	544.6	584.8	621.0
*250.4	111.0	127.0	157.0	177.0	179.0	193.0	199.0	203.0	205.0	210.0	212.0	224.0
F 38.2	226.5	268.6	313.0	341.4	366.0	378.3	399.3	423.8	448.6	421.0	435.0	447.0
*229.3	96.0	106.0	142.0	159.0	167.0	175.0	175.0	187.0	196.0	194.0	182.0	190.0
TOTALS	1224.8	1420.6	1621.5	1771.3	1968.9	2152.1	2264.8	2408.6	2553.2	2652.6	2760.1	2859.8
*1222.2	530.5	613.5	744.5	886.0	928.0	1008.0	1036.0	1102.0	1141.5	1138.5	1113.5	1166.0
MEAN	204.13	236.77	270.25	295.22	328.15	358.68	377.47	401.43	425.53	442.10	460.02	476.63
*203.70	84.42	102.25	124.08	147.67	154.67	168.00	172.67	183.67	190.25	189.75	185.58	194.33

F-female
M-male
*initial weight

Table 16. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"S"												
M 31.1	171.0	225.0	288.5	336.9	351.2	418.2	473.2	491.4	545.5	565.0	583.0	610.4
*136.5	94.0	129.0	141.5	147.5	148.0	186.5	213.5	214.0	216.0	229.0	231.5	238.5
F 32.1	239.0	299.2	324.7	350.0	370.0	408.8	424.5	454.0	466.0	496.0	529.8	535.5
*233.2	85.5	92.0	124.0	153.5	189.0	186.0	165.0	167.0	177.0	190.5	203.0	210.0
M 33.2	276.6	302.5	358.0	381.6	422.1	468.7	483.0	506.3	547.7	574.2	619.2	626.4
*259.1	94.0	130.5	154.0	169.0	197.0	214.0	215.0	224.0	236.0	245.0	248.0	257.0
M 35.2	240.0	257.4	274.1	313.0	381.5	409.5	414.7	438.4	481.5	521.6	556.0	597.1
*212.9	99.5	133.5	136.0	154.0	174.0	185.0	212.0	205.0	207.0	210.0	210.0	214.0
F 37.2	269.2	303.6	338.3	377.3	403.1	447.7	470.0	482.5	498.4	533.8	582.6	609.1
*243.5	112.0	123.0	152.0	168.0	160.0	166.0	168.0	168.0	174.0	175.0	179.0	182.0
M 38.1	186.1	225.3	289.3	337.8	391.0	432.3	473.0	499.2	543.2	561.0	568.5	573.1
*197.1	72.0	90.0	126.0	160.0	174.0	182.0	182.0	190.0	196.0	196.0	184.0	184.0
TOTALS	1383.9	1613.0	1872.9	2096.6	2318.9	2585.2	2738.4	2871.8	3082.3	3251.6	3439.1	3551.6
*1282.3	557.0	698.0	833.5	952.0	1042.0	1119.5	1155.5	1168.0	1206.0	1245.5	1255.5	1285.5
MEAN	236.50	268.83	312.15	349.43	386.48	430.87	456.40	478.63	513.72	541.93	573.18	591.93
*213.72	92.83	116.33	138.92	158.67	173.67	186.58	192.58	194.67	201.00	207.58	209.25	214.25

