FEEDING VALUE OF RUBBER SEED MEAL FOR LAYING HENS

By

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THESIS

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DECLARATION

I hereby declare that this thesis entitled " FEEDING VALUE OF RUBBER SEED MEAL FOR LAYING HENS" is a bona fide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship, or other similar title, of any other University or Society.

Amrithavally 12/8/77

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Mannuthy,
12-8-1977.

CERTIFICATE

Certified that this thesis, entitled "FEEDING VALUE OF RUBBER SEED MEAL FOR LAYING HENS" is a record of research work done independently by Smt. Amrithavally Panan under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship, or associateship to her.

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C O N T E N T S

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INTRODUCTION

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Diet surveys in India have indicated quantitative inadequacy and qualitative insufficiency in Indian diets. Though there has been a steady increase in agricultural production, it is insufficient to bridge the gap of calorie and protein requirements. An additional feature of Indian diet is the gross deficiency in protective feeds. In this context the necessity of increasing production of poultry meat and egg at cheaper cost assumes greater importance. During the last decade, poultry sector in India has made tremendous progress through scientific production practices. The total poultry population in India according to 1972 census was 137 millions. The total egg production in 1976 was estimated to be 9,290 millions and the target for 1979 is 12,000 million eggs (Anon, 1977a).

The major cost factor in poultry production is feed, accounting for about two-thirds of the total cost involved. The increasing chicken population with its higher production potential is directly competing with human population for high quality feeds such as cereals and other ingredients which are already in short supply. The situation is followed by increasing prices of most of the feed ingredients, resulting in higher cost of this major input in production.

Presently, the availability of common protein sources for poultry is not encouraging. The prices of groundnut oil cake and fish meal, the two major conventional sources of protein, have increased enormously. The groundnut oil cake is being diverted to other industries, while fish meal production has gone down in India. Even trash fish is being largely consumed by human population. Therefore, it has become necessary to explore newer unconventional feed resources for poultry.

Poultry being one of the most efficient converters of feed stuffs of low quality into products of high quality such as eggs and poultry meat, it is essential to develop rations for poultry that promote maximum response at least cost without competing with the necessities of human dietaries. Formulation of well balanced ration for poultry employing feeds which are unfit for human consumption is a recent trend in poultry nutrition. To achieve this, many agricultural byproducts and industrial wastes have been tried, which would not only relieve the pressure on conventional ingredients but would enable formulation of least-cost rations.

With this objective in mind poultry nutritionists around the globe have been trying out many alternate sources, which are cheap, locally available and not in use by other industries in order to be of value for the purpose intended.

Many alternate ingredients that might meet the protein requirements of chickens in the place of the conventional items are available in India. Some of these substitutes have been shown to replace groundnut cake in poultry rations partially or completely without affecting growth and production adversely. Rubber seed meal may be a newer addition to this category of ingredients, at least in areas where it is available.

In India, rubber (Hevea brasiliensis) is cultivated in an area of 2.18 lakh hectares (Anon, 1976a), out of which 2.02 lakh hectares are in Kerala (Anon, 1977b). Tempany (1947) reported that one ton of rubber seed could be obtained from 10-15 acres of rubber plantation. In Kerala, it appears that one tonne of rubber seed could be collected from four hectares of land under rubber cultivation. It is estimated that about 46,965 tonnes of rubber seed now mostly wasted in Kerala could be utilised for producing cake and inedible oils. About 11,700 tonnes of oil could be produced from the seeds in Kerala and its minimum value would come to Rs.4.68 crores. The value of oil cake would come to Rs. 48.9 lakhs (Varghese, 1972).

Azeemoddin and Rao (1962) reported that the average cost of rubber seed as Rs.300/- per tonne in India. In Kerala, the cost of rubber seed was estimated at Rs.200/- per tonne (Varghese, 1972).

