# Comparative Studies on Egg Production With Vegetable and Animal Protein Supplementation by Paddle Reversal Method

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# Studies on the Effect of Tetracycline Egg Formula (Pfizer) on Egg Production During Period of Stress

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November, 1964

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**Thesis**

**Submitted to the Faculty of Veterinary Science and Animal Husbandry, Magadh University, in partial fulfilment of the requirements for the Degree of Master of Science (Animal Husbandry)**

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I certify that this Thesis has been prepared under my supervision by Sri N.K.Prasad, a candidate for the degree of M.Sc.(A.H.) with Animal Nutrition as major subject, and that it incorporates the results of his independent study.

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# P A R T - I

# COMPARATIVE STUDIES ON EGG PRODUCTION WITH VEGETABLE AND ANIMAL PROTEIN SUPPLEMENTATION BY DOUBLE REVERSAL METHOD

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# C H A P T E R - I

## INTRODUCTION

The old adage "half the breeding goes down the throat" has merit. The poultry plays a very important part in converting grains and other products into eggs and poultry meat for the nutritional benefit of mankind. Providing consumers with food products of superior quality as economically as possible and at reasonable cost is the chief responsibility of poultry husbandry men.

Lepkovsky (1942) has paid a high tribute to the hen and her ability to concentrate such an abundance of important nutrients in the egg. The biological value of the egg is probably far greater than represented since it would be wrong to claim that all the valuable nutrients of the egg have been considered. Essentially, the process represents the subjection of a good diet to treatment whereby the chicken extracts the most valuable constituents out of the feed and packs it into the egg.

Practically all the carbohydrates of the chicken feed are lost in the process of conversion to egg. There is a gain in fat, an egg containing more fat of high biological value than the feed. There is a 28 per cent recovery of protein,

but the protein is of much higher biological value than the protein of the feed, the hen having concentrated those amino acids in the egg protein. There has, in fact, been a gain of protein of superior biological value; according to Mitchell as shown in the table below:

Table 1

Table showing biological value of proteins of human foods

| Food | Biological value of protein | Food | Biological value of protein |
|---|---|---|---|
| Whole egg | 94 | Whole wheat | 67 |
| Milk | 85 | Potato | 67 |
| Egg white | 83 | Rolled oats | 65 |
| Beef liver | 77 | Whole corn | 60 |
| Beef heart | 74 | Wheat flour | 52 |
| Beef round | 69 | Navy beans(cooked) | 38 |

Data from H.H.Mitchell, The protein values of foods in nutrition, J.Home Econ., 19: 122-131, 1927., as quoted by Maynard.

The protein feed stuffs are the most costly group of feed stuffs used in the poultry rations. They generally constitute from 10 to 30 per cent of the ration. Protein feed stuffs are derived from both plant and animal sources. Care is needed in the selection of protein feed stuffs for poultry rations in order to secure a sufficient quantity of the essential amino acids for growth and egg production.

Proteins are essential to all plant and animal life as components of the active protoplasm of each living cell and its nucleus. In plants the protein is largely concentrated in the actively growing portions, such as leaves, and the reproductive portions, such as the seeds. Plants have the ability to synthesise their own proteins from relatively simple compounds such as carbon dioxide, water, nitrates and sulphates as well as atmospheric nitrogen. Plants, therefore, are the original sources of the proteins.

In animals, protein displays a much greater diversity of function than in plants. For example, protein is a primary constituent of many structural and protective tissue, such as bones, ligaments, hair, nails and skin, as well as of the soft tissues which include the organs and muscles. Animals lack the ability of the plant to synthesise proteins from simple materials and must depend upon plants or other animals as a source of dietary protein. Animals have,however, a remarkable ability to convert dietary proteins into many different and specialised animal proteins.

Since proteins are being continually used by the animal, either to build new tissues, as in growth and reproduction, or to repair worn tissues, a fairly regular intake of proteins is required. If adequate proteins are lacking in the diet, there is a quick reduction or cessation of growth or a loss of weight and, ultimately, a withdrawal of protein from certain less vital tissues to maintain the function of the more vital tissues as long as possible.

Patton (1946) states that the best protein for a given type of production is one which matches the amino acid requirements exactly. That is why milk should be a good diet for a lactating cow, and eggs a good diet for egg production.

The amino acid requirements of the chick are probably known more completely than those of any other domestic animal. A comparison of the chick requirements with the known supply of amino acids in the feed stuff protein shows that only glycine, arginine, lysine, methionine, cystine and tryptophan need particular attention in practical rations for the chick. All the other amino acids may either be readily synthesised, or are present in sufficient quantities so that a deficiency is quite unlikely.

The approximate percentage of essential amino acids required by the starting chicks and laying hens have been determined and is shown in table 2.

Table 2

Table showing the requirements of essential amino acids for starting chicks and laying hens

| Essential amino acid requirements | Starting chicks (% of ration) | Laying hens (% of ration) |
|---|---|---|
| Arginine | 1.7 | - |
| Glycine | 1.0 | - |
| Histidine | 0.15 | - |
| Isoleucine | 0.6 | 0.5 |
| Leucine | 1.4 | 1.0 |
| Lysine | 1.0 | 0.5 |
| Methionine | 0.7 | 0.53 |
| or | | |
| Methionine plus | 0.33 | 0.28 |
| Cystine | 0.35 | 0.25 |
| Phenylalanine | 1.6 | - |
| or | | |
| Phenylalanine plus | 0.9 | - |
| Tyrosine | 0.7 | - |
| Threonine | 0.6 | - |
| Tryptophan | 0.15 | 0.15 |
| Valine | 0.8 | - |

Data from Morrison's Feeds and Feeding,1957.

So far as laying hen is concerned, only preliminary work has been done. The hen seems to be satisfied with a greater percentage of cereal protein in her diet. An actively laying hen is conducting an extensive synthesis of high

quality proteins which she deposits in the egg,and her amino acid requirements are,therefore, more extensive than those for mere maintenance of her own tissues. The amino acid composition of the proteins of the egg is not greatly different from the composition of the meat which the broiler or fryer produces. There are perhaps three differences in these poultry products.

The first is that egg protein contains quite distinctively more of the sulphur amino acids,methionine and cystine. This would seem to indicate that for optimal production the hen needs a generous supply of methionine and cystine. The egg protein contains definitely less lysine than muscle protein, and it is probable that the hen can make better use than the chick of proteins such as the cereals and many oil-seed proteins which are marginal in lysine content.

In poultry rations it is fully as important to have protein of good quality as it is to have a sufficient amount of protein.

Table 3 gives the amino acid contents of a normal egg which will necessarily be the minimum daily requirements (Munks, Robinson,Beach and Williams, 1945).

Table 3

Table showing the average amino acids composition of one egg

| Amino acids | Quantity in mg. |
|---|---|
| Arginine | 352 |
| Histidine | 111 |
| Lysine | 283 |
| Tryptophan | 78 |
| Threonine | 216 |
| Phenylalanine | 315 |
| Methionine | 286 |
| Tyrosine | 260 |
| Cystine | 132 |

It is evident that for very good egg production considerable quantities of high quality protein must be provided for the laying hen. The usual practice is to feed a diet containing 15 to 20 per cent of high quality protein, of which not less than 20 per cent comes from such animal sources as liquid skim milk,liquid butter milk,dried skim milk, dried butter milk, meat scrap or fish meal. The reputed superiority of animal over vegetable proteins has been emphasised for many years. Kempster (1924) reported that when the protein supplement supplied to laying hens was linseed meal, gluten meal or cottonseed meal, the rate of egg production was much lower than when the protein supplement was meat scrap

or butter milk.

For a number of years, scientists have known that certain unidentified growth factors were contained in such animal proteins as liver meal,condensed fish solubles,fish meal, meat scrap and milk by-products. This same unidentified factor was conspicuously absent in vegetable proteins. This unknown constituent was referred as animal protein factor.

Bird (1949) found that this unknown factor was, in reality a member of the vitamin B complex, namely vitamin $B_{12}$. Vitamin $B_{12}$ and the animal protein factor are not considered one and the same. Rather $B_{12}$ is a part, though a major part, of the animal protein factor. There is evidence that at least two different vitamins are included in the constituent referred as animal protein factor and there may be even more.

The name, animal protein factor is confusing because it suggests something of protein nature but actually this is not the case. When we speak of animal protein factors we are speaking of vitamins.

The animal protein factor has great practical application in poultry nutrition. It is needed by baby chicks for survival and early growth, by hens for the production of hatchable eggs.

Several reports appeared between 1937 and 1944, which indicated that fish meal was probably the best practical feeding stuff to use in combination with all vegetable diets in order to obtain good chick growth( Christiansen, Deobold, Halpin and Hart,1940; Carver and Evans,1943; Hammond and Titus,1944).

As far as layers are concerned it was observed by Savage, Turner, Kempster and Hogan (1952) that when hens are depleted of vitamin $B_{12}$ by giving them an all plant laying ration, increase in rate of egg production was not obtained by adding vitamin $B_{12}$ to the diet. There was, however, a considerable increase in the hatchability of fertile eggs. There is, however, a considerable body of evidence which shows that rate of egg production declines when the intake of vitamin $B_{12}$ by hens is severely restricted. The minimum requirements of vitamin $B_{12}$ of laying hens in cages is about 2.0 mcg. per pound of feed. When hens are on built up litter the requirement is not more than 0.75 mcg. per found of feed (Petersen, Wiese, Milne and Lampman, 1953).

It may be concluded that the animal protein factor alone is sufficient supplement for an otherwise adequate, all plant protein diet. Where the plant protein is of poor nutritive value, particularly deficient in such amino acids as methionine and cystine supplementation with animal protein as well as the animal protein factor is desirable.

The recent view has been that animal protein supplement is not necessary in the diet for laying hens (Carpenter, Duckworth and Ellinger, 1954; Davidson and Boyne, 1962). It has been made clear by the works of Carpenter(1954) that the difference in egg production on rations having protein supplement from white-fish meal and ground nut meal can only be observed when the ration has a critical crude protein

content of 11 per cent. It has been pointed out in the works done by Carpenter et al.(1954) that provided there is an excess of crude protein, all vegetable ration can allow as good egg production as conventional ration containing animal protein supplements.

With the knowledge of the amino acids requirement for egg production and as knowledge of the amino acid composition of various inexpensive sources of vegetable proteins becomes available it will be possible to substitute proteins in poultry rations and ensure the most economical feeding of required amino acids for the highest egg production.

It will not be out of way to mention the nutrient requirements of chickens before proceeding to the actual experiments.

The present problem deals with the study of the effect of a good all vegetable ration and a ration containing animal protein in addition on laying hens.

Effort has also been made to study the effect of double reversal method on subsequent egg production.

Table 4

Table showing the nutrient requirements of chickens

| Nutrients | Starting chickens | Growing chickens | Laying hens | Breeding hens |
|---|---|---|---|---|
| Total protein (%) | 20 | 16 | 15 | 15 |
| Vitamins: | | | | |
| Vitamin A activity (U.S.P.units) | 1200 | 1200 | 2000 | 2000 |
| Vitamin $D_3$ (I.C.U.) | 90 | 90 | 225 | 225 |
| Thiamine (mg.) | 0.8 | ? | ? | ? |
| Riboflavin (mg.) | 1.3 | 0.8 | 1.0 | 1.7 |
| Pantothenic acid (mg.) | 4.2 | 4.2 | 2.1 | 4.2 |
| Niacin (mg.) | 12.0 | ? | ? | ? |
| Pyridoxin (mg.) | 1.3 | ? | 1.3 | 1.3 |
| Biotin (mg.) | 0.04 | ? | ? | ? |
| Cholin (mg.) | 600.0 | ? | ? | ? |
| Folacin (mg.) | 0.25 | ? | 0.11 | 0.16 |
| Minerals: | | | | |
| Calcium (%) | 1.0 | 1.0 | 2.25 | 2.25 |
| Phosphorus (%) | 0.6 | 0.6 | 0.6 | 0.6 |
| Salt (%) | 0.25-0.50 | 0.25-0.50 | 0.50 | 0.50 |
| Potassium (%) | 0.2 | 0.16 | ? | ? |
| Manganese (mg.) | 25 | ? | ? | 15 |
| Iodine (mg.) | 0.5 | 0.2 | 0.2 | 0. 5 |
| Magnesium (mg.) | 220 | ? | ? | ? |

Data from Morrison's Feeds and Feeding, 1957.

# CHAPTER - II

## REVIEW OF LITERATURES

Nature has imposed a peculiar limitation on the ability of the body to manufacture its own supply of amino acids. It can produce some, but for others it is entirely dependent upon the proteins in the food. Each one of the large number of different kinds of proteins which enter into the composition of tissue cells requires for its construction a different but very definite assortment of amino acids. If only one of the amino acids required for the synthesis of a given protein is lacking, that particular protein can not be formed no matter how great a surplus there may be of the other amino acids.

### ROLE OF DIFFERENT PROTEINS AND VITAMIN $B_{12}$ ON GROWTH AND LAYING:

Macrander (1935) observed that extracted soyabean meal gave better weight increases and higher egg yield than earthnut cake meal, and a mixture of the two was better than either alone. It was claimed that this mixture gives satisfactory results as sole protein supplements for laying hens and even in large amounts has no harmful effect on health or egg production.

Fangauf and Bruninghaus (1936) studied the effect

of animal and vegetable protein on laying on six groups of laying hens. Some of the groups received rations containing very large proportions (up to 50%) of oil cake as sole protein source while others received rations containing 25 per cent fish meal but no oil cake. The groups did not differ in regard to the amount of food consumed but egg production was greatest in those receiving fish meal.

Ackerson, Blish and Mussehl (1937) fed the same basal mixture to two groups of 15 chicks, in which one group received protein of animal origin while the other received of vegetable origin. Food consumption was kept at the same level for each group. The rate of gain was greater in the group receiving animal protein. After a period of 60 days all birds were slaughtered and determinations were made of the total N, Ca & P. 15 per cent more of the ingested protein was retained by the group receiving the animal protein than by the other. The retention of Ca & P on the other hand were greater in the vegetable protein group. The Ca & P content of the two rations were not adjusted to the same level.

King and Coltier (1937) found peanut meal (a by-product higher in protein and lower in fat and fibre than peanuts) to be a very satisfactory poultry food especially when combined with milk. Peanut with shells also gave good growth and egg yield except where used as the sole protein supplement. The poor results obtained with peanuts from which shells had been removed were attributed to their high fat content.

Sherwood and Couch (1940) tested the supplementary values of fish meal, meat and bone scraps, cottonseed meal, soyabean oil meal, peanut meal, liver meal and linseed meal on chicks. The protein content of all the rations were from 18 to 20 per cent. In all experiments fish meal at a 6 per cent level gave the best and most economical results when used as a supplement to any two of the other protein concentrates. Soyabean oil meal and cottonseed meal were about equal in value when fed with the other protein supplements used. Liver meal was inferior to fish meal when fed in a ration along with soyabean oil meal and cottonseed meal. Peanut meal was not a good substitute for cottonseed meal or soyabean oil meal. Rations containing 6 per cent fish meal and 5 per cent good alfalfa leaf meal were not improved by the addition of dried whey. Rations not containing fish meal were, however, improved by the addition of 1 per cent dried whey.

Temperton and Dudley (1941) observed that both palm kernel meal and decorticated earthnut meal were palatable to poultry. With the former as a substitute for wheat middlings and the latter replacing fish meal and dried skimmed milk, satisfactory egg production was maintained in batteries over a period of 9 months.

Macdonald (1942) obtained normal growth, low mortality and efficient food utilisation during 24 weeks of life when the birds were fed on a cereal ration supplemented

by green food, separated milk and Ca. A basal ration plus 20 per cent of earthnut meal and 1 per cent NaCl did not produce as good growth during the first 16 weeks as the same ration plus separated milk. From 16 weeks to 24 weeks the basal ration gave somewhat better growth when fed with 10 per-cent earthnut meal than when fed with separated milk. Over the whole experimental period the basal ration plus separated milk was more satisfactory than the basal ration plus earthnut meal, even through the percentage of protein was lower at all stages than the accepted standards. It was concluded that if separated milk or other milk products are not available, earthnut meal and salt will form a useful substitute.

Carver and Evans (1943) compared 20 diets having a standard 20 per cent protein content. A protein concentrate composed of 80 per cent of soyabean oil meal and 20 per cent of herring fish meal was the most efficient ration. Cottonseed oil meal as sole supplementary protein gave poor growth, but could be used up to 35 per cent with combinations of herring, soyabean and pea meals.

Macdonald and Bose (1943) observed that a cereal ration containing 10.4 per cent of protein supplemented with 1 per cent of NaCl and limestone together with liberal amount of fresh green food proved unsatisfactory for egg production. Meat offal was almost equal to separated milk as a protein supplement, but soyabean meal and earthnut meal were of little

value. They also observed that high temperatures had a depressing influence on egg size.

Macdonald (1943) observed that the addition of NaCl to cereal rations improved growth and lowered mortality. A cereal ration containing 10.5 per cent protein and supplemented with NaCl and green food gave poor growth specially during the first 8 weeks. The inclusion of soyabean meal or earthnut meal to give a level of 17 per cent protein gave increased growth, both being of equal value as protein supplements. It was concluded that although they are less satisfactory than separated milk or meat offal they could be used with fair success when animal protein supplements were expensive or unobtainable.