F-female
M-male
*initial weight

Table 17. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"T"												
F 22.3	250.0	244.0	242.5	300.0	316.5	394.5	414.8	455.0	475.3	485.5	508.0	514.6
*238.5	68.0	66.0	64.0	118.0	156.0	175.0	204.0	208.0	216.0	195.0	226.0	228.0
M 23.1	197.2	220.0	245.6	270.0	291.7	287.8	295.0	321.3	354.0	370.7	380.8	388.8
*204.4	37.0	59.0	100.0	127.5	151.0	126.0	132.0	148.0	153.5	146.5	141.0	162.0
M 26.3	179.0	191.5	212.3	243.8	318.7	357.1	386.1	428.0	453.0	472.6	496.3	508.8
*186.6	63.0	66.5	90.5	118.5	145.5	170.0	194.0	210.0	195.0	197.0	200.0	202.0
F 26.4	152.2	195.0	213.0	233.2	267.8	302.2	321.2	355.7	391.4	397.1	422.0	431.1
*143.1	54.5	85.5	91.0	117.0	127.5	134.0	151.0	160.0	172.0	178.0	176.0	178.0
M 27.2	262.4	268.7	286.5	310.5	342.0	380.0	443.5	465.7	518.7	549.4	578.2	613.2
*251.3	96.5	91.5	126.0	98.0	122.0	146.0	174.0	189.0	192.0	198.0	210.0	214.0
M 29.1	237.0	285.6	321.8	386.6	430.7	450.5	438.7	-	-	-	-	-
*213.7	72.0	84.0	91.0	98.0	140.0	170.0	152.0	-	-	-	-	-
F 32.3	235.1	250.3	272.9	286.1	320.1	341.5	372.3	398.2	422.8	455.0	477.4	486.9
*219.7	84.0	98.0	100.0	104.0	113.0	120.0	140.0	144.0	145.0	147.0	150.0	166.0
TOTALS	1512.9	1660.1	1797.6	2030.2	2287.5	2513.6	2670.8	2423.9	2615.2	2730.3	2862.7	2943.4
*1457.3	475.0	550.5	662.5	781.0	955.0	1041.0	1147.0	1059.0	1073.5	1061.5	1103.0	1150.0
MEAN	216.13	237.16	256.80	290.03	326.79	359.09	381.54	403.98	435.87	455.05	477.12	490.57
*208.19	67.86	78.64	94.64	111.57	136.43	148.71	163.86	176.50	178.92	176.92	183.83	191.67

F-female
M-male
*initial weight

Table 18. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
T												
F 22.2	221.0	212.0	226.5	266.0	294.5	325.2	363.0	390.7	428.0	453.5	472.5	491.6
*223.5	101.0	99.0	103.5	151.5	155.0	172.0	185.0	191.0	195.0	198.0	200.0	205.0
F 23.2	201.0	178.2	168.4	-	-	-	-	-	-	-	-	-
*217.0	50.5	57.5	51.5	-	-	-	-	-	-	-	-	-
M 26.2	202.7	253.0	272.1	305.7	373.7	433.7	457.5	496.7	545.5	517.0	528.7	544.1
*194.1	71.5	95.5	125.0	155.0	187.5	212.0	224.0	228.0	191.0	162.0	154.0	166.0
F 26.1	202.8	247.4	259.0	290.3	338.7	359.4	377.7	416.0	443.0	453.2	471.3	486.8
*172.8	97.0	129.0	138.0	147.5	163.0	168.0	165.0	178.0	182.0	182.0	183.0	184.0
F 27.1	255.3	279.8	309.5	344.1	368.4	394.0	415.8	445.0	472.8	496.0	507.0	527.4
*238.7	102.5	119.0	133.5	140.0	160.0	168.0	174.0	175.0	182.0	180.0	178.0	178.0
F 29.2	157.3	163.0	145.0	158.6	166.1	-	-	-	-	-	-	-
*148.3	70.0	77.0	78.0	84.0	90.0	-	-	-	-	-	-	-
M 32.1	298.7	341.8	395.1	438.9	480.0	529.0	571.5	603.6	641.0	698.5	731.3	736.3
*269.4	91.0	98.0	140.0	160.0	170.0	180.0	200.0	210.0	210.0	215.0	220.0	220.0
TOTALS	1538.8	1675.2	1775.6	1803.6	1921.4	2041.3	2185.5	2352.0	2530.3	2618.2	2710.8	2886.2
*1463.8	583.5	675.0	769.5	838.0	925.5	900.0	948.0	982.0	960.0	937.0	935.0	953.0
MEAN	219.83	239.31	253.76	300.06	320.23	408.26	437.10	470.40	506.06	523.64	542.16	577.24
*209.11	83.36	96.43	109.93	139.67	154.25	180.00	189.60	196.40	192.00	187.40	187.00	190.60