Various researches have been reported on the utilisation of rubber seed meal in larger animals. It has been found that rubber seed meal could be efficiently utilised in cattle and swine rations (Pope, 1930; Dawson and Messenger, 1932; Morrison, 1957; George, 1970 and Anon, 1976b). Regarding the utilisation of rubber seed meal by chicken, the information available in the literature is rather scanty, barring a few reports from Ceylon and Malaysia; work in India with this valuable protein source is meagre. Therefore, this study was undertaken with a view to assess the feeding worth of rubber seed meal for laying hens with special reference to the more important characters like egg production, feed efficiency, body weight maintenance, livability and egg quality.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Decorticated rubber seed cake was comparable in nutritive value and digestibility with linseed cake and decorticated cotton seed cake and hence could be used as a feeding stuff (Anon, 1919).

Morrison (1957) reported that rubber seed meal was not much palatable but gave as good results as linseed meal when fed to milk cows and fattening cattle along with other feeds at a rate of 5 lbs per animal.

Bredemann (1931) reported that rubber seed products contained about 0.02 per cent of hydrocyanic acid and that while using the same as livestock feed this factor had to be borne in mind. But George et al. (1932) opined that hydrocyanic acid content of rubber seed meal (RSM) varied widely and it diminished rapidly during storage. Nadarajah (1969) also made similar observations. Lauw Tjin Giok et al. (1967) reported a value of 200 mg of hydrocyanic acid per 100 g of the fresh rubber seed. Hydrocyanic acid content of 9 mg/100 g of rubber seed cake has also been reported (Anon, 1976b).

Pope (1930) conducted comparative feeding tests in cows using rubber seed meal and linseed meal and found that rubber seed meal was better. The use of rubber seed meal as animal feed could be unwise as poisoning due to prussic acid was a possible drawback (Anon, 1948). It was suggested that unless a large part of its oil is extracted, rubber seed cake is not likely to make a suitable cattle feed (Dawson and Messenger, 1932 and Sen, 1952). But Bhushan (1958) reported that rubber seed cake was one of the most digestible cattle feed concentrates available and its nutritional value was equal to that of linseed cake and that the small amount of prussic acid presented no danger to livestock.

The composition and nutritive value of kernels of the seeds of Hevea brasiliensis were investigated by various workers They reported the proximate composition on percentage basis within the following range: crude protein 17.8-28.8, ether extract 3.8-49.49, crude fibre 3.8-10, mineral matter 3.1-6.39, nitrogen free extract 20.7-40.03, calcium 0.86-0.93 and phosphorous 0.65-0.71 (Morrison, 1957; Siqueira et al. 1955; Sankunny et al. 1964; Hyderali, 1970; Bhuvanendran and Siriwardene, 1970; Siriwardene and Nugara, 1972; Orok and Bowland, 1974 and Oluyemi et al. 1976). The difference in composition was attributed to methods of processing (Buvanendran and Siriwardene, 1970).

Amino acid composition of decorticated rubber seed has also been reported by many workers. The amino acid content ranged as follows: Isoleucine 3.1-4.2, Leucine 6.7-7.1, Lysine 3.6-5.4, Phenyl-alanine 3.8-4.8, Tyrosine 2.6-2.8, Cystine 1.4-2.9, Methionine 1.1-2.2, Threonine 2.8-3.8, Tryptophan 1.2-1.4, Histidine 2-2.3 and Valine 6.4-8.0 mg/100 g of protein (Lauw Tjin Giok et al. 1967; Orok and Bowland, 1974 and Rajaguru and Vohra, 1975).

Fatty acid levels on percentage weight of decorticated rubber seed were Myristic 0.1, Palmatic 8.1, Stearic 10.5, Arachidic 0.3, Oleic 21.5, Linoleic 37.3, Linolenic 21.7, Arachidonic 0.2 and Free fatty acids 7.4 (FAO, 1972).

Vitamin content of 100 g of untreated rubber seed kernels was thiamine 450 μg, nicotinic acid 2500 μg and carotene 250 μg (Siqueira _et al_. 1955).