Ott (1944) obtained satisfactory growth in young chicks on a ration devoid of animal protein and of the following composition:

| | | |
|---|---|---|
| Yellow maize meal | - | 27 parts |
| Soyabean meal | - | 25 parts |
| Wheat bran | - | 15 parts |
| Ground oats | - | 10 parts |
| Alfalfa meal | - | 5 parts |
| Calcium carbonate | - | 1.75 parts |
| Bone ash | - | 0.75 parts |
| Sodium chloride | - | 0.5 parts |
| Fish liver oil | - | 0.25 parts |
| Manganese sulphate | - | 0.01 parts |
| Riboflavin | - | 0.0003 parts |

Grau (1946) observed the effects of adding various amino acids on the growth rate and efficiency of gain in rations containing 20 per cent protein derived solely from maize gluten meal, cottonseed meal or peanut meal.

The nutritive value of maize gluten meal was improved by the addition of arginine, lysine and tryptophan as was shown by an increase in growth rate from 2 per cent to nearly 6 per cent per day. The addition of cystine,glycine, methionine, threonine and valine yielded no significant benefit and these amino acids were deemed to be already present in adequate amounts.

Supplementation of cottonseed meal with both methionine and lysine increased the growth rate from 4 to 7 per cent. The methionine deficiency was found to be less marked than that of lysine a result which was expected from the amino acid content of the cottonseed protein.

Peanut meal proved to be lacking primarily in methionine and to a limited extent in lysine.

Ingram, Gravens, Elvehjem and Halpin (1951) designed a laying ration to be deficient in methionine was made up from extracted groundnut meal 36.6, DL-tryptophan 0.2, DL lysine 0.84, salts 5, soyabean oil 3 and fish oil 2, choline chloride 0.2, vitamins including vitamin $B_{12}$ and dextrin to 100. Egg production of four hens on this ration for 8 weeks was 34 per cent. Further groups on the same ration supplemented with 0.16, 0.32 and 0.48 per cent of DL-methionine

had productions during the same period of 63,59 and 64 per cent respectively. It was concluded that lowest level of supplementation was satisfactory. The values for the cystine and methionine contents of basal ration found by microbiological estimation were 0.26 and 0.22 per cent respectively.

Carpenter, Duckworth and Ellinger (1954) observed equal egg production in birds given all vegetable rations during the laying period or from hatching to 18 months of age to that of birds receiving rations containing animal protein. Early growth was somewhat retarded by the absence of animal protein and was accelerated by aureomycin supplements, but neither the final weight of the pullets nor their egg production was thereby affected. The limited amount of fresh droppings available to hens kept on wooden floors which were cleaned daily provided enough of the animal protein factor to supply their requirements for sustained egg production. When the ration contained 8 per cent of cereal protein, supplemented with 3 per cent groundnut meal or white-fish meal,groundnut meal proved significantly inferior to fish meal; when the amounts were larger the supplements were of equal value. A ration containing 11 per cent protein, 3 per cent of which was provided by white-fish meal proved adequate for good egg production if the birds were kept in laying pens but appeared to be less adequate for birds kept in straw yards.

Gordon, Chubb and Stacey (1954) reared 500 cross bred chicks intensively on saw dust litter which was changed weekly.

The chicks received a standard ration consisting of oats, wheat and wheat middlings, maize and maize gluten feed, grass meal, white-fish meal, dried yeast, minerals, vitamin D and riboflavin, with or without vitamin $B_{12}$ or penicillin or both or the standard ration was modified by replacing the fish meal wholly or partly by groundnut meal, with or without the addition of a supplement of vitamin $B_{12}$. After 16 seeks the dried milk was omitted from the rations.

They observed that on a solely vegetable diet, fewer eggs were produced than on a diet containing animal protein and a supplement of vitamin $B_{12}$ conferred no advantage. Addition of vitamin $B_{12}$ and penicillin to the standard ration did not increase production.

Shaw and Nightall (1955) compared rations with no protein supplement, rations with a supplement of bean meal and normal rations with fish meals on growing chickens and laying pullets. The growth rate was best on fish meal ration and the birds began to lay 2 to 3 weeks earlier. Egg production was also best on this ration, but it was satisfactory on all the rations. The extra production of the birds getting animal protein offset the extra cost of the ingredients. In all respects the groups getting bean meal was least satisfactory.

Finally, trials were made with laying pullets in batteries receiving rations with or without 7 per cent fish meal. In all three trials egg production was much better when the fish meal was given and profits were greater. In two of the

trials the groups without fish meal produced satisfactory number of egg; in the other trial it became obvious after 14 weeks that the birds were doing badly and 3.5 per cent fish meal was added to the ration. Thereafter they produced almost as many eggs as the birds in the fish meal group.

Carpenter and Clegg (1957) kept 56 pullets in individual metabolism cages and fed them cereals consisting of maize,oats and barley and a mixture of all 3 and the protein concentrates were groundnut meal and white-fish meal. The 8 rations given in 7 complete replications provided daily 12 g. crude protein, 6.75 g. from the cereal or the mixture, 3.75 g. from the concentrate and 1.5 g. from dried yeast and maize starch was added to provide 300 Cal. metabolisable energy.

The mean for percentage N retained with groundnut meal and with the cereals or the mixture in the above order, were 42.9, 43.8, 39.4 and 43.5; corresponding values with fish meal were 51.4, 50.7, 47.7 and 52.1. The retention from barley was significantly less than from the other cereals or from the mixture; with fish meal as concentrate it was consistently greater than with the groundnut meal.

Rhys, Culpin, Forsyth and Westmacott (1957) conducted trials with laying hens kept in batteries, on deep litter,in colony houses or in folds on pasture. In each system 4 rations were used. The imported ration contained maize meal and wheat offals, replaced in the home grown ration by barley meal, oat meal and wheat meal. Both had fish meal 11 per cent, as

main source of protein. Home grown meals with the fish meal reduced to 4 per cent, or entirely replaced by pea and groundnut meal were the basis of the other rations. All rations were similar in content of crude protein, crude fibre and starch equivalent. Birds were given roughly equal quantities of meal and scratch grains.

There was no significant difference in egg production within systems between the imported and home grown rations with 11 per cent fish meal.

When the 3 home grown rations were compared there was no difference in egg production due to rations when the birds had access to pasture, in folds or in colony houses. The rations with only vegetable protein always gave fewer eggs in batteries. Weight of eggs and efficiency of feed utilisation for egg production showed the same trend as egg production. Final live weights of the birds in batteries given the vegetable protein were less than those of all others, continuing the inadequacy of this ration in batteries.

Swart (1958) conducted a growth trial in chickens from day old to 5 weeks in which the fish soluble concentrate used had 63 per cent protein. The ration contained vitamin $B_{12}$ 900 and Riboflavin 25,000 mcg. per kg. There were 4 groups of chickens; the protein level of all rations was about 20 per cent. The main source of protein for the control was 15 per cent of white-fish meal. One experimental group had 3 per cent fish solubles replacing the same amount of fish meal;for the other

groups protein was supplied by groundnut meals 22 or lupinseed meal 30 per cent and each had 4 per cent fish solubles. Final weights of birds in the groups in the order given above was 382, 395, 366, 370 g.

In another experiment weight at 6 weeks of chickens given an all vegetable ration with protein supplied by lupinseed meal was 255 g. When 5 per cent fish solubles concentrate replaced part of the lupinseed meal the final weight was 416 g.

Fangauf, Vogt and Barlowen (1958) gave rations to day old New Hampshire chicks for 8 weeks consisting of 76 per cent cereal, 6 per cent cod meal, 2 per cent dried yeast, 1 per cent mineral mixture and soyabean meal at 15-10-5-0 per cent level with groundnut cake at 0-5-10-15 per cent level respectively. Vitamin A, $D_3$ and Riboflavin were also given. They observed that groundnut cake at all 3 levels increased weight gain and feed consumption and at the 15 per cent level reduced nutrient requirements.

Douglas and Harms (1959) reared day old chickens to 8 weeks of age having equal numbers of males and females on a fortified maize and soyabean oil meal ration containing 28.1 per cent soyabean meal or on this ration with 25,50,75 per cent or all the soyabean meal replaced by groundnut oil meal. The rations were similar in protein and energy.

The results of the 3 experiments showed that when 50 per cent groundnut meal replaced a similar amount of soyabean

meal growth rate was restricted and the restriction increased as the level of groundnut meal rose. The efficiency of feed utilisation also was adversely affected. In all experiments there was evidence that the decrease of rate of gain with level of substitution was much less in females than in males, so that females are more tolerant to groundnut meal. Adding 0.25 per cent lysine to the ration in which groundnut meal completely replaced soyabean meal significantly improved rate of growth, but adding methionine also had little additional effect, so that lysine was the chief limiting amino acid. When they added lysine, methionine and glycine to a ration containing half the proteins from each source they found the growth equal to that obtained with a ration with soya meal only. When all soya meal was replaced by groundnut meal adding the 3 amino acids gave body weights equal to those obtained from a ration containing equal amounts of the 2 proteins, but less than those obtained from a ration with soyabean only.

Maslieva (1959) made a study with 7 groups each of 300 chickens reared from hatching to 2 months of age in cages and thereafter in colony houses. All the diets were similar in energy value and 13.5 per cent digestible protein. In some groups all the proteins were from plant origin viz; from cereals, linseed and soyabean meals and in others fish meal also was included for comparison with the effects of biomycin (aureomycin) or vitamin $B_{12}$ or both. One plant protein ration contained 1 g. choline chloride per kg. dry meal. Up to 2 months

the chickens of all group had 5 to 10 g. milk per head daily.

He observed that with a plant protein ration neither biomycin nor vitamin $B_{12}$ alone improved growth up to 6 weeks of age but together they were almost as good as the animal protein supplement and with the animal protein the growth was best. The chickens given choline did not differ from the controls given no supplement.

From 2 months of age only 3 groups of pullets were kept in the experiment; they were a control group with animal and plant proteins, one with plant protein and both biomycin and vitamin $B_{12}$ and one given animal protein as well as the supplements. The mean weight of the pullets at 5 months of age were 1665, 1743 and 1866 g. respectively. Thus the supplements made the plant protein diet as that with animal protein.

Lansbury (1961) fed diets of maize and palm kernel meal supplemented with groundnut meal 30 per cent,groundnut and soyabean meals each 30 per cent or groundnut meal and white-fish meal each 10 per cent to triplicate groups of Brown Leghorn x Light Sussex pullets for a period of 72 weeks. Both the all vegetable diets were thought to be deficient in cystine and methionine and that with 30 per cent groundnut meal deficient in lysine also.

He observed that birds on both all vegetable ration had a transitory check in growth at the beginning of the trial but this did not affect subsequent egg production. Birds of all groups produced equivalent number of eggs during 365 days.

Lansbury (1962) conducted another trial from day old chicks to 20 weeks of age in 3 groups. They were given an orthodox diet to 8 weeks, then the all vegetable diet. He observed that the weight of the birds at 14 weeks of age on the all vegetable diet was 64 per cent of that of those given the orthodox diet. But by the end of the trial there was little difference between the groups. Between 8 and 12 weeks when the birds changed from one diet to the other suffered a small check in growth, possibly because they found the all vegetable diet less palatable.

He also studied the egg production of 10 birds from each group for a period of one year. He found that there was no difference between groups. He concluded that expensive animal protein should be reserved for starting and breeding feeds.

Davidson and Boyne (1962) with the object of providing further information on the relative values of white-fish meal and groundnut meal as supplements to laying diets carried out a series of experiments with White Leghorn x Rhode Island Red hens housed intensively in battery cages for a period of 26 weeks and recorded their egg production and voluntary feed intake.

The diets which were based on a common cereal mixture, contained supplements of groundnut meal, white-fish meal or groundnut meal plus DL methionine or L- lysine or both. The protein concentrates under test provided 2.5 per cent protein

and the rest of the diet,including the cereal mixture with starch, minerals, and vitamins provided about 7.5 per cent protein in each diet.

A supplement of white-fish meal in the diet supported production of about 20 per cent more eggs than a supplement of the poorer groundnut meal. Egg production on this poorer diet was not improved by the addition of 0.1 per cent L-lysine, but was improved by about 10 per cent when 0.1 per cent DL - methionine was added and by about 20 per cent when both were added, the value of the groundnut meal being thus brought up to that of the white-fish meal.

They came up with the view that white-fish meal is not necessarily superior when added to diets for egg production.

Pingel (1964) fed a diet calculated to have methionine 0.15, crude protein 17.3 per cent and 1930 Kcal productive energy per kg. to two groups of 32 New Hampshire laying hens for a period of 180 days. The protein were of both plant and animal origin and 0.15 per cent DL-methionine was added to the diet. It was observed that egg production and feed conversion were better with the extra methionine, but not significant.

# C H A P T E R - III

## MATERIALS AND METHODS

The birds under experiment belonged to the Central Poultry Farm, Patna and they were of Rhode Island Red breed of the same hatch. They were maintained in the battery cages situated in the premises of the Bihar Veterinary College, Patna. The battery cages are of one tier and have accommodation for 48 x 4 birds. They are maintained in two units and have a common water trough in each with mash hoppers for every 8 birds in one unit. The experimental birds were maintained in the western row of the cages.

### SELECTION OF BIRDS FOR EXPERIMENT:

The main object of the selection of the birds was to obtain two groups of birds having very similar average flock production.

A preliminary selection of the birds were made on phenotypic basis and then they were kept in battery cages. They were given the standard mash mixture obtained from the farm, and their egg production was observed for a period of 16 days. The egg production of birds during the period of 16 days is given in table 5.

Table 5

Table showing egg production of birds during 16 days period

| Bird No. | Egg production | Bird No. | Egg production |
|---|---|---|---|
| 1 | 8 | 25 | 13 |
| 2 | 12 | 26 | 13 |
| 3 | 14 | 27 | 13 |
| 4 | 11 | 28 | 11 |
| 5 | 13 | 29 | 13 |
| 6 | 10 | 30 | 9 |
| 7 | 13 | 31 | 12 |
| 8 | 14 | 32 | 10 |
| 9 | 15 | 33 | 12 |
| 10 | 11 | 34 | 14 |
| 11 | 13 | 35 | 11 |
| 12 | 13 | 36 | 11 |
| 13 | 14 | 37 | 12 |
| 14 | 5 | 38 | 9 |
| 15 | 11 | 39 | 11 |
| 16 | 4 | 40 | 10 |
| *17 | 0 | 41 | 13 |
| 18 | 12 | 42 | 8 |
| 19 | 8 | 43 | 12 |
| *20 | 0 | 44 | 14 |
| 21 | 10 | 45 | 14 |
| 22 | 3 | 46 | 12 |
| 23 | 8 | 47 | 15 |
| 24 | 10 | 48 | 12 |

* Birds number 17 and 20 were replaced on phenotypic basis as they did not lay during this period.

The birds with same production were distributed in two groups and their egg production was again observed for a period of 25 days i.e. from 2.3.64 to 26.3.64 to observe the similarity of egg production in the two groups before the commencement of the experiment and to replace those birds if off lay. The egg production of the two groups of birds for a period of 25 days following this grouping is given in the table below:

Table 6

Table showing the egg production of birds after grouping

| Date | Group I | Group II |
|---|---|---|
| 2.3.'64 | 17 | 12 |
| 3.3. 64 | 11 | 11 |
| 4.3. 64 | 16 | 14 |
| 5.3. 64 | 14 | 14 |
| 6.3. 64 | 16 | 12 |
| 7.3. 64 | 19 | 19 |
| 8.3. 64 | 19 | 15 |
| 9.3. 64 | 13 | 10 |
| 10.3.64 | 16 | 19 |
| 11.3.64 | 17 | 16 |
| 12.3.64 | 15 | 15 |
| 13.3.64 | 13 | 14 |
| 14.3.64 | 14 | 11 |
| 15.3.64 | 15 | 13 |
| 16.3.64 | 11 | 14 |
| 17.3.64 | 11 | 11 |
| 18.3.64 | 17 | 11 |
| 19.3.64 | 11 | 12 |
| 20.3.64 | 13 | 14 |
| 21.3.64 | 18 | 12 |
| 22.3.64 | 11 | 13 |
| 23.3.64 | 12 | 13 |
| 24.3.64 | 16 | 15 |
| 25.3.64 | 11 | 14 |
| 26.3.64 | 13 | 12 |
| TOTAL | 369 | 336 |

The body weights of the birds were taken at the beginning of the experiment, then again in the middle prior to reversal and finally at the end of the experiment. The result is shown in table 18.

FEEDS AND THEIR PREPARATION:

The mash mixture used at the Central Poultry Farm, Patna was obtained and its crude protein content was determined. About 100 gm. of the samples were pooled up from different places of the heap of the mash and were mixed thoroughly and dried in oven at 100°C for removal of moisture. The analysis of the crude protein was done by the Kjeldahl's method as in A.O.A.C. methods. Then the crude protein content of fish meal and groundnut cake were separately analysed observing the same procedure in collecting the sample as in mash mixture and the average crude protein content of fish meal and groundnut cake was 62.0 and 44.6 per cent respectively. Then a ration was prepared in which the protein supplement was only from vegetable sources (fish meal was completely omitted) and the crude protein content adjusted by calculation according to the standard mash mixture. The crude protein content of this ration (vegetable protein only) was again analysed and it was observed that the crude protein content of both the rations were almost equal and its composition is given in table 7.