F-female
M-male
*initial weight

Table 19. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"U"												
M 55.1	206.5	230.3	280.0	292.4	295.2	348.0	382.3	363.0	394.0	400.0	428.3	437.5
*187.0	95.5	98.5	113.0	129.0	125.0	138.0	146.0	149.0	157.0	165.0	171.5	186.0
F 57.1	161.0	174.3	220.6	266.2	274.0	310.0	299.0	330.9	362.7	365.2	388.8	402.1
*143.5	43.0	52.5	91.5	114.5	125.5	131.5	124.5	126.5	130.0	144.0	167.0	174.0
M 58.3	128.7	159.4	171.0	196.7	251.5	259.5	280.0	303.5	333.4	348.0	364.0	401.4
*130.2	29.5	65.5	76.5	101.0	130.5	119.0	123.5	136.5	143.5	128.5	127.0	157.0
F 59.2	225.2	221.3	238.2	285.6	318.0	313.2	317.7	339.2	356.2	358.2	375.5	387.6
*219.0	86.5	84.0	95.0	107.5	113.0	116.0	109.0	117.0	126.0	131.0	124.0	129.0
M 60.4	124.0	120.4	133.5	145.9	151.6	164.8	173.0	202.0	211.3	213.5	208.3	210.4
*129.4	57.0	63.0	63.5	59.0	64.5	73.0	79.0	67.0	84.0	89.0	84.0	90.0
F 61.1	160.0	143.0	155.4	127.1	-	-	-	-	-	-	-	-
*159.5	52.0	33.5	52.5	47.0	-	-	-	-	-	-	-	-
M 63.1	142.6	168.3	187.0	208.8	255.0	287.8	293.0	323.1	339.7	334.8	352.0	388.2
*156.7	65.0	69.0	79.5	100.5	112.0	121.0	135.0	175.0	170.0	169.0	190.0	196.0
M 65.2	161.0	165.4	193.8	252.2	276.2	306.8	340.5	382.4	413.5	429.4	433.0	436.7
*157.2	49.0	74.0	80.0	88.0	113.0	124.0	130.0	142.0	147.0	153.0	161.0	164.0
M 65.3	158.2	160.5	204.2	257.7	297.5	335.8	360.9	393.8	411.6	440.0	476.2	505.7
*154.0	59.0	90.5	96.0	116.0	133.0	141.0	155.0	169.0	175.0	169.0	170.0	179.0
M 66.3	192.5	188.2	201.0	215.3	236.0	258.4	295.7	331.6	361.0	399.0	426.4	435.4
*171.5	66.0	70.0	91.0	97.0	105.0	107.0	119.0	120.0	130.0	135.0	150.0	149.0
F 68.2	198.0	250.3	272.3	291.4	313.4	330.0	352.6	368.1	377.7	386.1	404.7	415.5
*182.0	93.0	100.0	112.0	124.0	126.0	130.0	140.0	140.0	140.0	140.0	142.0	140.0
M 70.4	165.4	180.4	223.7	256.7	295.4	319.9	355.1	383.8	398.8	415.8	436.5	399.7
*150.9	55.0	70.0	80.0	84.0	94.0	101.0	106.0	117.0	137.0	150.0	164.0	97.0
M 71.2	185.0	207.0	251.6	284.3	312.6	340.5	362.7	367.9	389.5	412.2	434.8	448.6
*173.1	69.0	84.0	91.0	96.0	98.0	100.0	120.0	123.0	126.0	128.0	133.0	140.0
M 72.1	194.1	225.8	282.8	330.6	366.6	400.0	432.2	458.0	480.0	523.0	558.4	602.3
*189.5	57.0	66.0	86.0	118.0	140.0	156.0	165.0	171.0	192.0	194.0	210.0	230.0
F 74.1	184.6	194.2	233.8	260.7	279.7	301.0	350.0	383.0	416.0	437.2	465.4	476.5
*178.3	70.0	80.0	100.0	87.0	110.0	127.0	139.0	142.0	153.0	155.0	159.0	180.0

Continued

Continued

Table 19. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"U"												
TOTALS	2586.8	2678.8	3248.9	3671.6	3922.7	4275.7	4554.7	4930.3	5245.4	5462.4	5752.2	5947.6
*2481.8	946.5	1100.5	1307.5	1468.5	1589.5	1684.5	1791.0	1895.0	2010.5	2050.0	2152.5	2211.0
MEAN	172.45	175.25	216.59	244.77	280.19	305.41	325.33	352.16	375.57	390.29	410.78	424.83
*165.45	63.10	73.37	87.17	97.90	113.54	120.32	127.93	135.36	143.57	146.43	153.72	157.94