Siriwardene and Nugara (1972) observed the metabolizable energy value of rubber seed meal as 1788 K cal/kg in poultry diets. Orok and Bowland in 1974 reported the gross energy of rubber seed meal as 6.5 K cal/g. Oluyemi _et al_. (1976) reported the gross energy of autoclaved and raw rubber seed as 6.99 and 7.11 K cal/g respectively and that of defatted rubber seed meal as 4.48 K cal/g. They also reported the metabolizable energy (K cal/g) of whole rubber seed (raw) as 4.96 $\pm$ 0.29, whole rubber seed (autoclaved) as 4.58 $\pm$ 0.16 and defatted rubber seed meal as 2.46 $\pm$ 0.37.

Nutritive value of rubber seed meal was evaluated in rat diets. Rats fed a diet containing 52 per cent of defatted meal lost weight. When the defatted meal was heated at 100 to 105°C for two hours and then fed at a level of 50 per cent of the diet, rats accepted the food, but weight gains were poor (Siqueira _et al_. 1955). Feeding trial carried out in the Nutrition Laboratory of the Kerala Veterinary College and Research Institute in rats, with a ration containing 29.6 per cent rubber seed meal replacing 5 per cent of casein in the ration did not bring about any deleterious effects on the well being of albino rats as judged by body weight, red cell, haemoglobin and plasma protein concentration (Sankunny et al. 1964). Lauw Tjin Giok et al. (1967) conducted feeding trials with rubber seed protein using rats. The protein efficiency ratio was 2.3 which compared well with that of casein. The food intake of rats receiving 10 and 20 per cent rubber seed protein was almost the same as that of the casein fed control.

Nair (1969) conducted studies on the toxic effects of feeding rubber seed (20%) and rubber seed cake (20%) in 4-8 weeks old White Leghorn chicken, replacing groundnut cake completely in the ration. In addition, rubber seed oil was also fed orally to birds in one group to study the toxic effects. Weight gain and haematological values of rubber seed and rubber seed cake fed groups were comparable with control group. In the rubber seed oil fed group, there was progressive increase in weight during the first 10 weeks and after that there was slight reduction during the 12th week. There was also progressive reduction in haemoglobin level and erythrocyte count.

Buvanendran and Siriwardene (1970) have shown that rubber seed meal was a satisfactory substitute for coconut cake in broiler and layer diets in Sri Lanka. In broilers 20 per cent coconut meal or rubber seed meal or mixtures of them were given for seven weeks from two weeks of age. Broilers fed 15 or 20 per cent rubber seed meal gained more weight than those fed 10 per cent and control. The egg production or feed efficiency were not significantly affected even when the layer diets contained 25 per cent of rubber seed meal.

Rajaguru and Wettimuny (1971) evaluated the rubber seed meal in broiler ration and also in 12 week old White Leghorn pullet chicks. They concluded that rubber seed meal could be fed to broilers depending on the source of animal protein supplement used. It was found that rubber seed meal could be used satisfactorily upto 10 per cent level with meat meal with added methionine as protein source and upto 20 per cent with fish meal. In three months old pullets rubber seed meal could be used upto 40 per cent without affecting growth and feed efficiency. When rubber seed meal in the diet was increased there was reduction in growth in broilers and growers. Feed intake was also reduced as the rubber seed meal content increased above 30 per cent level Feather picking was also observed. On autopsy pale liver was noticed. The reason for this adverse effect was attributed to amino acid imbalance rather than the presence of deleterious factors.

Rajaguru (1971) reported the effect of feeding mature chicken with rubber seed meal at the rate of 10, 20, 30 and 40 per cent of ration with added methionine. Results showed that in pullets fed rubber seed meal diets, sexual maturity was delaye by 8-12 days in comparison to the control group. There was no effect on egg production. There was no statistical difference in egg weight, but the average weight of the eggs produced by the rubber seed meal fed groups was slightly lower at levels of 20 per cent and above. Increasing levels of rubber seed meal significantly lowered shell thickness, hatchability and the weights of chicks hathced out ($P \angle 0.05$). It was also found that the number of infertile eggs produced was significantly higher as the levels of rubber seed meal were increased ($P \angle 0.05$). This effect on layers was reported to be due to amino acid imbalance of rubber seed meal that lowered the biological value of protein in diets and also due to an unidentified antifertility factor. In case of male birds quality of semen was not affected with different levels of rubber seed meal. He concluded that rubber seed meal should not be used in breeder ration and in layers it could be used upto 20 per cent only.