Table 7

Table showing the composition and crude protein contents of the mash mixtures (with animal protein and vegetable protein, and with vegetable protein only)

| Ingredients | Animal protein and vegetable protein | Vegetable protein only |
|---|---|---|
| Crushed yellow maize | 44 parts | 44 parts |
| Wheat bran | 20 parts | 17 parts |
| Groundnut cake (C.P. 44.6%) | 20 parts | 28 parts |
| Fish meal(C.P.62.0%) | 5 parts | - |
| Limestone powder | 4 parts | 4 parts |
| Bone meal | 1 part | 1 part |
| Salt | 1 part | 1 part |
| TOTAL | 95 parts | 95 parts |
| Crude protein (per cent of ration) | 18.7 | 18.67 |

For the rest 5 parts of dried berseem of the ration, green berseem @ 1 oz. per bird per day used to be given. During the last two weeks of the experiment before reversal green berseem was not available and as such dried berseem was given @ 5 oz. for each group of 24 birds mixed with the mash prior to distribution in the hoppers.

Vitamin A, Riboflavin and $D_3$ which are commonly added in the mash for layers were not added in the mash mixture of the farm due to their non-availability and as such were not used in the experiment as well.

The feeding experiment started on 29.3.64 in which group I was fed the animal protein supplement ration and group II was fed the vegetable protein supplement ration.

The egg production of the individual birds was observed daily and the group egg weight was recorded. Feed consumption was recorded weekly. Efficiency of food conversion was calculated by comparing the amount of food consumed per dozen of eggs between the groups.

MANAGEMENT:

The following table gives the schedule of management observed during the experimental period:

Table 8

Table showing the daily schedule of management

| Items | Time | Remark |
|---|---|---|
| Mash | 6 a.m. | |
| Berseem | 9 a.m. | Not available during the reversal period |
| Mash | 3 p.m. | |
| Shell grit @ 1 oz. per bird | weekly | |
| Egg recording and egg weight recording | 4 p.m. | |
| Water | | Water trough was always kept full. |

Room temperature was recorded daily.

After a period of 8 weeks the ration was reversed i.e. the group getting the animal protein supplement ration was given the vegetable protein supplement ration and the group getting the vegetable protein supplement ration was given the animal protein supplement ration.

The daily schedule of management was as before and all the observations were made in a similar manner and the experiment lasted for another 8 weeks. Both the groups did not get green in any form through out the experimental period because of non-availability during summer months.

STATISTICAL ANALYSIS:

'F' test was done for comparison of egg production between the groups. This was done by Square Root transformation method as described by Snedecor (1961).

't' test was done to compare the efficiency of food conversion as described by Panse and Sukhatme (1961).

'F' test was done to test the significance of difference between the live body weight of the two groups.

# C H A P T E R - IV

## RESULTS AND DISCUSSION

### Composition of Ration:

This has been indicated in table 7 in the chapter on materials and methods. The crude protein content of the two mashes were 18.7 per cent approximately.

### FEED CONSUMPTION

Weekly feed consumption of the birds were recorded. It was done by substracting the amount of feed left in the hoppers from the amount of feed given in a week. It was observed that left overs in the hoppers usually consisted of a large part of bran indicating the preference of the birds for coarser ingredients in the feed. Accordingly the amount of feed given per week was increased to offer the birds to have more of coarser ingredients in the feed but this did not affect the feed consumption.

From statistical analysis it was observed that the difference in feed consumption between the groups was insignificant.

Table 9 and 10 shows the number of eggs produced and feed consumed per week in both the groups before and after reversal of the ration.

Table 9

Table showing the weekly egg production and feed consumption of birds in both the groups before reversal

| Weeks | No. of birds | Vegetable protein group | | No. of birds | Animal protein group | |
|---|---|---|---|---|---|---|
| | | No. of eggs produced | Feed consumed (lbs) | | No. of eggs produced | Feed consumed (lbs) |
| 1 | 24 | 62 | 25.3 | 24 | 74 | 29.3 |
| 2 | 24 | 44 | 25.8 | 24 | 82 | 24.8 |
| 3 | 23 | 48 | 26.7 | 23 | 45 | 25.8 |
| 4 | 23 | 59 | 25.2 | 23 | 61 | 29.0 |
| 5 | 23 | 52 | 18.4 | 23 | 61 | 18.4 |
| 6 | 23 | 34 | 23.25 | 23 | 36 | 25.2 |
| 7 | 21 | 41 | 25.6 | 22 | 53 | 31.4 |
| 8 | 21 | 31 | 19.3 | 22 | 44 | 24.0 |
| TOTAL | | 371 | 189.55 | | 456 | 207.9 |

Difference in egg production between the groups in 8 weeks = 85.

Difference in feed consumption between the groups in 8 weeks = 18.35 lbs.

Table 10

Table showing the weekly egg production and feed consumption of birds in both the groups after reversal

| Weeks | No. of birds | Animal protein group (original V.P. group) | | No. of birds | Vegetable protein group (original A.P. group) | |
|---|---|---|---|---|---|---|
| | | No. of eggs produced | Feed consumed (lbs) | | No. of eggs produced | Feed consumed (lbs) |
| 1 | 19 | 23 | 16.7 | 19 | 27 | 19.9 |
| 2 | 19 | 10 | 10.6 | 19 | 12 | 12.9 |
| 3 | 19 | 3 | 15.8 | 19 | 2 | 16.5 |
| 4 | 19 | 10 | 20.3 | 19 | 8 | 21.8 |
| 5 | 19 | 22 | 21.8 | 19 | 30 | 22.6 |
| 6 | 19 | 27 | 18.7 | 19 | 42 | 17.0 |
| 7 | 19 | 34 | 25.7 | 19 | 29 | 21.8 |
| 8 | 19 | 33 | 22.6 | 19 | 32 | 21.8 |
| TOTAL | | 162 | 152.2 | | 182 | 154.3 |

Difference in egg production between the groups in 8 weeks = 20.

Difference in feed consumption between the groups in 8 weeks = 2.1 lbs.

From table 9 and 10 it appears that the palatability of the vegetable protein supplement ration was almost equal to that of the animal protein supplement ration.

Weekly food consumption of the group varied from 18.4 lbs. (1.8 oz. per bird per day) to 26.7 lbs. (2.6 oz. per bird per day) in the group getting the vegetable protein supplement ration and 18.4 lbs. (1.8 oz. per bird per day) to 31.4 lbs. (3.3 oz. per bird per day) in the group getting the animal protein supplement ration before reversal.

After reversal the food consumption varied from 10.6 lbs. (1.3 oz. per bird per day) to 25.7 lbs.(2.9 oz. per bird per day) in the group getting the animal protein supplement ration and 12.9 lbs. (1.5 oz. per bird per day) to 22.6 lbs.(2.7 oz. per bird per day) in the group getting vegetable protein supplement ration.

During the second and third week of the experiment after reversal where the consumption was lowest in both the groups was due to very high prevailing temperature which was 109.4° and 110°F respectively. Thereafter the temperature came down to 97.8°F in the fourth week and continued to be almost same for the rest of the period of the experiment bringing in improvement in food consumption.

It was noticed that water consumption was perceptibly increased during high room temperatures.

EGG PRODUCTION

The egg production of the individual bird was recorded daily and has been arranged fortnightly. Table 11 and 12 shows the actual egg production of the individual bird on a fortnightly basis of both the groups before and after reversal of the ration. The abbreviations used for fortnights in the table is $F_1$ - $F_4$.

Table 11

Table showing the actual egg production of the birds of both the groups before reverval

| No. of birds | Vegetable protein group | | | | TOTAL | Animal protein group | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | Time interval | | | | | Time interval | | | | |
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | | $F_1$ | $F_2$ | $F_3$ | $F_4$ | |
| 1 | 2 | 9 | 5 | 5 | 21 | 9 | 8 | 8 | 9 | 34 |
| 2 | 4 | 5 | 3 | 4 | 16 | 7 | 0 | 2 | 5 | 14 |
| 3 | 6 | 6 | 8 | 5 | 25 | 0 | 3 | 1 | - | 4 |
| 4 | 3 | 8 | 5 | - | 16 | 7 | 10 | 10 | 8 | 35 |
| 5 | 3 | 0 | 1 | 5 | 9 | 10 | 7 | 7 | 9 | 33 |
| 6 | 9 | 8 | 5 | 4 | 26 | 4 | 1 | 0 | 4 | 9 |
| 7 | 2 | 0 | 0 | 1 | 3 | 7 | 1 | 4 | 1 | 13 |
| 8 | 4 | 5 | 3 | 4 | 16 | 8 | 6 | 6 | 5 | 25 |
| 9 | 5 | 2 | 3 | 1 | 11 | 7 | 5 | 9 | 3 | 24 |
| 10 | 2 | 5 | 2 | 4 | 13 | 8 | 9 | 4 | 6 | 27 |
| 11 | 4 | 1 | 5 | 2 | 12 | 5 | 0 | 0 | 0 | 5 |
| 12 | 5 | 6 | 1 | 2 | 14 | 8 | 5 | 8 | 9 | 30 |
| 13 | 6 | 6 | 6 | 2 | 20 | 8 | 7 | 2 | 6 | 23 |
| 14 | 9 | 8 | 8 | 5 | 30 | 10 | 6 | 3 | 4 | 23 |
| 15 | 0 | 6 | 3 | 8 | 17 | 7 | 1 | 3 | 6 | 17 |
| 16 | 4 | 4 | 2 | 3 | 13 | 4 | 1 | 0 | 0 | 5 |
| 17 | 6 | 4 | 6 | 5 | 21 | 6 | 6 | 9 | 3 | 24 |
| 18 | 9 | 1 | 6 | 3 | 19 | 2 | - | - | - | 2 |
| 19 | 0 | 6 | 0 | 1 | 7 | 7 | 4 | 2 | 4 | 17 |
| 20 | 8 | 8 | 6 | 3 | 25 | 8 | 3 | 2 | 2 | 15 |
| 21 | 2 | 4 | 2 | 3 | 11 | 9 | 6 | 5 | 1 | 21 |
| 22 | 4 | - | - | - | 4 | 8 | 10 | 5 | 6 | 29 |
| 23 | 3 | 2 | 3 | - | 8 | 6 | 1 | 1 | 2 | 10 |
| 24 | 6 | 3 | 3 | 2 | 14 | 1 | 6 | 6 | 4 | 17 |
| TOTAL | 106 | 107 | 86 | 72 | 371 | 156 | 106 | 97 | 97 | 456 |

Table 12

Table showing the actual egg production of the birds of both the groups after reversal

| No. of birds | Animal protein group (original V.P. group) Time interval | | | | TOTAL | Vegetable protein group (original A.P. group) Time interval | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | | $F_1$ | $F_2$ | $F_3$ | $F_4$ | |
| 1 | 4 | 3 | 7 | 8 | 22 | 4 | 3 | 7 | 7 | 21 |
| 2 | 0 | 0 | 1 | 2 | 3 | 3 | 0 | 2 | 2 | 7 |
| 3 | 6 | 4 | 9 | 9 | 28 | - | - | - | - | - |
| 4 | - | - | - | - | - | 4 | 0 | 5 | 5 | 14 |
| 5 | 0 | 0 | 0 | 1 | 1 | 5 | 5 | 8 | 2 | 20 |
| 6 | 1 | 1 | 1 | 4 | 7 | 0 | 0 | 1 | 2 | 3 |
| 7 | 1 | 0 | 0 | 0 | 1 | 2 | 0 | 3 | 1 | 6 |
| 8 | 2 | 0 | 5 | 4 | 11 | - | - | - | - | - |
| 9 | 0 | 0 | 1 | 1 | 2 | 0 | 1 | 6 | 0 | 7 |
| 10 | 2 | 0 | 5 | 7 | 14 | 0 | 1 | 7 | 2 | 10 |
| 11 | 1 | 0 | 3 | 1 | 5 | 0 | 0 | 0 | 0 | 0 |
| 12 | 5 | 0 | 3 | 0 | 8 | 1 | 0 | 0 | 7 | 8 |
| 13 | 0 | 0 | 0 | 2 | 2 | 0 | 0 | 5 | 2 | 7 |
| 14 | 4 | 3 | 7 | 8 | 22 | 3 | 0 | 7 | 4 | 14 |
| 15 | 2 | 0 | 2 | 6 | 10 | 2 | 0 | 6 | 5 | 13 |
| 16 | 0 | 0 | 2 | 6 | 8 | 0 | 0 | 2 | 3 | 5 |
| 17 | 3 | 1 | 0 | 3 | 7 | 6 | 0 | 9 | 8 | 23 |
| 18 | 2 | 1 | 2 | 4 | 9 | - | - | - | - | - |
| 19 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 4 | 6 |
| 20 | 0 | 0 | 1 | 0 | 1 | 3 | 0 | 2 | 3 | 8 |
| 21 | - | - | - | - | - | 1 | 0 | 1 | 4 | 6 |
| 22 | - | - | - | - | - | 4 | 0 | 0 | 0 | 4 |
| 23 | - | - | - | - | - | - | - | - | - | - |
| 24 | - | - | - | - | - | - | - | - | - | - |
| TOTAL | 33 | 13 | 49 | 67 | 162 | 39 | 10 | 72 | 61 | 182 |

## Statistical analysis for egg production

Test for the significance of difference in egg production between the groups before and after reversal of the ration was done. Table 13 and 14 shows the analysis of variance for egg production between the two groups and fortnights and interaction between groups and fortnights.

Table 13

Table showing the analysis of variance between the groups before reversal

| Sources of variation | d.f. | S.S. | M.S. | 'F' |
|---|---|---|---|---|
| Between groups | 1 | 1.13 | 1.13 | 2.89 |
| Between interval | 3 | 3.29 | 1.09 | 2.79 |
| Between groups and interval | 3 | 0.52 | 0.17 | 0.43 |
| Error | 175 | 68.80 | 0.39 | |
| TOTAL | 182 | 73.74 | | |

From the analysis of variance no significant difference in egg production was found.

Table 14

Table showing the analysis of variance between the groups after reversal

| Sources of variation | d.f. | S.S. | M.S. | 'F' |
|---|---|---|---|---|
| Between groups | 1 | 0.20 | 0.20 | 0.55 |
| Between interval | 3 | 14.46 | 4.82 | 13.39 |
| Between groups and interval | 3 | 0.78 | 0.26 | 0.72 |
| Error | 144 | 52.51 | 0.36 | |
| TOTAL | 151 | 67.95 | | |

From the analysis of variance no significant difference in egg production was found.

It appears from table 6 that after grouping of the birds before commencing the experiment the birds in group I had on an average approximately 59.8 per cent production and group II had 56 per cent production during the total period of observation of 25 days. The daily egg production in group I and II varied from 11 to 19 and 10 to 19 respectively during the period of observation of 25 days. It indicates that group I (which was getting the animal protein supplement ration during the experimental period) had a slightly better production than group II (receiving the vegetable protein supplement ration) before the commencement of the experiment. After 8 weeks of the experiment that is prior to reversal, the group getting the

vegetable protein supplement ration had an over all production of 29.1 per cent and the group getting the animal protein supplement ration had 35.4 per cent production during the total period of 8 weeks.

After reversal of the ration the group getting the vegetable protein supplement ration (original animal protein group) had 17.1 per cent production and the group getting the animal protein supplement ration (original vegetable protein group) had 15.2 per cent production during the total period of 8 weeks.

The weekly egg production varied from 31 to 62 in the group receiving the vegetable protein supplement ration and 36 to 82 in the group getting the animal protein supplement ration before reversal. After reversal the weekly egg production varied from 3 to 34 in the animal protein supplement group and 2 to 42 in the vegetable protein supplement group.

Adverse effect of high environmental temperature:

From the perusal of table 6, 11 and 12 it is observed that there was a perceptible drop in egg production in both the groups before and after reversal as compared to the production before starting the feeding experiment. The high room temperature prevailing through out the experimental period had its adverse effect on both the groups and as the temperature went on increasing the egg production continued to be low which was worse during the second, third and fourth week of the experiment after reversal when the temperature rose as high as

110°F and the production for each group of 19 birds dropped down as low as 2 and 3 representing virtual cessation of laying.

Whether, the low food consumption or high temperature was responsible for lower egg production during the second, third and fourth week of the experiment after reversal in both the groups is clarified from table 9 in which the birds having the similar food consumption during the fifth week had much better egg production in both the groups when the temperature was 102.5°F as compared to the temperature of 110°F in the third week after reversal.

The birds during the second, third and fourth week after reversal consumed on an average 1.9 oz. and 2.0 oz. of food per bird per day in the animal protein and vegetable protein group respectively and produced on an average only one egg per bird during the period of three weeks. While, the birds in both the groups before reversal produced on an average two eggs per week per bird and consumed 1.8 oz. of food per bird per day.

Although, there was lack of greens in the diet after reversal and one possible reason for lowered egg production can be attributed to deficiency of vitamin A in the ration, is contradicted by the fact that egg production of the birds improved as the temperature decreased. It indicates that the birds had sufficient storage of vitamin A in their body.

The number of poor layers producing eggs below ten during the experimental period of 8 weeks before reversal were 3 in each group and 12 in each group after reversal.