F-female
M-male
*initial weight

Table 20. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"U"												
M 55.2	218.0	245.0	293.5	312.5	319.2	357.7	386.5	398.0	410.0	441.0	468.6	486.4
*207.5	97.5	123.5	128.5	137.0	141.0	147.5	169.0	176.0	182.5	184.0	191.0	204.0
F 57.2	205.6	220.6	278.0	316.1	323.5	352.0	368.2	401.8	432.2	427.5	451.4	465.7
*190.5	75.5	82.0	108.0	115.5	123.0	135.5	143.5	161.5	191.0	210.5	211.5	224.5
M 58.2	161.8	193.6	232.8	253.0	317.0	342.5	373.2	410.0	465.0	520.4	557.5	568.2
*161.0	56.0	64.5	104.5	122.5	138.0	150.5	162.0	177.5	198.0	218.5	229.5	240.0
F 59.1	240.7	248.0	277.0	317.3	327.4	353.0	361.0	385.7	393.8	430.0	463.2	480.2
*225.1	106.0	122.0	124.0	121.0	135.0	157.0	140.0	155.0	170.0	179.0	185.0	199.0
M 60.3	130.5	107.5	109.0	115.5	116.5	-	-	-	-	-	-	-
*137.3	49.0	54.0	48.0	41.5	56.0	-	-	-	-	-	-	-
F 61.2	145.3	162.0	170.5	151.7	-	-	-	-	-	-	-	-
*171.9	39.5	71.0	72.5	68.0	-	-	-	-	-	-	-	-
M 63.2	188.2	205.5	212.3	230.0	271.8	290.0	296.5	326.4	364.2	395.2	427.4	454.4
*172.9	81.0	78.0	84.5	98.0	114.5	92.0	121.0	158.0	151.0	142.0	160.0	168.0
M 65.1	197.0	235.7	279.2	339.3	371.6	429.0	472.7	507.8	525.3	546.3	577.0	558.0
*175.4	90.0	110.0	136.0	170.0	183.0	202.0	212.0	217.0	220.0	220.0	206.0	196.0
M 65.4	192.0	210.7	241.2	304.0	333.3	382.0	413.7	449.0	464.3	502.7	530.6	549.9
*155.2	91.5	102.0	112.0	130.0	148.0	169.0	183.0	208.0	202.0	222.0	222.0	221.0
M 66.1	201.0	223.5	265.5	300.0	354.0	382.6	421.8	463.7	500.0	525.2	537.7	555.8
*162.2	97.0	105.0	119.0	122.0	133.0	134.0	140.0	161.0	200.0	210.0	230.0	240.0
F 68.1	101.4	149.0	173.4	200.0	237.7	259.6	286.3	304.5	323.7	354.2	384.5	392.9
*113.0	47.0	58.0	77.0	89.0	98.0	99.0	105.0	120.0	130.0	140.0	150.0	155.0
M 70.1	163.8	193.8	240.0	265.3	294.6	319.9	333.3	352.5	376.0	401.0	414.6	440.0
*143.0	60.0	70.0	70.0	77.0	89.0	120.0	136.0	145.0	145.0	150.0	150.0	162.0
M 71.1	175.7	205.7	257.1	289.2	318.0	338.3	368.6	322.0	340.7	375.5	400.6	425.6
*151.5	67.0	82.0	84.0	90.0	98.0	100.0	120.0	147.0	180.0	182.0	185.0	188.0
M 72.2	168.0	199.7	238.1	251.5	275.0	299.7	248.0	379.0	425.0	456.0	497.1	533.4
*147.5	56.0	65.0	79.0	84.0	95.0	115.0	150.0	175.0	173.0	172.0	174.0	211.0
F 74.2	195.1	219.0	264.7	300.8	322.6	342.6	360.0	384.5	419.7	451.0	488.3	496.4
*170.0	70.0	80.0	100.0	110.0	120.0	122.0	137.0	158.0	150.0	150.0	152.0	180.0