Buvanendran (1971) studied the effect of rubber seed meal on hatchability of hen eggs. Rations containing 10, 20 and 25 per cent of rubber seed meal were given to White Leghorn pullets. Fertility was not affected in the experimental group. Hatchability was markedly affected in the treatment groups, the same was found to decrease with increasing levels of rubber seed meal in the ration. The average depression in hatchability was approximately 11 and 38 per cent in the 10 and 20 per cent rubber seed meal fed groups, when compared to controls. It was also found that depression in hatchability was affected from the 10th week of inclusion of rubber seed meal in the layer diets, which progressively worsened with time. He concluded that the depression in hatchability caused by feeding of rubber seed meal was probably due to a toxic factor in the meal since the hatchability decreased with increasing levels of the meal. The delay between the commencement of feeding the rubber seed meal and depression in hatchability was attributed to the possibility that the concentration of the toxic factor increased gradually in the blood stream but did not reach lethal levels to the embryo unless the meal had been in the layer diet for about 5-10 weeks. He opined that the lethal effect on the chick embryo could also be attributed to the presence of free fatty acids (FFA) in the rubber seed meal.

MATERIALS AND METHODS

MATERIALS AND METHODS

A feeding trial of 20 weeks duration was carried out at the Department of Poultry Science, College of Veterinary and Animal Sciences, Mannuthy to evaluate the feeding worth of rubber seed meal for caged layers. Thirty-six S.C. White Leghorn pullets of 20 weeks age constituted the experimental subjects. All the birds belonged to a single hatch and strain. At the start of the experiment these birds had attained 30 per cent production.

The birds were leg banded, weighed and randomly allotted to four groups of nine birds each. They were housed in individual standard laying cages (Fig. 1). The laying battery was placed in a well ventilated and well lighted room. Rubber seed meal incorporated in the experimental diets was analysed for proximate composition (ISI, 1968) and hydrocyanic acid content (A.O.A.C., 1970) (Table 1). The experimental diets were computed according to ISI (1968). Each group of birds was assigned at random with a different experimental diet. Diet I formed the control diet while diets II, III and IV contained 10, 15 and 20 per cent of rubber seed meal (Table 2). These diets were also analysed for proximate composition (Table 2a).

Feed and water were provided _ad libitum_ throughout the experimental period. Care was taken to keep the feed wastage minimum, by keeping the feed troughs always half-full. Shell grit was provided free choice to all the experimental birds.

Normal managemental practices were followed for the whole period of study. The experiment was carried out for a duration of five 28-day periods.

Table 1. Proximate composition of the rubber seed meal used in the experiment.

Nutrient	Per cent
Dry matter	93.90
Crude protein	26.59
Crude fibre	3.80
Ether extract	17.56
N.F.E.	45.55
Total ash	6.50
Acid insoluble ash	0.16
Calcium	0.35
Phosphorous	0.62
Hydrocyanic acid (mg)	5.17

Birds were weighed on the last day of each 28-day period and gain or loss in weight recorded to study the pattern of body weight maintenance of each group. Feed consumption for each period was recorded to calculate average mean daily feed consumption per bird. Daily record of egg production was maintained. The feed efficiency (Kg feed/dozen eggs) of each group was arrived at using the above data.

Table 2. Composition of experimental diets.

Ingredients (Parts/100)	Diet I	Diet II	Diet III	Diet IV
Maize	32	35	37	38
Groundnut cake	11	7	4	3
Gingelly oil cake	5	5	5	5
Rice polish	20	20	20	20
Rubber seed meal	-	10	15	20
Wheat bran	18	9	5	-
Dried fish	10	10	10	10
Starmin PS[1]	2	2	2	2
Shell meal	2	2	2	2
Total	100	100	100	100
Added per 100 kg of diet				
Vitablend[2] A, B_2 & D_3	25 g	25 g	25 g	25 g
Aurofac-2A[3]	125 g	125 g	125 g	125 g

1 Starmin PS (Shaw Wallace), the mineral mixture contained 28% calcium, 7% phosphorous, 0.5% iron, 0.008% iodine, 0.013% manganese, 0.005% cobalt, 17% sodium chloride and 0.25% fluorine.