The results are in general agreement with the works done by Macrander (1935), Temperton and Dudley (1941), Carpenter *et al.*(1954), Shaw and Nightall (1955), Lansbury (1961 and 1962) and Davidson and Boyne (1962).

The old belief that fish meal is an essential ingredient in the rations of laying hens has been clarified by Carpenter (1954) and he has suggested that the difference in egg production on rations having protein supplement from white-fish meal and groundnut meal can only be observed when the ration has a critical crude protein content of 11 per cent, because in that circumstances white-fish meal provides a more favourable amino acid balance.

It has been pointed out in works done by Carpenter *et al.* (1954) that provided there is an excess of crude protein, all vegetable rations composed of cereal mixtures, wheat offals and groundnut meal can allow as good egg production as conventional rations containing animal protein supplements such as white-fish meal. Diets containing 14 per cent total protein, with 11 - 10 per cent from cereal sources and 3 - 4 per cent from protein supplements gave rise to similar egg productions irrespective of whether the supplement was vegetable protein from groundnut meal or animal protein from white-fish meal. However, when the total protein content of the diet was reduced to 11 per cent with 8 per cent from cereal sources and 3 per cent from protein supplement, the protein of white-fish meal proved superior to groundnut meal protein. The diet containing 11 per cent protein

with 3 per cent from white-fish meal was as productive as the diets containing a total of 14 per cent protein with 4 per cent from either white-fish meal or groundnut meal.

The vegetable protein supplement ration in the present experiment had a crude protein content of 18.67 per cent and as such animal protein supplementation is not expected to exert much beneficial effect.

The group getting the animal protein supplement ration although produced 85 extra eggs during the period of 8 weeks before reversal had also consumed 18.35 lbs. of extra food. Moreover, this group appeared to be little superior in laying as observed from the 25 days production before commencement of the experiment (table 6). Whether, this slight increase in egg production during the experimental period in the animal protein group was due to the inherent slight superiority of the birds in the group or to the beneficial effect of animal protein can not be settled conclusively.

However, the inference that animal protein did not significantly increase egg production has to be limited because the experiment was conducted during the period when season in terms of high temperature had its adverse effect on egg production. Through out the entire experimental period the temperature was above 90°F except in the last two weeks when it came down to 87.4°F and 87.7°F, respectively. Table 15 gives the weekly average maximum room temperature during the experimental period.

It is felt, that the results would have been more conclusive, if the experiment would have continued for the whole laying year.

Table 15

Table showing the weekly average maximum room temperature during the experimental period.

| Weeks | Temperature (°F) before reversal | Temperature (°F) after reversal |
|---|---|---|
| 1 | 102.4 | 104.8 |
| 2 | 106.4 | 109.4 |
| 3 | 99.0 | 110.0 |
| 4 | 96.0 | 97.8 |
| 5 | 102.3 | 91.4 |
| 6 | 99.6 | 93.1 |
| 7 | 92.8 | 87.4 |
| 8 | 97.8 | 87.7 |

Efficiency of food conversion:

Efficiency of food conversion has been determined by calculating the amount of food consumed per dozen of eggs in different weeks both before and after reversal. Table 16 and 17 shows the efficiency of food conversion in both the groups before and after reversal.

Table 16

Table showing the weekly egg production, feed consumption and amount of food consumed per dozen of eggs by both the groups before reversal

| Weeks | Vegetable protein group | | | Animal protein group | | |
|---|---|---|---|---|---|---|
| | No.of eggs produced | Feed consumed (lbs) | Feed consumed per doz. of eggs (lbs) | No.of eggs produced | Feed consumed (lbs) | Feed consumed per doz. of eggs (lbs) |
| 1 | 62 | 25.3 | 4.9 | 74 | 29.3 | 4.75 |
| 2 | 44 | 25.8 | 7.0 | 82 | 24.8 | 3.6 |
| 3 | 48 | 26.7 | 6.7 | 45 | 25.8 | 6.9 |
| 4 | 59 | 25.2 | 5.1 | 61 | 29.0 | 5.7 |
| 5 | 52 | 18.4 | 4.2 | 61 | 18.4 | 3.6 |
| 6 | 34 | 23.25 | 8.2 | 36 | 25.2 | 8.4 |
| 7 | 41 | 25.6 | 7.5 | 53 | 31.4 | 7.1 |
| 8 | 31 | 19.3 | 7.5 | 44 | 24.0 | 6.5 |

Average per dozen= 6.38 lbs. Average per dozen = 5.82 lbs.

Table 17

Table showing the weekly egg production, feed consumption and amount of food consumed per dozen of eggs by both the groups after reversal.

| Weeks | Animal protein group (original V.P.group) | | | Vegetable protein group (original A.P.group) | | |
|---|---|---|---|---|---|---|
| | No.of eggs produced | Feed consumed (lbs) | Feed consumed per doz. of eggs. (lbs.) | No.of eggs produced | Feed consumed (lbs) | Feed consumed per doz. of eggs (lbs) |
| 1 | 23 | 16.7 | 8.7 | 27 | 19.9 | 8.8 |
| 2 | 10 | 10.6 | 12.7 | 12 | 12.9 | 12.9 |
| 3 | 3 | 15.8 | 63.2 | 2 | 16.6 | 99.0 |
| 4 | 10 | 20.3 | 24.4 | 8 | 21.8 | 32.7 |
| 5 | 22 | 21.8 | 11.9 | 30 | 22.6 | 9.0 |
| 6 | 27 | 18.7 | 8.3 | 42 | 17.0 | 4.8 |
| 7 | 34 | 25.7 | 9.1 | 29 | 21.8 | 9.0 |
| 8 | 33 | 22.6 | 8.2 | 32 | 21.8 | 8.2 |

Average per dozen = 18.3 lbs. Average per dozen = 23.05 lbs.

There was no significant difference in food consumed per dozen of eggs between the groups before reversal and as such the efficiency of food conversion in terms of food consumed per dozen of eggs were almost similar for both the groups.

The efficiency of food conversion after reversal of the ration was not analysed statistically because the egg production was less than a dozen in some weeks.

The weekly variation in food consumption per dozen of eggs in the vegetable protein supplement group varied from 4.2 lbs. to 8.2 lbs. and in the animal protein supplement group from 3.6 lbs. to 8.4 lbs. before reversal. After reversal it varied from 8.2 lbs. to 63.2 lbs. in the animal protein supplement group and 4.8 lbs. to 99.0 lbs. in the vegetable protein supplement group.

The adverse effect of high temperature was on both the characters viz, egg production and food consumption but egg production was more severely affected.

Body weight:

The average body weight of the two groups of birds before the experiment was 4.33 lbs. for the group getting the animal protein supplement ration and 4.39 lbs. for the group getting the vegetable protein supplement ration. Before reversal the average body weight of both the groups was 4.28 lbs. and at the end of the experiment the average body weight of the group getting the vegetable protein supplement ration was 4.39 lbs. and 4.45 lbs. for the group getting the animal protein supplement ration. Table 18 shows the analysis of variance for body weights between the two groups.

Table 18

Table showing the analysis of variance for body weight

| Sources of variation | d.f. | S.S. | M.S. | 'F' |
|---|---|---|---|---|
| Between groups | 1 | 0.04 | 0.04 | 0.09 |
| Between interval | 2 | 0.43 | 0.21 | 0.47 |
| Between groups and interval | 2 | 0.01 | 0.005 | 0.011 |
| Error | 124 | 56.39 | 0.45 | |
| TOTAL | 129 | 56.87 | | |

From the analysis of variance no significant difference in body weights were found at all the stages.

Egg weight:

The group egg weight was taken daily and the average weight of the egg of both the groups before and after reversal is given in table below:

Table 19

Table showing the average weight of the egg of both the groups before and after reversal

| Period | Vegetable protein group | Animal protein group |
|---|---|---|
| Before reversal | 1.93 oz. | 1.84 oz. |
| After reversal | 1.80 oz. | 1.91 oz. |

There was no perceptible difference in egg weight between the groups before and after reversal. (Statistical analysis has not been done as individual weight of egg was not taken)

**Mortality:**

During the experimental period 3 birds in the vegetable protein group and 2 birds in the animal protein group died before reversal. After reversal 2 birds in the animal protein group and 3 birds in the vegetable protein group died. The death of the birds probably was due to the adverse effect of the high temperature.

# C H A P T E R - V

## SUMMARY

Studies on 48 Rhode Island Red birds of the same hatch in group of 24 each, maintained in individual battery cages were made to see the effect of a good all vegetable ration and a ration containing animal protein in addition on laying. Studies were also made to see the effect of double reversal method on subsequent egg production.

The ration containing vegetable protein supplement had a crude protein content of 18.67 per cent and the ration containing animal protein supplement in addition had a crude protein content of 18.7 per cent.

The experiment continued for a period of 8 weeks and then the rations were reversed and again it was continued for a period of another 8 weeks.

No significant difference in egg production between the groups before and after reversal was observed.

The change in body weight was insignificant in both the groups.

Efficiency of food conversion was almost similar for both the groups and differences in their food consumption were insignificant during the experimental period.

The adverse effect of high temperature on egg production was very severe during the second, third and fourth

week of the experiment after reversal when the temperature rose as high as 110°F . During this period although the food consumption was about 20 per cent and 10 per cent lower in the animal protein and vegetable protein group respectively than the average for the whole period of the experiment, the egg production dropped down to approximately 60 per cent of the average of the whole period. That adverse weather condition and not low food intake was primarily responsible for this drop is evident from the fact that similar food intake at a different period with lower atmospheric temperature resulted in approximately six times more egg production.

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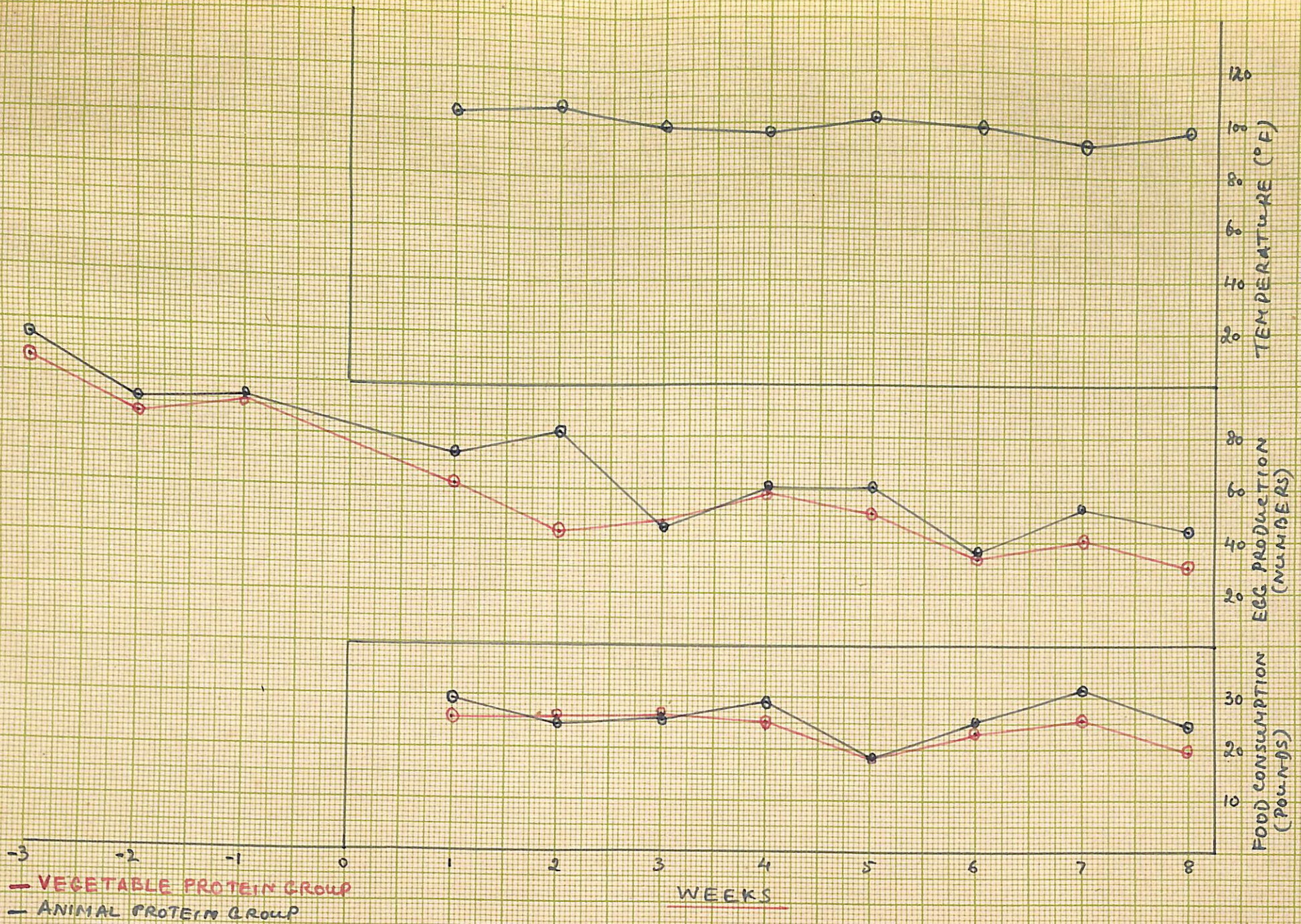
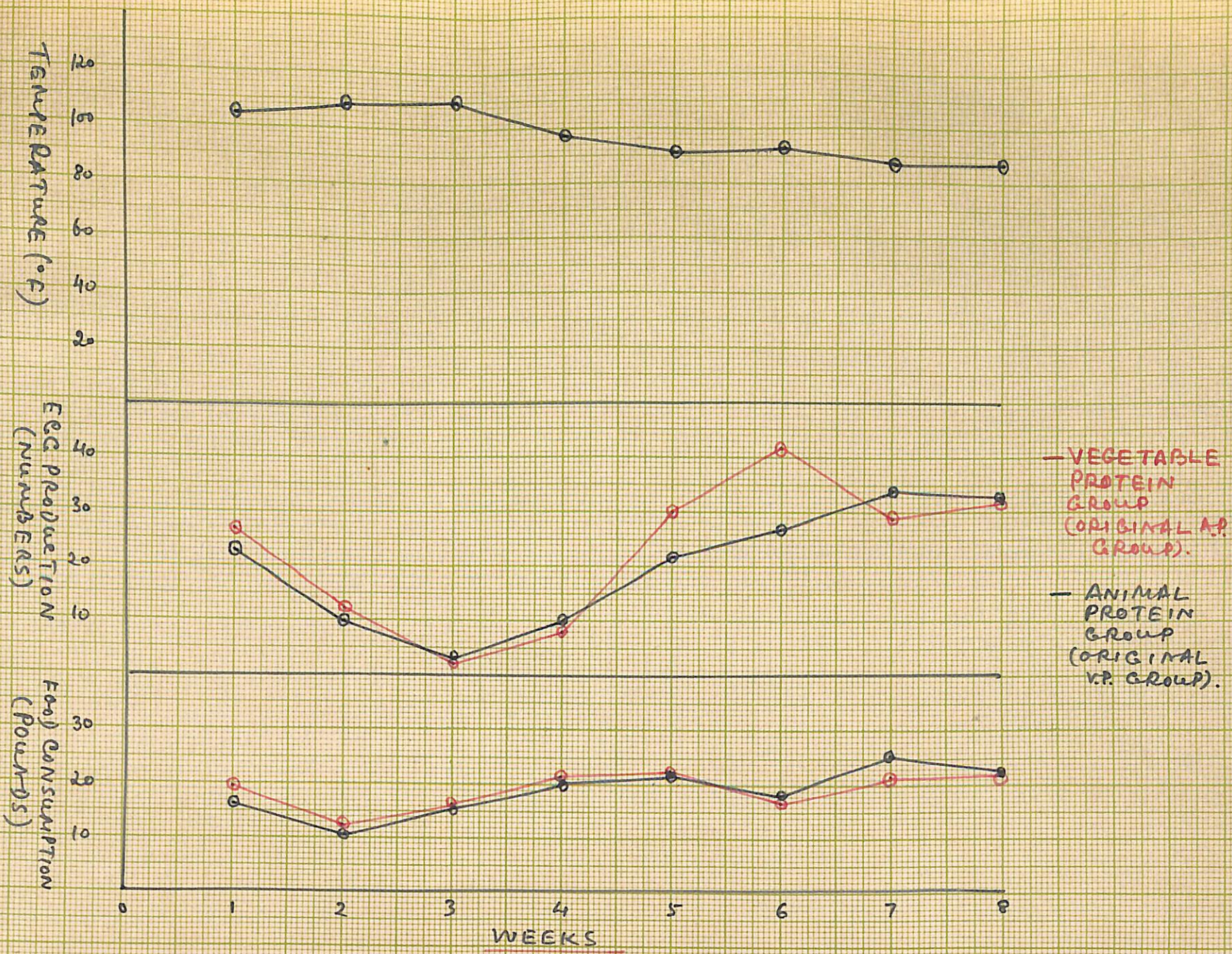



GRAPH SHOWING THE FEED CONSUMPTION, EGG PRODUCTION AND (TEMPERATURE) IN THE VEGETABLE AND ANIMAL PROTEIN GROUP BEFORE REVERSAL.