Continued

Continued

Table 20. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"U"												
TOTALS	2684.1	3019.3	3532.3	3946.2	4182.2	4448.9	4789.8	5084.9	5439.9	5826.0	6198.6	6406.9
*2484.0	1083.0	1267.0	1447.0	1575.5	1671.5	1743.5	1918.5	2059.0	2292.5	2380.0	2446.0	2588.5
MEAN	178.94	201.29	235.49	263.08	298.73	342.22	368.46	391.15	418.46	448.15	476.82	492.84
*165.60	72.20	84.47	97.13	105.33	119.39	133.35	147.58	158.39	176.35	183.08	188.15	199.12

F-female
M-male
*initial weight

Table 21. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"W"												
M 3.1	157.7	164.6	186.5	199.2	245.0	287.4	321.7	332.7	392.0	419.5	441.0	468.0
*170.0	43.0	46.5	72.5	92.5	104.5	127.0	141.0	162.0	165.0	168.0	178.0	208.0

M-male
*initial weight

Table 22. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"W"												
M 3.3	230.2	291.9	330.7	380.0	444.6	486.0	522.7	534.2	561.5	587.2	620.7	646.8
*201.2	95.0	149.5	173.5	175.0	193.5	198.0	206.0	211.0	217.0	220.0	226.0	231.0

M-male
*initial weight

Table 23. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"X"												
M 63.3	121.5	149.5	149.0	150.5	174.5	192.6	208.7	213.0	227.4	228.7	240.0	276.4
*121.0	82.0	99.5	108.0	95.5	103.0	103.5	106.0	101.0	95.0	84.5	92.0	118.0
M 64.2	135.5	204.2	218.2	247.8	287.7	325.2	377.1	385.1	424.4	445.0	475.9	481.0
*151.6	45.0	61.5	99.0	133.5	146.5	151.5	163.0	171.0	188.5	202.0	209.0	218.0
F 67.2	145.7	159.7	169.0	203.4	230.0	241.0	263.8	297.5	307.0	327.0	347.0	353.2
*144.5	52.7	65.5	86.5	90.5	112.0	114.0	121.0	141.5	157.0	125.0	126.0	130.0
F 72.1	205.0	233.5	254.6	278.7	291.7	-	-	-	-	-	-	-
*193.4	118.0	130.0	131.0	123.0	119.0	-	-	-	-	-	-	-
F 73.2	239.2	288.0	296.5	306.5	318.2	353.0	380.6	403.0	417.2	434.6	449.8	462.5
*220.0	93.0	103.0	109.0	116.0	128.0	140.0	142.0	147.0	160.0	160.0	165.0	183.0
M 75.1	177.0	204.0	221.5	260.4	274.5	296.1	329.8	362.3	407.5	447.5	493.2	509.2
*188.5	63.0	75.0	105.0	105.0	105.0	107.0	112.0	140.0	150.0	170.0	180.0	190.0
M 77.2	200.5	226.0	248.5	291.6	321.8	347.3	383.2	429.5	461.5	500.5	525.0	556.3
*190.4	70.0	75.0	79.0	84.0	120.0	130.0	150.0	170.0	175.0	180.0	188.0	200.0
TOTALS	1224.4	1464.9	1557.3	1738.9	1898.4	1755.2	1943.2	2090.4	2245.0	2383.3	2530.9	2638.6
*1209.4	523.7	609.5	717.5	747.5	833.5	746.0	794.0	870.5	925.5	921.5	960.0	1039.0
MEAN	174.91	209.27	222.47	248.41	271.20	292.53	323.87	348.40	374.17	397.22	421.82	439.77
*172.77	74.81	87.07	102.50	106.79	119.07	124.33	132.33	145.08	154.25	153.58	160.00	173.17