2 Vitablend A, B_2 & D_3 (Glaxo Laboratories (India) Ltd.) contained 40,000 I.U. of Vitamin A, 25 mg of Vitamin B_2 and 6,000 I.U. of Vitamin D_3 per g respectively.

3 Aurofac-2A supplement (Cyanamid India Limited) contained 8 g of 'aureomycin' chlortetracycline per kg.

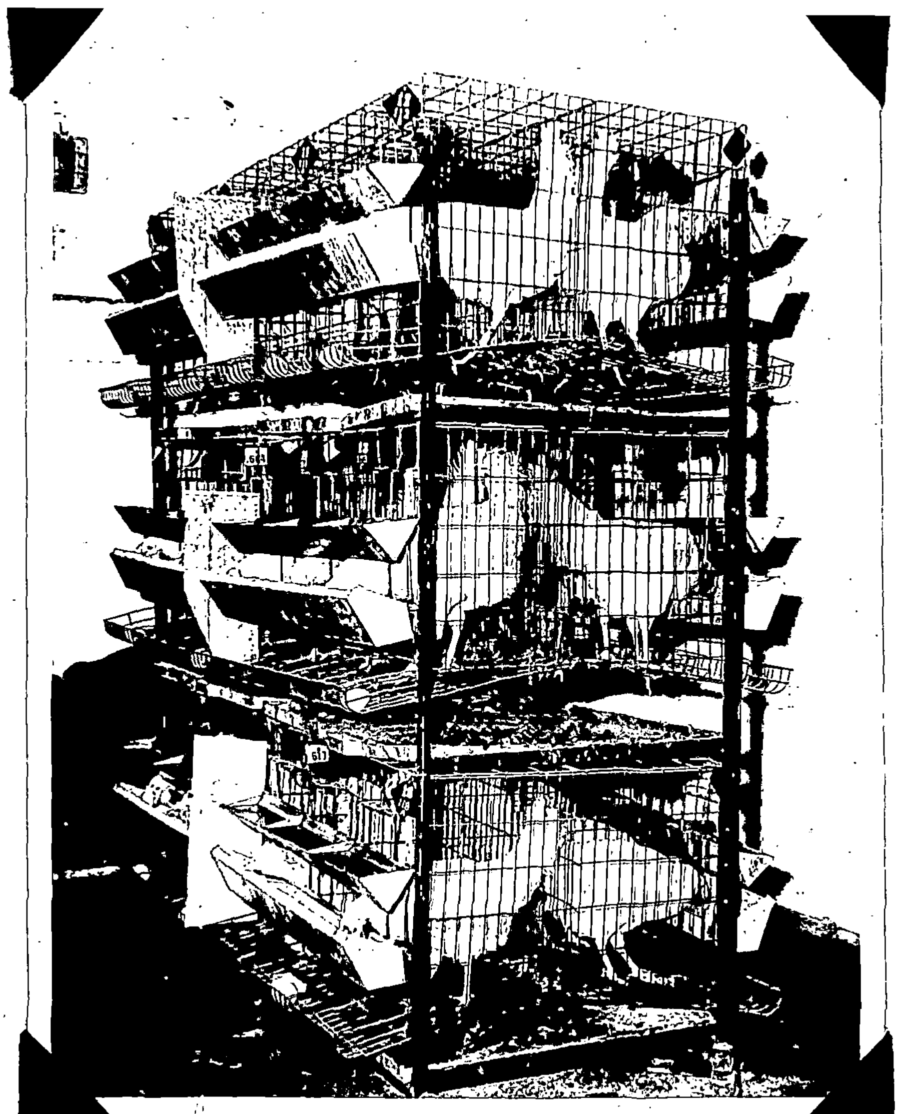
Table 2a. Proximate composition of the experimental rations. (Percentage)