GRAPH SHOWING THE FEED CONSUMPTION, EGG PRODUCTION AND TEMPERATURE) IN THE VEGETABLE AND ANIMAL PROTEIN GROUP AFTER REVERSAL

# P A R T - II

STUDIES ON THE EFFECT OF TERRAMYCIN EGG FORMULA (PFIZER) ON EGG PRODUCTION DURING PERIOD OF STRESS

# C O N T E N T S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# C H A P T E R - I

## INTRODUCTION

If we look at the history of the poultry development in the country, it will be amazing to know that a country which was the cradle of the ancestry of poultry in the world has now fallen on such evil days that the average production of eggs per hen per year is very low.

India possesses about one hundred millions of poultry, of which 36 millions are layers (Bose,1962) with an average egg production of 53 per bird, in comparison to an improved bird, whose egg production is more than 125 per bird per year (Bose,loc.cit.). The average per capita consumption of eggs in India works out to be only 5 eggs per year in comparison to per capita consumption of 400 eggs in the U.S.A., U.K. and Denmark (Bose, loc.cit.).

The Nutritional Advisory Committee has recommended a balanced diet for a human being, which includes, among other things, 10 oz. of milk, 3 oz. of meat and fish and one egg per day. This clearly shows that we are far below the recommendations.

The importance of poultry in human nutrition can not be over emphasised. The hen ranks with the dairy

cow in her productive performance. In a year she may produce up to four times as much dry matter as is contained in her body. It is clear that an intensive metabolism and very large nutritive requirements are involved. The egg has the following approximate composition: water 66 per cent, protein 13 per cent, fat 10.5 per cent, ash 10.5 per cent. Besides, eggs are a very rich source of vitamin A and D and good source of riboflavin,thiamin, and a fair source of nicotinic acid. An average egg contains 2 gm. of calcium and 0.12 gm. of phosphorus in the ash and are rich sources of iron. Because they contribute mineral,vitamins and protein, eggs are a good food for human beings of all ages.

Poultry feed represents the largest single expense in the production of poultry and eggs accounting for approximately two-thirds of the total cost of production. Scientists have been putting constant efforts to produce human foods from animal sources at lower cost for the consumers and this has spearheaded a continuing search for more suitable combinations of known nutrients and for new chemical substances with the hope of increasing the efficiency and rate of growth and production. These wide spread efforts have led to the present use of antibiotics, hormones and other chemicals in animal feeds.

The antibiotics are drugs, not nutrients, and thus their effects upon the nutrition of animals is of necessity

a secondary one. The specific method by which antibiotics exert this influence has not been fully explained, although several theories have been proposed, each of which seems to fit some of the facts but not all of them. Among the various theories the following seem to be best supported by facts:

Antibiotics may function by means of a selective action upon the microorganisms of the intestinal tract. This could occur by the control of transmissible agents, either pathogens or non-pathogens, which produce slightly harmful products and which accumulate in quarters where animals or birds are kept year after year. This view supported by the observation that chicks housed in new quarters do not respond to antibiotics and uniformly make better growth without antibiotics than chicks in buildings repeatedly used.

Antibiotics may exert their effect by controlling the microorganisms which compete with the host for vitamins, amino acids, or other nutrients or which reduce the availability of any nutrient.

It is also possible that antibiotics may exert a direct action upon the animal organism. However, the final answer on the specific roles of antibiotics in the nutrition of animals awaits further research and evaluation.

Besides, antibiotics, the role of greens in poultry nutrition is long known. It's value lies in the fact that vitamins are the most expensive ingredients in poultry ration

and greens are a cheap source of many of them. Chickens have probably utilised herbage in their diets in one form or another ever since their origin. Bennet (1853) considered that green food was indispensable in the diet of poultry. Thomas (1933) found that cut green lucerne increased egg production by 20 per cent and reduced mortality by two-thirds among confined birds, but there were signs that his basal ration was deficient in vitamin A. Jones,Zscheile and Griffth (1953) and Thompson (1949) showed that the leaves of grasses and legumes contain between 80 and 90 per cent of the total carotene in the plant throughout the growing season. This is important, because poultry select leaf in preference to stem.

Gilkeson (1940) in a popular magazine article, reports: "Chickens like green better than any other color, regardless of the color of the chicken or the fact that a black hen will lay a white egg. At any rate, when 5 glass drinking fountains were lined up in a row, each one containing a different color of water, the layers drank all of the green water first, red next, then brown, and yellow. Clear water was left until last, despite the fact that the hens had been used to clear water all of their lives".

In summer months when there is usually a shortage of greens, the deficiency of vitamins is likely to occur. This shows the necessity of supplementing rations with vitamins (particularly vitamin A,riboflavin and $D_3$).

If these vitamins could be given in any other form to be utilised by the birds its value is going to increase. Science has shown that when the oil soluble vitamin A and D are first converted into water soluble form they are several times more effective in poultry feeds. The other water soluble vitamins of the vitamin B-complex are also quickly available to the bird when put into feeds in a liquid form.

Kramer et al., Lewis et al. and Popper et al.(1947) have observed that oral intake of vitamin A in aqueous dispersion produces a significantly higher rise of the blood vitamin A level than in oily menstruum. This was considered evidence of improved intestinal absorption, especially since after intake of the aqueous preparation, the faecal excretion of vitamin A appeared reduced and the storage in the liver increased (Sobel et al.,1948).

Observation by Popper and Volk (1948) of the vitamin A fluorescence in the intestine of rats showed that greater amounts of vitamin A - approximately three times as much - were absorbed if the latter was administered in an aqueous instead of an oily menstruum. In addition vitamin A in water penetrated the intestinal wall faster, the peak of absorption occurred at a higher level of the intestine and vitamin A remained longer in the villi.These differences were explained by passage of increased amounts of vitamin A through the epithelium if given in aqueous dispersion and not by a different physical state of vitamin A after passage.

The present problem deals with the study of the effect of Terramycin egg formula (Pfizer) in laying hens during stress of high temperature and humidity. According to the manufacturer each 4 gm. (measureful) Terramycin egg formula contains:

| | |
|---|---|
| Oxytetracycline H.C.L.,B.P. | 200 mg. |
| Vitamin K | 2.88 mg. |
| Vitamin E | 2.4 units |
| Vitamin A | 8000 units |
| Vitamin $B_{12}$ B.P. | 8 mcg. |
| Vitamin $D_3$ U.S.P. | 1440 units |
| Riboflavin | 10.4 mg. |
| Niacinamide | 48 mg. |
| Pantothenic acid | 16.8 mg. |

The chief object behind the study is to see the combined effect of antibiotic and vitamins given in an aqueous dispersion during the period when the birds are subjected to stress of heat and high humidity and particularly when there is a lack of greens in the feed.

# C H A P T E R - II

## REVIEW OF LITERATURES

Carpenter and Duckworth (1952) studied the effect of aureomycin supplement in the ration of Buff Rock chickens. The birds were fed on starting,growing and laying rations consecutively with or without the addition of aureomycin. At 6 weeks of age the supplemented birds were 18 per cent heavier than controls but at 42 weeks this difference disappeared. Sexual maturity which was gauged by the age when the fifth egg was laid was not advanced by the faster growth of the supplemented birds. The egg production was 7 per cent less in the supplemented group and the greater body weight did not result in larger eggs. Feed utilisation was also not better in the supplemented group.

Sizemore,Lillie, Denton and Bird (1953) conducted feeding trials on Rhode Island Red chicks. All the chicks used in this trial were given a similar mash mixture and were kept on saw dust litter to 8 weeks of age. From this age to 22 weeks groups 1 and 2 received the Connecticut broiler ration (CBR), groups 4 and 5 CBR+antibiotic, groups 7 and 8 a mixed maize and soyabean ration (CS) and groups 10 and 11 CS+antibiotic. All groups had mixed wheat and maize free choice in addition. The antibiotic was supplied as 0.5 per cent of a supplement containing 1.8 mg. vitamin $B_{12}$ and 1.8 gm.

aureomycin hydrochloride per lb. At 22 weeks of age representatives of each group were placed in each of 6 wire floored houses and 8 saw dust litter houses, making groups of 40 and 36 for the respective types of house. The groups on saw dust litter were given a standard laying mash containing ample vitamin $B_{12}$ and the groups on wire floor received a maize and soyabean ration deficient in vitamin $B_{12}$ with or without antibiotic.

For the rearing period i.e. up to 22 weeks of age the birds on range given antibiotic grew faster than the controls, but the supplement had no effect on age at sexual maturity or mortality.

During the laying period, no effect of chick diet or laying diet was found on egg production, mortality, egg weight or shell thickness.

Balloun (1954) fed an all vegetable ration supplemented with vitamin $B_{12}$ to New Hampshire pullets housed in wire floored cages in groups of 9 to 12 and observed 35 per cent production in the second 8 weeks period of the trial and 36 per cent in the third period. Two similar groups gave a mean of 37 per cent production in the second period and a mean of 46 per cent production in the third period when the ration was supplemented with 110 mg. aureomycin per kg.Further groups received 3 other ration which included 2 per cent of fish solubles and their egg production after receiving aureomycin was also generally higher than that of unsupplemented

birds, but the differences were less than in the groups receiving the all vegetable ration.

Sherwood and Milby (1954) observed an overall mean production of 54 per cent from 750 birds on a hen day basis fed a variety of practical rations, maintained under different systems of management in a series of 6 laying trials. The mean production from parallel groups receiving similar rations with the addition of one or more antibiotics was also 54 per cent. The use of antibiotics was without effect on mortality,efficiency of feed conversion or hatchability of fertile eggs. Both light and heavy birds were used and the supplements, with their concentrations in the total ration in mg. per pound, were terramycin (5), aureomycin hydrochloride (6 and 50), terramycin and aureomycin mixed ( 11 and 18) and penicillin(2).

They did not observe any response to the use of an antibiotic in any particular combination of feed management and supplement.

Lillie and Sizemore(1954) housed a flock of New Hampshire birds intensively for the first seven months of egg production and fed an all vegetable ration of soyabean meal 20, alfalfa meal 5, butyl fermentation solubles 0.5, mineral supplements 7.5, vitamin A and D feeding oil 0.3 and yellow maize meal to 100.

The pullets were trapnested, and at the end of this period 40 birds which had given less than 50 per cent

production were divided into two groups of which one continued to receive the same ration, and the other a similar ration fortified with 1 per cent of a supplement containing an unstated quantity of vitamin $B_{12}$ and an unstated quantity of (unspecified) antibiotic.

During the period from 1 to 6 months after the segregation the supplemented group gave 40 per cent and the unsupplemented group 28 per cent production.

92 pullets that had given more than 50 per cent production in the first 6 months were divided into 4 groups which received respectively the original ration, the original supplement with 0.1 per cent of a supplement containing an unstated quantity of vitamin $B_{12}$ but no antibiotic and a commercial ration (composition not stated but reported to contain some fish meal). After the re-grouping the mean egg production in the 4 groups from 1 to 6 months was 56,50,47 and 47 per cent respectively.

It was concluded that incorporation of a supplement of vitamin $B_{12}$ and an antibiotic into a laying ration improved the egg production of low producers but not that of high producers.

Heywang (1956) fed a basal all mash ration unsupplemented or supplemented with 50 or 100 mg. Chlortetracycline hydrochloride per ton for periods from 100 to 112 days during hot weather to four groups of 25 to 27 White Leghorn hens. The average maximum air temperature was 99° to 103°F. The birds

were housed in pens which had been in use for some years. Most of the hens were fairly good layers but in two of the groups there were some relatively poor layers. Egg production was recorded by trapnesting. In three experiments in which both levels of antibiotics were used, egg production was 36.5 per cent in the unsupplemented group, 44.8 per cent in the groups receiving the lower levels of antibiotic and 47.2 per cent on the higher level. Data were insufficient to determine whether the difference between the supplemented group was significant.

In two experiments in which a comparison could be made between good and poor layers, it was found that the increase in egg production due to the antibiotic was greater in the poor than in the good layers. Total feed consumption was not affected by the antibiotic, but almost always feed consumption per dozen eggs was reduced. The supplement had no effect on live weight, mortality rate or hatchability of fertile eggs.

Querner and Staufenbiel (1959) conducted a feeding trial lasting for 47 weeks with groups of 40 Leghorns x Rhode Island Red laying hens housed in batteries. They were given an all mash ration with 0, 25 or 50 gm. terramycin added per metric ton feed or with 3, 6 or 10 gm. per ten litres of drinking water.

Terramycin increased egg yield by 7 to 19 per cent, most with 3 gm. per ten litres of drinking water and least

with 50 gm. per ton. Feed intake was higher up to 7.3 per cent on 3 gm. per 10 litres in the groups getting terramycin except in that getting 50 gm. per ton. Terramycin improved feed efficiency by 2.5 to 9 per cent; 3 gm. per ten litres was best. Weight gains were 13.8 and 10.4 per cent better in the groups getting 3 gm. and 10 gm. per ten litres respectively, but those of hens getting 25 gm. or 50 gm. per ton were only about two-thirds those of hens not getting terramycin. Losses were smallest, 15 per cent in the groups getting terramycin in the drinking water and greatest 40 per cent in the group getting 50 gm. per ton feed. Adding 10 gm. terramycin per ten litres drinking water of hens under different forms of stress improved performance.

Saxena and Kumar (1959) fed terramycin in the mash portion of the basal ration in quantities of 0, 100 and 200 p.p.m. in the total ration to 3 groups of White Leghorn pullets, each group having 14 birds. The grain portion of the ration was regulated to 40 per cent of the total diet and was fed as scratch grain. The mash was fed adlibitum. The experiment was conducted for a period of 24 weeks. Individual egg production records were kept daily by trapnesting.

He observed an increase in egg production of 37.2 and 23.7 per cent in the groups receiving terramycin @ 100 and 200 p.p.m. respectively as compared to the group getting no supplement. He concluded that the addition of terramycin to the diet of laying hens resulted in a significant increase in egg

roduction.

Mantel and Prill (1959) conducted two trials for
0 days with groups of 30 Leghorn laying hens having an
rage weight of 1.71 kg. They were given daily 50 gm.
ed grain and laying meal to appetite. In the first trial,
25, 50 or 100 gm. terramycin per metric ton was added to
laying meal. The groups getting 50 and 100 gm. terramycin
hat order, had the highest egg yields and weight gains;
. had no effect. Feed cost increased with rise in
ycin but per 100 gm. eggs, cost were lowest with 50 gm.
25 or 100 gm. terramycin cost per 100 gm. eggs was
ly higher than on the ration with no terramycin.

In the second trial no terramycin or terramycin
ent to 50 or 100 gm. per ton laying meal was added to
king water throughout or equivalent to 300 gm. given
vals. The rations with 50 and 100 gm. terramycin gave
etter egg yield and weight gains and that with 50 gm.
ter feed efficiency. The ration with 300 gm. per
tervals was in general inferior to that with
oses varied widely between the groups but
to feeding.

(1959) conducted 3 experiments in successive
of White Leghorn pullets. They were fed
ler and the hotter seasons of the year on
l ration alone or supplemented with 90 gm.
50 gm. chlortetracycline, 4 gm.procaine

production.

Mantel and Prill (1959) conducted two trials for 350 days with groups of 30 Leghorn laying hens having an average weight of 1.71 kg. They were given daily 50 gm. mixed grain and laying meal to appetite. In the first trial, 0, 25, 50 or 100 gm. terramycin per metric ton was added to the laying meal. The groups getting 50 and 100 gm. terramycin in that order, had the highest egg yields and weight gains; 25 gm. had no effect. Feed cost increased with rise in terramycin but per 100 gm. eggs, cost were lowest with 50 gm. With 25 or 100 gm. terramycin cost per 100 gm. eggs was slightly higher than on the ration with no terramycin.

In the second trial no terramycin or terramycin equivalent to 50 or 100 gm. per ton laying meal was added to the drinking water throughout or equivalent to 300 gm. given at intervals. The rations with 50 and 100 gm. terramycin gave slightly better egg yield and weight gains and that with 50 gm. slightly better feed efficiency. The ration with 300 gm. per ton given at intervals was in general inferior to that with no supplement. Losses varied widely between the groups but were not related to feeding.

Heywang (1959) conducted 3 experiments in successive years with groups of White Leghorn pullets. They were fed during both the cooler and the hotter seasons of the year on an all mash practical ration alone or supplemented with 90 gm. arsanilic acid, 10 or 50 gm. chlortetracycline, 4 gm.procaine

penicillin or a mixture of 5 gm. chlortetracycline and 2 gm. procaine penicillin per ton. During the hotter season the average maximum temperature was from 97° to 102°F and during cooler season 71° to 76°F.

The average data from the 3 experiments showed that during the hot weather all supplements except the combination of chlortetracycline and penicillin increased egg production significantly. During the cooler season all the supplements increased egg production but the increases were not significant.

Fangauf, Vogt and Boysen (1959) conducted feeding trials on 3 groups of 181 inbred Leghorn laying hens on deep litter. They were given 50 gm. cereals daily, mussel shell and a laying meal to appetite with no antibiotic or with Aurofac 2 A supplying 10 or 50 mg. aureomycin per kg.feed. In 32 weeks eggs laid numbered 170.7, 172.7 and 164.5 and final weight of hens were 1.774, 1.800 and 1.896 kg. The antibiotic had no significant effect on intake of laying meal, about 84.5 gm. daily,or on mortality. Net profits were highest without antibiotic and lowest with 50 mg. It was concluded that the use of aureomycin in a laying meal is, on economic grounds not advisable.