F-female
M-male
*initial weight

Table 24. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"X"												
M 63.2	156.7	198.2	213.5	237.0	303.3	328.5	348.5	358.0	397.6	441.9	451.6	484.4
*148.0	77.5	97.5	104.5	104.5	135.5	139.0	146.5	149.5	158.5	166.5	186.0	188.0
M 64.1	181.2	236.1	271.8	287.0	308.5	363.1	391.7	430.0	459.5	495.5	533.6	546.1
*180.0	76.5	86.0	108.0	142.5	162.5	163.0	169.5	181.5	194.0	194.5	202.0	204.0
F 67.1	186.2	195.5	211.0	249.2	281.3	309.0	325.7	373.5	390.6	405.7	444.2	451.2
*163.0	69.5	75.5	97.0	135.0	149.5	168.0	172.0	176.0	182.0	164.0	165.0	168.0
F 72.2	130.8	140.0	132.0	-	-	-	-	-	-	-	-	-
*130.3	70.0	65.0	47.0	-	-	-	-	-	-	-	-	-
F 73.1	165.1	213.8	245.1	262.1	284.1	324.5	342.8	367.3	388.1	408.8	424.8	450.0
*149.8	100.0	96.0	108.0	117.0	136.0	140.0	148.0	154.0	156.0	164.0	170.0	174.0
M 75.2	184.5	224.5	241.5	277.7	300.0	324.3	352.8	383.5	427.3	447.0	459.8	452.6
*177.0	87.0	93.0	105.0	113.0	122.0	126.0	126.0	150.0	170.0	170.0	180.0	142.0
M 77.3	241.4	300.0	341.0	388.6	420.0	462.3	505.5	543.0	565.2	580.0	611.0	641.3
*206.7	84.0	90.0	97.0	100.0	148.0	160.0	170.0	180.0	195.0	205.0	187.0	210.0
TOTALS	1145.9	1508.1	1655.9	1701.6	1897.2	2111.7	2267.0	2455.3	2628.3	2778.9	2924.8	3025.6
*1154.8	564.5	603.0	666.5	712.0	853.5	896.0	932.0	991.0	1055.5	1064.0	1090.0	1186.0
MEAN	163.63	215.44	236.56	283.60	316.20	351.95	377.83	409.22	438.05	463.15	487.47	542.67
*164.97	80.64	86.14	95.21	118.67	142.25	149.33	155.33	165.17	175.92	177.33	181.67	197.67

F-female
M-male
*initial weight

Table 25. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"Y"												
M 13.2	252.8	267.1	289.6	316.6	365.0	387.6	420.0	476.3	491.7	539.5	569.5	571.5
*212.2	92.5	127.5	142.0	144.5	159.0	164.0	179.0	208.0	209.0	195.0	208.0	222.0
F 14.1	131.0	158.2	184.0	188.3	214.2	235.2	265.6	295.0	312.6	327.5	359.2	392.5
*123.8	72.0	71.0	74.5	76.0	105.0	126.0	150.0	169.0	179.0	198.0	210.0	214.0
F 15.2	247.0	257.5	292.0	332.1	362.5	409.0	424.5	442.7	481.7	533.0	548.8	565.4
*255.2	97.0	105.0	125.0	152.0	154.0	156.0	160.0	165.0	192.0	196.0	200.0	210.0
M 16.1	256.2	295.2	334.0	358.2	402.8	446.8	468.3	525.0	548.9	572.9	605.7	625.7
*246.4	116.0	126.0	134.0	154.0	154.0	162.0	182.0	182.0	189.0	189.0	231.0	246.0
F 17.1	185.8	228.3	266.7	309.8	346.1	386.4	412.0	434.4	465.7	499.8	544.0	581.0
*168.7	71.0	77.0	84.0	120.0	154.0	162.0	156.0	170.0	182.0	176.0	176.0	178.0
F 17.2	151.0	169.8	189.0	203.7	235.6	255.6	276.4	307.0	330.0	361.5	383.5	411.0
*132.0	70.0	84.0	100.0	110.0	117.0	120.0	130.0	130.0	140.0	138.0	148.0	160.0
TOTALS	1223.8	1376.2	1555.3	1708.7	1926.2	2120.6	2266.8	2480.4	2630.6	2834.2	3010.7	3147.1
*1138.3	518.5	590.5	659.5	756.5	843.0	890.0	957.0	1024.0	1091.0	1092.0	1173.0	1230.0
MEAN	203.97	229.37	259.22	284.78	321.03	353.43	377.80	413.40	438.43	472.20	501.78	524.52
*189.72	86.42	98.42	109.75	126.08	140.50	148.33	159.50	170.67	181.83	182.00	195.56	205.00

F-female
M-male
*initial weight

Table 26. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"Y"												
M 13.1	291.0	320.0	354.1	390.8	455.0	483.3	520.6	565.0	590.7	633.4	668.2	689.2
*257.6	105.5	155.0	173.0	181.0	201.5	208.0	218.0	238.0	231.0	224.0	242.0	256.0
M 14.4	222.1	265.5	324.7	359.1	385.8	443.0	490.8	530.8	585.3	630.5	659.0	696.1
*195.0	120.5	150.0	178.0	204.0	245.0	248.0	278.0	287.0	294.0	322.0	322.0	326.0
M 15.1	274.0	320.8	371.0	435.3	460.0	518.0	546.5	585.5	611.3	626.3	641.8	661.2
*261.5	139.0	171.0	190.0	204.0	211.0	221.0	224.0	231.0	231.0	242.0	268.0	275.0
M 16.2	238.7	288.1	327.0	351.6	403.0	451.2	472.0	517.0	548.6	569.8	597.8	625.5
*227.0	112.0	119.0	122.0	140.0	140.0	156.0	170.0	182.0	186.0	190.0	205.0	214.0
F 17.3	165.7	185.3	208.0	230.5	255.1	290.0	318.5	341.6	370.0	410.5	439.5	447.8
*146.9	64.0	73.0	100.0	100.0	102.0	120.0	128.0	147.0	148.0	154.0	154.0	156.0
M 17.4	158.3	202.6	226.0	246.4	286.5	317.0	348.6	389.0	428.8	490.7	531.6	566.0
*117.0	84.0	91.0	110.0	130.0	145.0	160.0	163.0	180.0	192.0	194.0	205.0	210.0
TOTALS	1349.8	1582.3	1710.8	2013.7	2245.4	2502.5	2697.0	2928.9	3134.7	3361.2	3537.9	3685.8
*1205.0	625.0	759.0	873.0	959.0	1044.5	1113.0	1181.0	1265.0	1282.0	1326.0	1396.0	1437.0
MEAN	224.97	263.73	285.13	335.62	374.23	417.08	449.50	488.15	522.45	560.20	589.65	614.30
*200.83	104.17	126.50	145.50	159.83	174.08	185.50	196.83	210.83	213.67	221.00	232.67	239.50

F-female
M-male
*initial weight

Table 27. Record of individual liveweights and feed consumption, in grams, of guinea pigs at high level of protein (23%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"Z"												
M 40.2	320.8	336.5	357.5	389.0	420.0	461.3	430.2	416.1	404.4	376.1	380.8	398.0
*290.2	123.0	150.0	154.0	159.0	175.0	195.0	157.0	110.0	100.0	71.0	114.0	145.0
F 42.1	175.8	215.0	254.3	277.0	305.0	329.8	324.2	316.5	320.4	340.0	332.0	352.1
*196.6	78.0	84.0	102.0	113.0	110.0	118.0	88.0	50.0	67.0	80.0	78.0	102.0
TOTALS	496.6	551.5	611.8	666.0	725.0	791.1	754.4	732.6	724.8	716.1	712.8	750.1
*486.8	201.0	234.0	256.0	272.0	285.0	313.0	245.0	160.0	167.0	151.0	192.0	247.0
MEAN	248.30	275.75	305.90	333.00	362.50	395.55	377.20	366.30	362.40	358.05	356.40	375.05
*243.4	100.50	117.00	128.00	136.00	142.50	156.50	122.50	80.00	83.50	75.50	96.00	123.50

F-female
M-male
*initial weight

Table 28. Record of individual liveweights and feed consumption, in grams, of guinea pigs at low level of protein (14%) from 1st week thru 12th week of the experiment.