Ryan, Potter, Singsen and Matterson (1961) fed a high energy basal laying ration with or without 100 gm. chlortetracycline per ton to replicated groups of 13 laying hens of 5 pure breeds and some cross breeds, from 41 different breeders.

Egg production and efficiency of feed utilisation for

egg production were recorded for a total period of 48 weeks. Egg production of those given antibiotic was 3.67 per cent more during the 48 weeks, a highly significant difference; the difference was greater in first 36 weeks; in the winter. There was a significant difference also in feed per dozen eggs, those given antibiotic required 0.191 lb. less, most evident between the 4th and 20th and the 24th and 28th weeks.

Gerriets (1961) fed 50 gm. grain daily and standard laying meal to appetite and vitamin supplements to three groups of 15 Brown Leghorn hens. The groups were given no antibiotic or 10 or 100 mg. aureomycin per kg. feed. Egg production during a year was increased by 10.3 and 13.4 per-cent, total egg weight by 8.6 and 11.8 per cent and feed used per egg was reduced by 4.6 and 3.1 per cent by 10 and 100 mg. antibiotic, respectively.

Satava (1962) fed a basal diet to laying hens stated to be of high quality but which contained considerably less than the recommended amounts of vitamins A and D, riboflavin, pyridoxine and choline and was somewhat low also in nicotinic acid and vitamin $B_{12}$. The experimental group received a supplement which supplied stabilised procaine penicillin and enough vitamins to bring intake of all those named to well above the recommended standards.

He observed that although the hens given the supplement laid significantly more eggs than the controls in several months, the overall increase was not significant.

Scholtyssek (1962) fed to appetite on diets with 400 gm. soyabean meal per 100 kg. feed or 400 gm. Aurofac per 100 kg. feed, equivalent to 32 mg. aureomycin per kg. to 400 White Leghorn hens for 12 months. Up to the end of first 3 months, from July 1960, there was no difference in egg production. In the next 9 months mean egg production of hens receiving antibiotic was 165.6 compared with 151.2 for the others. The respective feed intakes were 32.6 and 32.1 kg. and feed per egg was 197.0 and 213.1 gm., an insignificant difference.

Srivastava and Bose (1962) studied the effect of Terramycin Egg formula given @ 2 gm. in a gallon of drinking water on two groups of birds having 56 and 54 number of birds in the two groups respectively. The experiment was conducted for a period of 15 days. They observed an increase in egg production from 40.7 to 48.3 per cent in the group getting the Terramycin egg formula, whereas, in the group not getting the Terramycin egg formula the production was almost the same.

Curto, Orsatti and Zelioli (1963) conducted a preliminary trial with groups of 30 hens at the start or end of the laying year with 30 or 300 mg. of oxytetracycline per kg. feed. There was no consistent effect on egg production .

In the main trial there were 746 hens of 4 different breeds. The trial was in preliminary and study periods each of 30 days starting when egg production was expected to decline in the summer. Experimental hens received 30 mg.

oxytetracycline per kg.feed, with 15.5 per cent protein during the study period. During that period the egg production of controls fell by 19.2, 9.7, 41.3 and 24.5 per cent compared with falls of 4.0, 0.9, 15.3 and 6.0 per cent in comparable birds given antibiotic. Feed intake was less when antibiotic was given.

Potter, Ryan, Matterson and Singsen (1963) gave a practical diet for 4 weeks to 806 laying hens of 7 breeds from 23 sources. One of each pair was then given a supplement of 10 gm. erythromycin thiocynate per ton feed for 44 weeks. Egg production for each 11 weeks period was, without antibiotic 77.8, 70.1, 66.6 and 61.8 per cent and with antibiotic 80.6, 73.7, 63.4 and 60.2 per cent. Production was significantly greater with erythromycin during the first 2 periods.

Verma (1963) studied the effect of Terramycin egg formula on egg production given in drinking water @ 2 gm. per gallon. There were 48 White Leghorn and 48 Rhode Island Red pullets in their first year of lay and 96 cross bred birds in their second year of lay. The experiment lasted for 10 weeks.

He observed a significant difference in egg production in the second year birds which was only perceptible from the 7th week of the experiment, while the difference in egg production was insignificant in the first year birds.

Although efficiency of food conversion was insignificant, it was better in the experimental groups. The

average food consumed per dozen of eggs was 5.7 lbs. and 7.1 lbs. for the experimental and control group of birds of second year respectively, while in first year birds, it was 5.2 lbs. and 5.7 lbs. for the experimental and control group respectively.

# C H A P T E R - III

## MATERIALS AND METHODS

The birds under experiment belonged to the Central Poultry Farm, Patna and they were of Rhode Island Red and White Leghorn breed of the same hatch. They were maintained in the battery cages within the premises of the Bihar Veterinary College, Patna. The battery cage is of one tier and accommodates 192 birds in 4 rows. There are 2 rows in each unit having the common water trough in each unit and the mash hoppers are for eight birds in one unit. The experimental birds were maintained in the second and third row of the cage.

### SELECTION OF BIRDS FOR EXPERIMENT:

The selection of birds was done with the object to obtain two groups of birds in both the breeds having very similar average flock production.

A preliminary selection of birds of both the breeds were made on phenotypic basis and then they were put in the cages. They were fed the standard mash mixture obtained from the Central Poultry Farm, Patna and their egg production was observed for a period of 19 days. The egg production of both the breeds for a period of 19 days is given in table 1 and 2.

Table 1

Table showing the egg production of birds of Rhode Island Red breed during 19 days period

| Bird No. | Egg production | Bird No. | Egg production |
|---|---|---|---|
| 1 | 6 | 25 | 11 |
| 2 | 13 | 26 | 3 |
| 3* | 1 | 27 | 9 |
| 4 | 6 | 28 | 2 |
| 5 | 5 | 29* | 1 |
| 6* | 1 | 30* | 1 |
| 7 | 3 | 31 | 9 |
| 8 | 4 | 32 | 11 |
| 9 | 6 | 33 | 12 |
| 10* | 1 | 34 | 12 |
| 11 | 5 | 35 | 4 |
| 12 | 12 | 36 | 10 |
| 13 | 3 | 37 | 10 |
| 14 | 5 | 38 | 12 |
| 15 | 9 | 39 | 6 |
| 16 | 7 | 40 | 6 |
| 17 | 6 | 41 | 7 |
| 18 | 7 | 42 | 2 |
| 19 | 2 | 43 | 8 |
| 20* | 1 | 44 | 8 |
| 21 | 12 | 45 | 6 |
| 22 | 6 | 46* | 1 |
| 23 | 2 | 47 | 4 |
| 24 | 13 | 48 | 10 |

* Birds No.3,6,10,20,29,30 and 46 were changed on phenotypic basis as they proved to be very poor layers during the period of observation of 19 days.

Table 2

Table showing the egg production of birds of White Leghorn breed during 19 days period

| Bird No. | Egg production | Bird No. | Egg production |
|---|---|---|---|
| 1 | 3 | 25 | 10 |
| 2 | 5 | 26 | 13 |
| 3 | 14 | 27 | 13 |
| 4 | 12 | 28 | 3 |
| 5 | 4 | 29 | 3 |
| 6 | 10 | 30 | 12 |
| 7 | 11 | 31 | 12 |
| 8 | 13 | 32 | 9 |
| 9 | 10 | 33 | 9 |
| 10 | 6 | 34 | 12 |
| 11 | 13 | 35 | 5 |
| 12 | 12 | 36 | 5 |
| 13 | 13 | 37 | 8 |
| 14 | 7 | 38 | 4 |
| 15 | 6 | 39* | 1 |
| 16 | 13 | 40 | 9 |
| 17 | 9 | 41 | 7 |
| 18 | 7 | 42 | 6 |
| 19 | 12 | 43 | 10 |
| 20 | 2 | 44 | 11 |
| 21 | 11 | 45 | 10 |
| 22 | 2 | 46 | 4 |
| 23 | 2 | 47* | 1 |
| 24 | 12 | 48 | 10 |

* Birds No.39 and 47 were replaced on phenotypic basis as they proved to be very poor layers during the period of observation of 19 days.

The birds with same production were distributed in two groups in both the breeds and their egg production was again observed for a period of 20 days i.e. from 11.5.64 to 30.5.64 to observe the similarity of egg production in the two groups in both the breeds before the commencement of the experiment and to replace those birds, if offlay. The egg production of two groups of birds of both the breeds for a period of 20 days following this grouping is given in table 3 and 4.

Table 3

Table showing the egg production of Rhode Island Red birds after grouping

| Date | Group I(control) | Group II(experimental) |
|---|---|---|
| 11.5.64 | 3 | 10 |
| 12.5.64 | 10 | 11 |
| 13.5.64 | 3 | 11 |
| 14.5.64 | 11 | 10 |
| 15.5.64 | 6 | 9 |
| 16.5.64 | 9 | 13 |
| 17.5.64 | 9 | 11 |
| 18.5.64 | 6 | 11 |
| 19.5.64 | 10 | 12 |
| 20.5.64 | 6 | 13 |
| 21.5.64 | 14 | 13 |
| 22.5.64 | 4 | 11 |
| 23.5.64 | 13 | 11 |
| 24.5.64 | 7 | 11 |
| 25.5.64 | 12 | 8 |
| 26.5.64 | 10 | 8 |
| 27.5.64 | 6 | 8 |
| 28.5.64 | 12 | 9 |
| 29.5.64 | 5 | 8 |
| 30.5.64 | 11 | 11 |
| TOTAL | 167 | 209 |

Table 4

Table showing the egg production of White Leghorn birds after grouping

| Date | Group I (control) | Group II (experimental) |
|---|---|---|
| 11.5.64 | 11 | 11 |
| 12.5.64 | 10 | 7 |
| 13.5.64 | 11 | 11 |
| 14.5.64 | 10 | 6 |
| 15.5.64 | 11 | 14 |
| 16.5.64 | 9 | 6 |
| 17.5.64 | 9 | 16 |
| 18.5.64 | 6 | 14 |
| 19.5.64 | 10 | 12 |
| 20.5.64 | 9 | 11 |
| 21.5.64 | 5 | 11 |
| 22.5.64 | 12 | 13 |
| 23.5.64 | 9 | 6 |
| 24.5.64 | 2 | 13 |
| 25.5.64 | 7 | 9 |
| 26.5.64 | 3 | 6 |
| 27.5.64 | 10 | 6 |
| 28.5.64 | 7 | 7 |
| 29.5.64 | 4 | 9 |
| 30.5.64 | 8 | 7 |
| TOTAL | 163 | 195 |

The body weight of the birds of both the breeds were taken at the beginning of the experiment, then again in the middle (after 5 weeks) and finally at the end of the experiment. The result is shown in table 18 and 19.

FEEDS AND THEIR PREPARATION:

The birds under the experiment were fed the mash obtained from the Central Poultry Farm, Patna, the composition of which is as follows:

| | |
|---|---|
| Crushed yellow maize | 44 parts |
| Wheat bran | 20 parts |
| Groundnut cake | 20 parts |
| Fish meal | 5 parts |
| Limestone powder | 4 parts |
| Bone meal | 1 part |
| Salt | 0.5 part |

No greens in any form was given to the birds(due to its non-availability during summer months).

Vitamin A, riboflavin and $D_3$ which are commonly included in the rations for layers could not be added due to their non-availability.

The analysis of the mash was done only for its crude protein content. About 100 gm. of the samples were pooled from different bags and were mixed thoroughly and dried in oven at 100°C for removal of moisture. The analysis of the crude protein was done by the Kjeldahl's method as in A.O.A.C. methods.

The experiment started on 31.5.64 and continued for a period of 10 weeks. The experimental birds (consisting of 24 birds each in both the breeds) received Terramycin egg formula mixed in drinking water @ 2 gm. in one gallon.

The egg production of the individual birds was observed daily and the group egg weight was recorded. After a period of 10 weeks when Terramycin egg formula was withdrawn from the drinking water, egg production was further observed for a period of 20 days to see its residual effect.

Feed consumption was recorded weekly. The efficiency of food conversion was calculated by comparing the amount of food consumed per dozen of eggs between the control and experimental birds of both the breeds.

MANAGEMENT:

The following table gives the schedule of management observed during the experimental period:

Table 5

Table showing the daily schedule of management

| Items | Time | Remarks |
|---|---|---|
| Mash | 6 A.M. | |
| Mash | 3 P.M. | |
| Shell grit @ 1 oz. per bird | weekly | |
| Egg recording and egg weight recording | 4 P.M. | |
| Water | | Water trough was always kept full. For experimental birds the water used to be measured first, then Terramycin egg formula used to be mixed with it according to the levels mentioned & then it was poured in the water trough. |

Room temperature was recorded daily.

STATISTICAL ANALYSIS:

'F' test was done for comparison of egg production between the control and experimental group of birds of both the breeds. This was done by Square root transformation method as described by Snedecor (1961).

't' test was done to compare the efficiency of food conversion between the groups in both the breeds as mentioned by Panse and Sukhatme (1961).

'F' test was done to test the significance of difference between the live body weight of the two groups of birds of both the breeds.

# C H A P T E R - IV

## RESULTS AND DISCUSSION

### Composition of Ration:

The composition of the ration used in this experiment has been mentioned in the chapter on Materials and Methods. During the course of the experiment the mash was prepared two times and thus the crude protein content of the mash was determined twice. The crude protein content of the mash was 21.87 per cent and 21.25 per cent respectively, which happens to be little higher than the recommended levels.

### FEED CONSUMPTION

Weekly feed consumption of the birds were recorded by substracting the amount of the feed left in the hoppers from the amount of feed given in a week.

From statistical analysis it was found that the differences in feed consumption between the control and the experimental group of birds of both the breeds were significant.

Table 6 and 7 shows the number of eggs produced and feed consumed per week by the control and experimental group of birds of both the breeds.

Table 6

Table showing the weekly egg production and feed consumption of the control and experimental birds of Rhode Island Red breed

| Week | Control | | | Experimental | | |
|---|---|---|---|---|---|---|
| | No.of birds | No.of egg produced | Feed consumed (lbs.) | No.of birds | No.of egg produced | Feed consumed (lbs.) |
| 1 | 24 | 40 | 20.0 | 24 | 42 | 20.0 |
| 2 | 24 | 19 | 25.5 | 24 | 20 | 25.5 |
| 3 | 24 | 15 | 33.5 | 24 | 33 | 31.5 |
| 4 | 24 | 39 | 33.5 | 24 | 64 | 34.5 |
| 5 | 24 | 68 | 23.5 | 24 | 72 | 29.5 |
| 6 | 24 | 43 | 28.5 | 24 | 74 | 32.5 |
| 7 | 23 | 33 | 31.1 | 24 | 85 | 39.5 |
| 8 | 23 | 29 | 34.0 | 24 | 77 | 39.5 |
| 9 | 21 | 21 | 27.8 | 24 | 86 | 35.5 |
| 10 | 21 | 13 | 22.4 | 24 | 85 | 27.5 |
| TOTAL | | 320 | 279.6 | | 638 | 315.5 |

Difference in egg production between the groups in 10 weeks = 318.

Difference in feed consumption between the groups in 10 weeks = 35.9 lbs.

Table 7

Table showing the weekly egg production and feed consumption of the control and experimental birds of White Leghorn breed

| Week | Control | | | Experimental | | |
|---|---|---|---|---|---|---|
| | No.of birds | No.of egg produced | Feed consumed (lbs.) | No.of birds | No.of egg produced | Feed consumed (lbs.) |
| 1 | 24 | 56 | 20.0 | 24 | 58 | 23.0 |
| 2 | 24 | 37 | 25.5 | 24 | 54 | 27.5 |
| 3 | 24 | 27 | 26.5 | 24 | 47 | 35.5 |
| 4 | 24 | 55 | 28.5 | 24 | 74 | 28.5 |
| 5 | 24 | 58 | 23.5 | 24 | 88 | 30.5 |
| 6 | 24 | 58 | 32.5 | 24 | 105 | 32.5 |
| 7 | 24 | 51 | 32.5 | 24 | 92 | 37.5 |
| 8 | 24 | 38 | 33.5 | 24 | 97 | 36.5 |
| 9 | 24 | 43 | 29.5 | 24 | 101 | 36.5 |
| 10 | 24 | 40 | 27.5 | 24 | 102 | 28.5 |
| TOTAL | | 463 | 279.5 | | 818 | 316.5 |

Difference in egg production between the groups in 10 weeks = 355.

Difference in feed consumption between the groups in 10 weeks = 37.0 lbs.

From table 6 and 7 it appears that feed consumption was much better in the experimental birds as compared to the control birds in both the breeds. Weekly feed consumption of the control and experimental group of Rhode Island Red birds varied from 20.0 lbs. (1.9 oz. per bird per day)

to 34.0 lbs. ( 3.4 oz. per bird per day) and 20.0 lbs. (1.9 oz. per bird per day) to 39.5 lbs.(3.8 oz. per bird per day) respectively and in the White Leghorn birds it varied from 20.0 lbs. (1.9 oz. per bird per day) to 33.5 lbs. (3.2 oz. per bird per day) and 23.0 lbs.(2.2 oz. per bird per day) to 37.5 lbs.(3.6 oz. per bird per day) in the control and experimental group respectively.