Animal	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
"Z"												
M 40.1	260.8	289.0	320.0	344.5	395.5	436.7	450.0	469.8	451.4	458.4	469.0	498.8
*231.7	80.0	121.0	126.0	130.0	154.0	161.0	169.0	175.0	130.0	140.0	150.0	160.0
F 42.2	234.5	281.8	326.0	356.9	383.2	414.7	431.2	442.0	475.0	501.2	507.0	520.5
*227.2	84.0	105.0	115.0	150.0	150.0	150.0	155.0	152.0	140.0	160.0	152.0	170.0
TOTALS	495.3	570.8	646.0	701.4	778.7	851.4	881.2	911.8	926.4	959.6	976.0	1019.3
*458.9	164.0	226.0	241.0	260.0	294.0	311.0	324.0	327.0	270.0	300.0	302.0	330.0
MEAN	247.65	285.40	323.00	350.70	389.35	425.70	440.60	455.90	463.20	479.80	488.00	509.65
*229.45	82.00	113.00	120.50	130.00	147.00	155.50	162.00	163.50	135.00	150.00	151.00	165.00

F-female
M-male
*initial weight

EFFECTS OF TWO PROTEIN LEVELS ON THE GROWTH PATTERN AND FEED EFFICIENCY OF GUINEA PIGS FROM DIFFERENT INBRED LINES

by

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There is a growing interest among nutritionists, working with inbred animals to understand their metabolism and their response to the various nutrients in a particular ration.

The objective of this study was to determine the effects of two protein levels on the growth pattern and feed efficiency of guinea pigs from various highly inbred lines.

The data were collected from 182 weanling guinea pigs from 12 inbred lines. These animals were on test for 84 days and were pair-fed. Determination of the differences in total and weekly feed consumption, total and weekly gain, total and four-week interval feed efficiencies were made by using the analysis of variance (Snedecor 1959).

There were highly significant ($P < .01$) differences in total feed consumption and total gain due to ration, line and sex. The pigs on the low protein diet consumed more feed (1878g) and gained faster (358g) than those on the high protein ration (consumed: 1773 g and gained: 273g). The males consumed more feed (1839g) and gained more (336g) than the females (1681g and 289g). Some lines ate more and gained faster than others. The average for total feed consumption ranked from the highest to the lowest were as follows: Y2007g, S1993g, A1862g, G1848g, T1828g, B1822g, D1798g, I1751g, R1729g, X1625g, U1559g, Z1518g and the average for total gain Y 374g, B 361g, A 348g, G 338g, I 337g, S326g, X 312g, T 308g, U 291g, R 263g, D 261g, Z 206g. All first and second order interactions involving total feed consumption were highly significant, but the only highly significant difference in total gains was that due to line x ration x sex interaction.

The total gain line x sex interaction was statistically significant ($P < .05$).

Highly significant or significant differences in weekly feed consumption due to ration, line and sex were obtained during all weeks. The line x ration interaction for feed consumption was found to be non-significant during all weeks except the 5th ($P < .05$). There were also highly significant line x sex, and ration x sex interactions in feed consumption during the 11th week. Highly significant line x ration x sex interactions were present during all weeks except the 7th week when the interaction was only significant ($P < .05$).

Highly significant or significant differences in weekly gains due to line, ration or sex were obtained during most of the weeks. No significant difference was found in weekly gain due to line x ration interaction during any of the weeks except the 9th ($P < .05$). The line x sex interaction involving weekly gain was significant during the 7th and highly significant during the 9th week. A highly significant line x ration x sex interaction was obtained during all weeks.

There was a highly significant difference in feed efficiency during the 12 week trial due to ration and line but no significant difference due to sex was obtained. The low protein ration was shown to result in a slightly higher feed efficiency than the high protein ration. The average feed efficiency was 0.17 for the high and 0.19 for the low protein ration. The only highly significant second order interaction for total feed efficiency was line x ration x sex.

The difference between rations was significant during the first four weeks. The low protein diet with a feed efficiency index of 0.26 was superior to the high protein ration (0.22). The males had a higher feed efficiency index (.26) than the females (0.21).

During the 5th through the 8th week, there was a highly significant variation in feed efficiency due to ration, line, sex, and line x ration x sex interaction. The low protein had a better feed efficiency index (0.15) than the high protein ration (0.12) and the males (0.14) had a higher feed efficiency than the females (0.12).

For feed efficiency during the 9th through the 12th week, the results showed no significant differences due to lines, rations, sex or first order interaction, however the line x ration x sex interaction was significant.