Water consumption:

Measured amount of water containing one measureful ( 4 gm.) of Terramycin egg formula in 2 gallons of drinking water was given to the experimental birds, while the control birds had access to clean water. The consumption was almost similar for both the groups in both the breeds and varied between 3 to 5 gallons per day depending upon the weather conditions.

## EGG PRODUCTION

The egg production of the individual birds of the control and experimental group of both the breeds was recorded daily and has been arranged fortnightly. Table 8 and 9 shows the egg production of the individual birds of both the groups and of both the breeds. The abbreviations used for the fortnights in the table is $F_1$ - $F_5$ .

Table 8

Table showing the actual egg production of the birds of the control and experimental group of Rhode Island Red breed

| No. of birds | Control | | | | | | Experimental | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Time interval | | | | | | Time interval | | | | | |
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | Total | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | Total |
| 1 | 1 | 1 | 1 | 5 | 1 | 9 | 1 | 0 | 8 | 10 | 10 | 29 |
| 2 | 1 | 2 | 1 | 1 | 1 | 6 | 2 | 3 | 4 | 2 | 5 | 16 |
| 3 | 3 | 3 | 10 | 10 | 2 | 28 | 3 | 6 | 9 | 4 | 8 | 30 |
| 4 | 2 | 1 | 1 | - | - | 4 | 5 | 5 | 9 | 10 | 10 | 39 |
| 5 | 4 | 1 | 4 | 1 | - | 10 | 1 | 0 | 1 | 9 | 10 | 21 |
| 6 | 5 | 4 | 3 | 1 | 2 | 15 | 4 | 4 | 10 | 9 | 8 | 35 |
| 7 | 4 | 0 | 5 | 4 | 3 | 16 | 0 | 0 | 0 | 0 | 2 | 2 |
| 8 | 5 | 2 | 10 | 5 | 7 | 29 | 7 | 8 | 10 | 9 | 10 | 44 |
| 9 | 1 | 3 | 3 | 5 | 1 | 13 | 2 | 0 | 0 | 1 | 1 | 4 |
| 10 | 0 | 1 | 1 | 0 | 0 | 2 | 6 | 5 | 6 | 10 | 9 | 36 |
| 11 | 8 | 6 | 4 | 3 | 1 | 22 | 4 | 3 | 7 | 6 | 5 | 25 |
| 12 | 0 | 2 | 5 | 1 | 3 | 11 | 4 | 8 | 8 | 10 | 12 | 42 |
| 13 | 0 | 7 | 6 | 1 | 4 | 18 | 2 | 4 | 7 | 9 | 8 | 30 |
| 14 | 7 | 5 | 6 | 3 | 3 | 24 | 0 | 5 | 8 | 9 | 8 | 30 |
| 15 | 4 | 4 | 5 | 3 | - | 16 | 1 | 5 | 7 | 8 | 4 | 25 |
| 16 | 0 | 1 | 5 | 0 | 0 | 6 | 1 | 2 | 0 | 12 | 8 | 23 |
| 17 | 0 | 0 | 7 | 0 | 1 | 8 | 2 | 8 | 1 | 1 | 3 | 15 |
| 18 | 3 | 1 | 8 | 5 | 0 | 17 | 5 | 4 | 7 | 6 | 6 | 28 |
| 19 | 1 | 3 | 9 | 5 | 0 | 18 | 0 | 1 | 3 | 0 | 4 | 8 |
| 20 | 8 | 7 | 10 | 5 | 0 | 30 | 0 | 8 | 11 | 10 | 10 | 39 |
| 21 | 1 | 0 | 3 | 2 | 2 | 8 | 7 | 6 | 9 | 8 | 9 | 39 |
| 22 | 1 | 0 | 2 | 1 | 1 | 5 | 5 | 8 | 9 | 10 | 11 | 43 |
| 23 | 0 | 0 | 1 | 1 | 1 | 3 | 0 | 2 | 7 | 6 | 7 | 22 |
| 24 | 0 | 0 | 1 | 0 | 1 | 2 | 0 | 2 | 5 | 3 | 3 | 13 |
| TOTAL | 59 | 54 | 111 | 62 | 34 | 320 | 62 | 97 | 146 | 162 | 171 | 638 |

Table 9

Table showing the actual egg production of the birds of the control and experimental group of White Leghorn breed

| No. of birds | Control Time interval | | | | | | Experimental Time interval | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | Total | $F_1$ | $F_2$ | $F_3$ | $F_4$ | $F_5$ | Total |
| 1 | 8 | 4 | 7 | 3 | 5 | 27 | 4 | 7 | 9 | 11 | 11 | 42 |
| 2 | 6 | 3 | 5 | 3 | 2 | 19 | 7 | 8 | 10 | 9 | 8 | 42 |
| 3 | 1 | 3 | 3 | 2 | 0 | 9 | 5 | 3 | 7 | 6 | 8 | 29 |
| 4 | 1 | 5 | 2 | 2 | 1 | 11 | 6 | 0 | 4 | 3 | 8 | 21 |
| 5 | 6 | 6 | 7 | 9 | 7 | 35 | 5 | 6 | 10 | 8 | 10 | 39 |
| 6 | 7 | 3 | 6 | 5 | 4 | 25 | 8 | 3 | 6 | 6 | 6 | 29. |
| 7 | 5 | 3 | 8 | 4 | 3 | 23 | 8 | 7 | 8 | 6 | 6 | 35 |
| 8 | 5 | 4 | 6 | 2 | 1 | 18 | 3 | 4 | 11 | 7 | 9 | 34 |
| 9 | 2 | 2 | 7 | 7 | 6 | 24 | 6 | 3 | 9 | 9 | 7 | 34 |
| 10 | 8 | 2 | 4 | 1 | 2 | 17 | 4 | 7 | 8 | 10 | 9 | 38 |
| 11 | 6 | 5 | 6 | 2 | 3 | 22 | 8 | 10 | 10 | 9 | 10 | 47 |
| 12 | 1 | 3 | 5 | 0 | 4 | 13 | 6 | 4 | 10 | 9 | 10 | 39 |
| 13 | 6 | 7 | 9 | 1 | 5 | 28 | 2 | 7 | 8 | 9 | 9 | 35 |
| 14 | 1 | 0 | 0 | 3 | 6 | 10 | 4 | 5 | 9 | 10 | 10 | 38 |
| 15 | 2 | 5 | 10 | 8 | 7 | 32 | 5 | 8 | 8 | 8 | 9 | 38 |
| 16 | 0 | 2 | 1 | 2 | 2 | 7 | 2 | 0 | 5 | 10 | 9 | 26 |
| 17 | 6 | 4 | 1 | 2 | 0 | 13 | 6 | 5 | 10 | 9 | 10 | 40 |
| 18 | 0 | 0 | 0 | 0 | 0 | 0 | 7 | 8 | 10 | 9 | 11 | 45 |
| 19 | 6 | 3 | 4 | 3 | 2 | 18 | 5 | 5 | 8 | 7 | 9 | 34 |
| 20 | 2 | 2 | 1 | 3 | 4 | 12 | 5 | 8 | 9 | 5 | 9 | 36 |
| 21 | 4 | 2 | 5 | 5 | 1 | 17 | 1 | 2 | 8 | 11 | 12 | 34 |
| 22 | 0 | 0 | 2 | 4 | 0 | 6 | 1 | 4 | 7 | 8 | 8 | 28 |
| 23 | 2 | 7 | 9 | 9 | 9 | 36 | 4 | 7 | 9 | 9 | 5 | 34 |
| 24 | 8 | 7 | 8 | 9 | 9 | 41 | 0 | 0 | 0 | 1 | 0 | 1 |
| TOTAL | 93 | 82 | 116 | 89 | 83 | 463 | 112 | 121 | 193 | 189 | 203 | 818 |

Statistical analysis for egg production:

Test for the significance of difference in egg production between the control and experimental group of birds of both the breeds was done. Table 10 and 11 shows the analysis of variance between the two groups, and fortnights and interaction between groups and fortnights.

Table 10

Table showing the analysis of variance between the groups in Rhode Island Red breed

| Sources of variation | D.F. | S.S. | M.S. | F. |
|---|---|---|---|---|
| Between groups | 1 | 18.47 | 18.47 | 41.98** |
| Between interval | 4 | 13.33 | 3.33 | 7.57** |
| Between group and interval | 4 | 10.41 | 2.60 | 5.91** |
| Error | 226 | 99.97 | 0.44 | |
| TOTAL | 235 | 142.18 | | |

** Significant at 1% level.

From the analysis of variance highly significant difference in egg production was found at all the stages.

Table 11

Table showing the analysis of variance between the groups in White Leghorn breed

| Sources of variation | D.F. | S.S. | M.S. | F. |
|---|---|---|---|---|
| Between groups | 1 | 21.88 | 21.88 | 60.78** |
| Between interval | 4 | 7.43 | 1.86 | 5.17** |
| Between group and interval | 4 | 6.26 | 1.56 | 4.33** |
| Error | 230 | 82.60 | 0.36 | |
| TOTAL | 239 | 118.17 | | |

** Significant at 1% level.

From the analysis of variance highly significant difference in egg production was found at all the stages.

From the perusal of table 8 and 9 it appears that the experimental birds had an increase in egg production from the second fortnight in both the breeds. The overall production of the control and experimental birds of the Rhode Island Red breed was 34.8 per cent and 43 per cent respectively while that of the White Leghorn breed was 34 per cent and 40.6 per cent before the start of the experiment during the period of observation of 20 days. The daily egg production of the control and experimental group of Rhode Island Red birds varied from 3 to 16 and 8 to 13 respectively and in White Leghorn birds it varied from 2 to 12 and 6 to 14 in the control and experimental group

during the period of observation of 20 days.

The overall production of the control and experimental birds of Rhode Island Red breed was 19.7 and 38 per cent while that of White Leghorn breed was 27.5 and 48.7 per cent during the period of 10 weeks of the experiment respectively.

The weekly egg production in the control and experimental group of Rhode Island Red birds varied from 13 to 68 and 20 to 86 respectively and in White Leghorn birds it varied from 27 to 58 and 47 to 105 in the control and experimental group respectively. The approximate weekly difference in egg production between the control and experimental birds of both the breeds is given in table below.

Table 12

Table showing the percentage of increased egg production in the experimental groups at weekly intervals in both the breeds

| Week | Rhode Island Red | White Leghorn |
|---|---|---|
| 1 | 5 | 3.6 |
| 2 | 5 | 46 |
| 3 | 120 | 74 |
| 4 | 64 | 34 |
| 5 | 6 | 52 |
| 6 | 72 | 81 |
| 7 | 150 | 80 |
| 8 | 157 | 155 |
| 9 | 258 | 135 |
| 10 | 467 | 155 |

From the table it appears that the increase in egg production was perceptible from third week in case

of Rhode Island Red birds and second week in case of White Leghorn birds. There is definite indication that the beneficial effect of Terramycin egg formula was more perceptible in both the breeds with the progress of the experiment being very high during the last three weeks. The number of poor layers producing eggs below ten during the entire experimental period in the control and experimental group of Rhode Island Red breed was nine and three respectively and in the White Leghorn breed it was four and one for the control and experimental group respectively.

The Terramycin egg formula which consists of an antibiotic as well as some vitamins (composition mentioned in the chapter of Introduction) has been effective in reducing the heat stress by increasing the egg production in the experimental group of both the breeds.

The weekly average maximum room temperature during the entire experimental period of ten weeks is given in table below.

Table 13

Table showing the weekly average maximum room temperature during the experimental period

| Weeks | Temperature(°F) | Weeks | Temperature(°F) |
|---|---|---|---|
| 1 | 109.4 | 6 | 87.4 |
| 2 | 110.0 | 7 | 87.7 |
| 3 | 97.8 | 8 | 91.4 |
| 4 | 91.4 | 9 | 87.4 |
| 5 | 93.1 | 10 | 93.1 |

It is observed that although the temperature dropped

down appreciably during the last few weeks of the experiment the control group of birds of both the breeds could not improve in egg production. This decline in egg production of the control groups can be attributed to a continuous lack of greens in the ration or in other words a deficiency of vitamin A.

As quoted by Ewing (1951), the effect of vitamin A on egg production was strikingly demonstrated by tests conducted at the U.S. Poultry Experiment Station at Glendale, Arizona. In these tests a series of groups of 25 mature White Leghorn pullets, which had been matured on alfalfa range, was used. These groups were placed in laying pens where no feed, other than that given, was available. The basal diet was an all-in-one mash which was practically free from vitamin A. Various vitamin A feeds were used as supplements to the basal diet. One group, which received no supplement to the basal diet, was used as a check to measure the effect of vitamin A on egg production.

During the first 28 day period the check pen produced 193 eggs while the pen receiving fresh green alfalfa as a supplement produced 237 eggs. At the end of 84 days, the check pen had produced 508 eggs, and the pen which had received the green alfalfa supplement produced 817 eggs. The experiment was conducted over a period of 364 days during which time the no-supplement pen produced only 682 eggs while the pen receiving fresh green alfalfa produced 3,021 eggs.

t is interesting to note that during the period of this
periment all birds in the no-supplement pen died where as
y six died in the pen receiving fresh green alfalfa.

In the present experiment the experimental group of
of both the breeds received on an average vitamin A
units and Riboflavin 0.43 mg. per bird per day from
rramycin egg formula.

The daily requirement of a laying hen is 200 [illegible] ts
min A and 1.0 mg. of Riboflavin in her diet
ded by the N.R.C.

hat is, the birds were getting approximate[illegible]
itamin A requirement and double ⅓ of the Riboflav[illegible]
nt from the Terramycin egg formula daily [illegible]
h.

has been observed by Popper and Volk (1[illegible]3) [illegible]
n A absorption increases approximately [illegible]
dispersion. Thus the birds might have [illegible]
ly double ⅓ of the requirement of vitamin A f[illegible]
egg formula in addition to the vitamin [illegible]
sh.

(1963) conducted a similar experiment
gg formula for a period of ten weeks.
t the difference in egg production was only
rom the seventh week onwards in the experimental
perimen the present experiment it was perceptible
ntrol g[illegible]y. This difference in observation may
[illegible]ed to the fact that the former experiment

It is interesting to note that during the period of this experiment all birds in the no-supplement pen died where as only six died in the pen receiving fresh green alfalfa.

In the present experiment the experimental group of birds of both the breeds received on an average vitamin A 333.3 units and Riboflavin 0.43 mg. per bird per day from the Terramycin egg formula.

The daily requirement of a laying hen is 2000 units of vitamin A and 1.0 mg. of Riboflavin in her diet as recommended by the N.R.C.

That is, the birds were getting approximately 1/6th of the vitamin A requirement and double of the Riboflavin requirement from the Terramycin egg formula daily in aqueous dispersion.

It has been observed by Popper and Volk (1948) that the vitamin A absorption increases approximately three times in aqueous dispersion. Thus the birds might have received approximately double of the requirement of vitamin A from the Terramycin egg formula in addition to the vitamin A available from the mash.

Verma (1963) conducted a similar experiment on Terramycin egg formula for a period of ten weeks. He observed that the difference in egg production was only perceptible from the seventh week onwards in the experimental birds, while in the present experiment it was perceptible from second week only. This difference in observation may possibly be attributed to the fact that the former experiment

was conducted during the months of August and September when the adverse effect of high temperature is much less as compared to the months of June and July and also possibly due to the fact that in his experiment the birds were getting greens (Gadpurna) in their ration, while in this experiment, there was a complete lack of greens.

Adverse effects of high environmental temperature and humidity:

The adverse effect of high temperature was observed in both the groups of birds of both the breeds. During the second week of the experiment when the temperature was as high as 110°F, there was a precipitous drop in egg production in the control and experimental group of Rhode Island Red bird and in the control group of White Leghorn bird, the observation being similar to that of the animal protein group and vegetable protein group after reversal when their egg production also dropped very low during the same period. While the drop in egg production continued in the third week also in the control group of birds of both the breeds, from the fourth week onwards the control group of birds of both the breeds improved in their egg production. This improvement in egg production from the fourth week was fairly maintained by the control group of birds of the White Leghorn breed for the rest of the period of the experiment. On the other hand, the egg production of the control group of the Rhode Island Red birds again started

dropping from the sixth week (middle of July) when atmospheric humidity was very high, and continued to decrease till the end of the experiment.

This gives an indication that Rhode Island Red birds could not withstand high temperature as well as high humidity as compared to the White Leghorn birds which is evident from the trend of egg production of the control group of birds of the two breeds.

Our findings on the beneficial effect of Terramycin egg formula are in general agreement with the works done by Balloun (1954), Lillie and Sizemore (1954), Heywang (1956, 1959), Querner and Staufenbiel (1959), Saxena and Kumar (1959), Mantel and Prill (1959), Ryan *et al.* (1961), Gerriets (1961), Srivastava and Bose (1962), Curto *et al.* (1963), Potter *et al.* (1963) and Verma (1963).

Egg production after withdrawal of Terramycin egg formula from drinking water:

Recording of egg production was continued for a period of 20 days after the withdrawal of Terramycin egg formula from the drinking water to see its residual effect on egg production, the ration of the birds being the same as before.

Table 14 shows the weekly egg production of the control and experimental groups of birds of both the breeds after withdrawal of the Terramycin egg formula from the drinking water.

Table 14

Table showing the weekly egg production of the control and experimental birds of both the breeds after the withdrawal

| Week | Rhode Island Red | | White Leghorn | |
|---|---|---|---|---|
| | Control | Experimental | Control | Experimental |
| 1 | 25 | 74 | 42 | 84 |
| 2 | 28 | 61 | 30 | 94 |
| 3( 6 days record only) | 16 | 54 | 35 | 71 |

From the table it appears that the residual effect of Terramycin egg formula in the experimental birds continued till the period of observation of 20 days after withdrawal. The average production of the experimental group of birds of the Rhode Island Red and White Leghorn were 63 and 83 respectively after the withdrawal, which is almost similar to the overall average production of the birds of the experimental group of Rhode Island Red and White Leghorn which was 63.8 and 81.8 respectively. The egg production of the control group of the birds of both the breeds were also similar to that of the production during the experimental period.

Efficiency of food conversion:

Efficiency of food conversion has been determined by calculating the amount of food consumed per dozen of eggs by both the groups in both the breeds. Table 15 and 16 gives the weekly egg production, feed consumption and amount of food consumed per dozen of eggs by both the groups in both the breeds.

Table 15

Table showing the weekly egg production, feed consumption and feed consumed per dozen of eggs by the control and experimental group of birds of Rhode Island Red breed

| Weeks | Control | | | Experimental | | |
|---|---|---|---|---|---|---|
| | No. of eggs produced | Feed consumed (lbs) | Feed consumed per dozen (lbs.) | No. of eggs produced | Feed consumed (lbs.) | Feed consumed per dozen (lbs.) |
| 1 | 40 | 20.0 | 6.0 | 42 | 20.0 | 5.7 |
| 2 | 19 | 25.5 | 16.1 | 20 | 25.5 | 15.3 |
| 3 | 15 | 33.5 | 26.8 | 33 | 31.5 | 11.4 |
| 4 | 39 | 33.5 | 10.3 | 64 | 34.5 | 6.4 |
| 5 | 68 | 23.5 | 4.1 | 72 | 29.5 | 4.9 |
| 6 | 43 | 28.5 | 7.9 | 74 | 32.5 | 5.25 |
| 7 | 33 | 31.1 | 11.3 | 85 | 39.5 | 5.6 |
| 8 | 29 | 34.0 | 14.1 | 77 | 39.5 | 6.1 |
| 9 | 21 | 27.6 | 15.8 | 86 | 35.5 | 4.9 |
| 10 | 13 | 22.4 | 20.5 | 85 | 27.5 | 3.9 |

Average per dozen = 13.29 lbs. Average per dozen = 6.94 lbs.

Table 16

Table showing the weekly egg production, feed consumption and feed consumed per dozen of eggs by the control and experimental group of birds of White Leghorn breed

| Weeks | Control | | | Experimental | | |
|---|---|---|---|---|---|---|
| | No. of eggs produced | Feed consumed (lbs.) | Feed consumed per dozen (lbs.) | No. of eggs produced | Feed consumed (lbs.) | Feed consumed per dozen (lbs.) |
| 1 | 56 | 20.0 | 4.2 | 58 | 23.0 | 4.75 |
| 2 | 37 | 25.5 | 8.2 | 54 | 27.5 | 6.1 |
| 3 | 27 | 26.5 | 11.75 | 47 | 35.5 | 9.0 |
| 4 | 55 | 28.5 | 6.2 | 74 | 28.5 | 4.7 |
| 5 | 58 | 23.5 | 4.9 | 88 | 30.5 | 4.1 |
| 6 | 58 | 32.5 | 6.7 | 105 | 32.5 | 3.7 |
| 7 | 51 | 32.5 | 7.6 | 92 | 37.5 | 4.9 |
| 8 | 38 | 33.5 | 10.6 | 97 | 36.5 | 4.5 |
| 9 | 43 | 29.5 | 8.2 | 101 | 36.5 | 4.3 |
| 10 | 40 | 27.5 | 8.2 | 102 | 28.5 | 3.4 |

Average per dozen = 7.65 lbs. Average per dozen = 4.94 lbs.

From the tables it appears that efficiency of food conversion was very much improved in the experimental birds as compared to the controls in both the breeds.

The weekly variation in feed consumption per dozen of eggs in the control and experimental groups of birds in the Rhode Island Red breed was from 4.1 to 26.8 lbs. and 3.9 to 15.3 lbs. respectively. While in the White Leghorn birds it varied from 4.2 to 11.75 lbs. and 3.4 to 9.0 lbs. in the

control and experimental groups respectively.

Economics of using Terramycin egg formula:

An approximate estimate was made on the economy of using Terramycin egg formula. The Terramycin egg formula was used @ 8 gm. daily on an average. The approximate price of one gm. of Terramycin egg formula = 13.3 nP. The total cost of Terramycin egg formula for a period of 10 weeks of the experiment = Rs. 74.20 nP.

The number of extra eggs produced by the experimental birds of both the breeds = 673 or 56 dozens approximately. Considering the average price of the eggs @ Rs.2.50 nP. per dozen, the price of extra eggs = Rs. 140/-.

For producing extra eggs the experimental birds of both the breeds consumed 73 lbs. of extra food, the price of which works out to be Rs.14.60 nP. approximately @ Rs.16/- per maund. Therefore, the total extra expenditure including the cost of Terramycin egg formula and the feed = Rs.88.80 nP.

Net gain over a period of 10 weeks on 48 birds = Rs.51.20 nP .

Body weight:

The average body weights of the control and experimental birds of both the breeds taken before the experiment, then again in the middle and finally at the end of the experiment is presented in table 17.

Table 17

Table showing the average body weights of the control and experimental birds of both the breeds at different stages

| Weight at different intervals | Rhode Island Red | | White Leghorn | |
|---|---|---|---|---|
| | Control, weight (lbs.) | Experimental, weight (lbs.) | Control, weight (lbs.) | Experimental, weight (lbs.) |
| Ist weight (before commencement of experiment | 4.43 | 3.97 | 3.44 | 3.31 |
| 2nd weight | 3.99 | 4.04 | 3.48 | 3.47 |
| 3rd weight (final) | 4.19 | 4.38 | 3.78 | 3.72 |

Analysis of variance was done to find out the difference in body weights between the control and experimental groups of birds of both the breeds, which is given in table 18 and 19.

Table 18

Table showing the analysis of variance for body weights in Rhode Island Red birds

| Sources of variation | D.F. | S.S. | M.S. | F. |
|---|---|---|---|---|
| Between groups | 1 | 0.06 | 0.06 | 0.21 |
| Between interval | 2 | 1.36 | 0.68 | 2.34 |
| Between group and interval | 2 | 3.68 | 1.84 | 6.34 |
| Error | 136 | 39.84 | 0.29 | |
| TOTAL | 141 | 44.94 | | |

From the analysis of variance no significant difference in body weight was found.

Table 19

Table showing the analysis of variance for body weights in White Leghorn birds

| Sources of variation | D.F. | S.S. | M.S. | F. |
|---|---|---|---|---|
| Between groups | 1 | 0.16 | 0.16 | 0.67 |
| Between interval | 2 | 3.53 | 1.76 | 7.33 |
| Between group and interval | 2 | 0.76 | 0.38 | 1.58 |
| Error | 138 | 33.30 | 0.24 | |
| TOTAL | 143 | 37.75 | | |

From the analysis of variance no significant difference in body weight was found.

Egg weight:

The group egg weight was taken daily and the average weight of the egg of both the group of both the breeds is given in table below.

Table 20

Table showing the average weight of an egg of the control and experimental birds of both the breeds

| Group | Rhode Island Red | White Leghorn |
|---|---|---|
| Control | 1.8 oz. | 1.98 oz. |
| Experimental | 1.9 oz. | 2.0 oz. |

There was no difference in egg weight between the groups in both the breeds.(Statistical analysis could not be done as individual weight of the egg was not taken)

**Mortality:**

During the experimental period only 3 birds of the control group of the Rhode Island Red breed died.

# C H A P T E R - V

## SUMMARY

Studies on 48 Rhode Island Red birds and 48 White Leghorn birds of the same hatch, divided into two similar groups, were made to see the effect of Terramycin egg formula (Pfizer) on egg production during stress such as high temperature and high humidity.

The birds were placed in individual cages. The experimental birds received Terramycin egg formula in drinking water @ 2 gm. per gallon. Both the groups were fed mash mixture having animal protein and a crude protein content of 21.56 per cent.

The experiment continued for a period of 10 weeks (June - August) after which the residual effect of Terramycin egg formula on egg production was studied for a period of 20 days.

The difference in egg production was highly significant , the experimental birds having an increased production of 99.4 and 76.7 per cent over the controls in the Rhode Island Red and White Leghorn birds respectively.

The difference in egg production was perceptible from the third week in Rhode Island Red birds and from the

second week in White Leghorn birds, being highest during the last three weeks in both the breeds.

Efficiency of food conversion in terms of egg production was highly significant in the experimental birds of both the breeds. The average food consumed per dozen of eggs in Rhode Island Red birds was 13.29 lbs. for the control group and 6.94 lbs. for the experimental group.

In White Leghorn birds the average food consumed per dozen of eggs was 7.65 lbs. for the control group and 4.94 lbs. for the experimental group.

No significant change in body weights in both the groups of both the breeds was observed.

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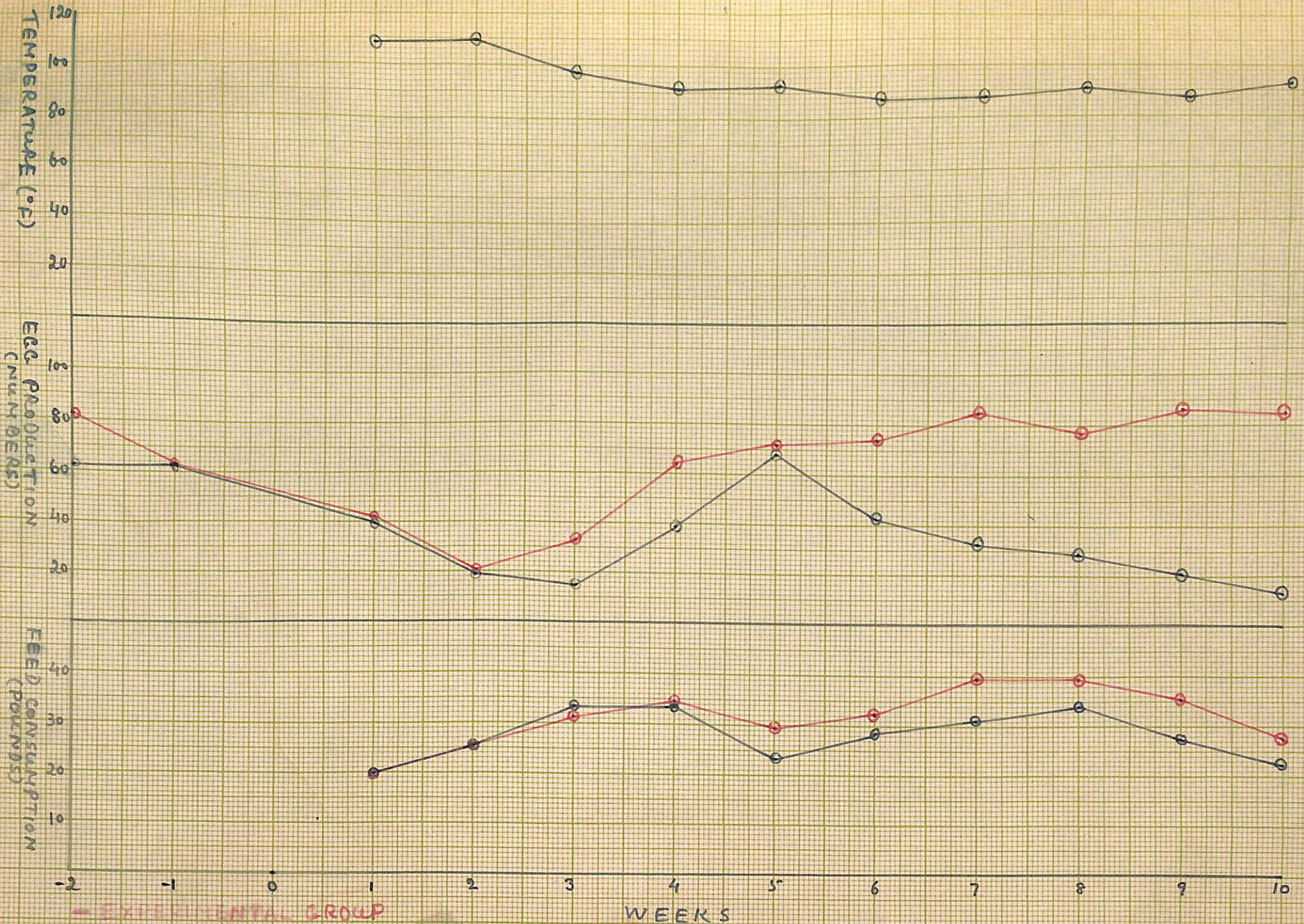
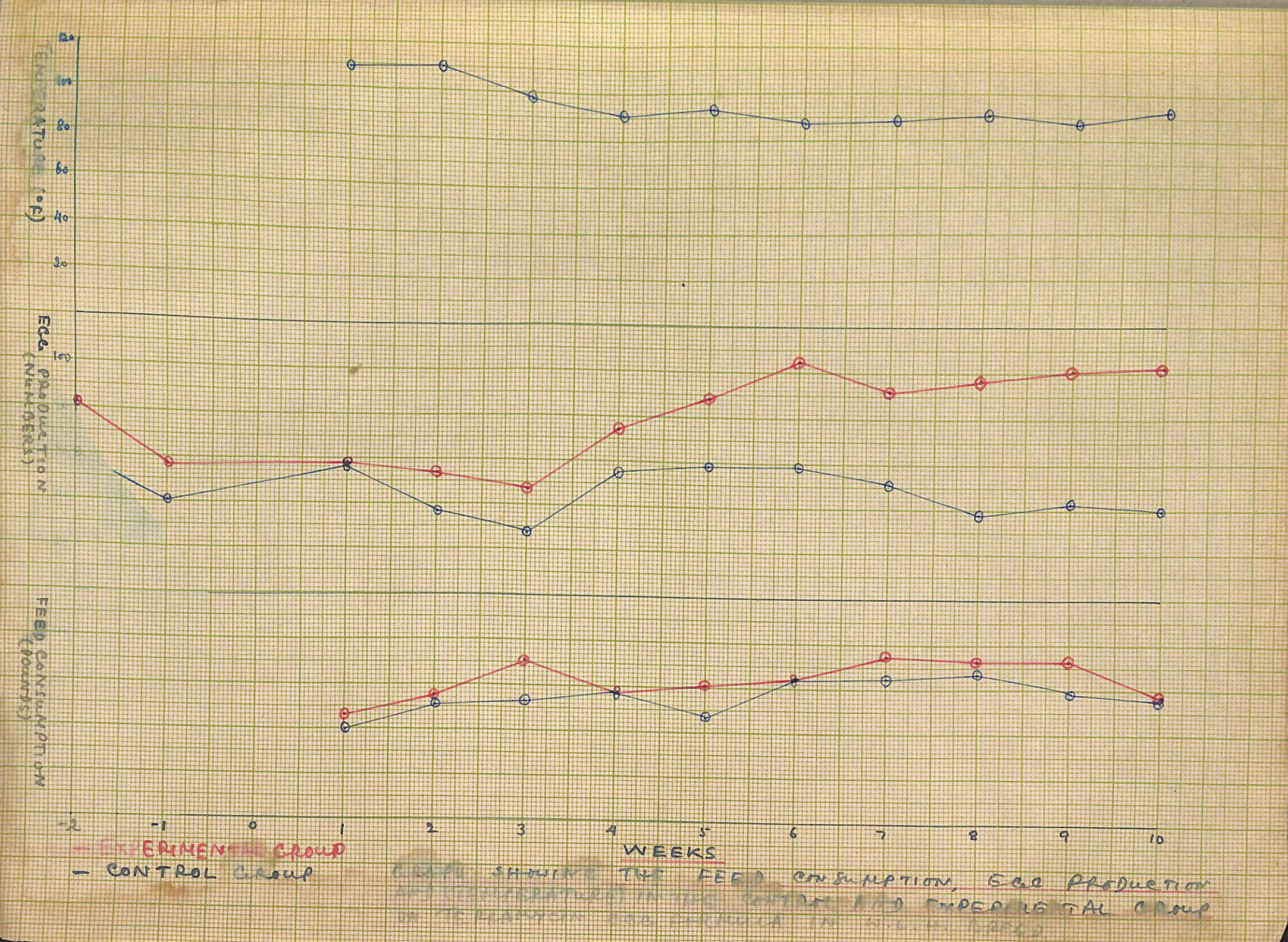



GRAPH SHOWING THE FEED CONSUMPTION, EGG PRODUCTION AND (TEMPERATURE) IN THE CONTROL AND EXPERIMENTAL GROUP ON TERRANYCIN EGG FORMULA IN R.I.R. BREED.




GRAPH SHOWING THE FEED CONSUMPTION, EGG PRODUCTION AND TEMPERATURE IN THE CONTROL AND EXPERIMENTAL GROUP OF THE PHEASANTS [illegible]