	Diet I	Diet II	Diet III	Diet IV
Dry matter	92.50	91.10	91.00	91.00
Crude protein	15.10	15.20	15.60	15.70
Ether extract	6.31	7.20	8.10	8.14
Crude fibre	9.69	9.23	8.46	8.69
N.F.E.	55.97	54.98	53.63	55.36
Total ash	12.93	13.39	14.21	12.11
Acid insoluble ash	6.51	5.76	6.32	4.70
Calcium	2.36	2.61	2.68	2.57
Total phosphorous	1.06	1.08	0.99	0.87

During the last day of each 28-day period, three eggs from each treatment were collected at random and stored in a refrigerator for quality studies on the next day.

During the course of the experiment one bird in the group fed Diet II was found to be a nonlayer. At the end of the third period, this bird was autopsied and found to be an internal layer. Data pertaining to this bird was therefore discarded.

The data collected during the course of this investigation was subjected to statistical analysis (Snedecor and Cochran, 1967). The economics of feeding rubber seed meal was evaluated based on the overall performance of birds in the experiment.



R E S U L T S

R E S U L T S

Egg production

The mean percentage hen-day egg production (Table 3) was 72.88, 77.32, 69.68 and 58.33 for groups fed diet I (control diet), diet II (containing 10 per cent rubber seed meal), diet III (containing 15 per cent rubber seed meal) and diet IV (containing 20 per cent rubber seed meal) respectively. Statistical analysis of the data (Table 12) showed significant differences in mean egg production among treatment groups ($P < 0.05$). However, groups fed diets I, II and III had comparable egg production as the differences between these were not statistically significant. Birds receiving diet IV laid significantly lesser number of eggs during the experimental period than the groups fed diet I and diet II. Neverthless, mean egg production between groups fed diets III and IV did not differ significantly.

Feed consumption

Data on mean daily feed consumption is presented in the table 4. Statistical analysis of the data showed significant differences ($P < 0.01$) among treatments (Table 12). There was no significant differences in feed intake between groups fed diet I and diet II, whereas diet III and diet IV were significantly different from diets I and II in this regard. There was no significant differences between groups III and IV in respect of this parameter. Average feed consumption of birds in different periods also differed significantly ($P \angle 0.01$). Feed intake of birds during the first three periods was lower than that of periods 4 and 5 and differed significantly. However, the differences in feed consumption among the first three periods and between the last two periods did not differ significantly.

Feed efficiency

Data on feed efficiency is presented in table 5. Statistical analysis revealed no significant differences among treatments though the group fed diet III appeared to be superior to other groups in feed conversion efficiency. However, the differences in mean feed efficiency of the experimental groups periodwise were statistically significant ($P \angle 0.01$). The feed efficiency observed during the second period was the highest and differed from that registered during the third, fourth and fifth periods, while the difference in feed efficiency between the periods 1 and 2 was not statistically significant. Feed efficiency observed during the first period was also significantly higher than that recorded during the fourth and fifth periods. Similarly feed efficiency observed during third period was found to be significantly more when compared to that during the fifth period ($P \angle 0.01$). The values in feed efficiency during periods 4 and 5 also showed significant differences. Feed efficiency of birds during the fifth period was significantly less when compared to other periods (Table 12).

Body weight

Average body weight of birds for the 5 periods are given in table 6. Birds fed diet II maintained better body weight than the other groups, but this difference was not statistically significant (Table 11). In fact, there were no significant differences in body weight of birds among the different treatments as well as periods.

Egg weight

Average egg weight for various dietary treatments are shown in table 7. Mean weight of eggs laid by birds in the control group differed significantly ($P < 0.01$) from that of the treatment groups. The best egg weight was recorded for the control group (diet I), while mean egg weights of birds fed experimental diets did not differ significantly. The egg weight registered by the birds on diet II, diet III and diet IV was lower. However, these treatments did not differ significantly among themselves. The differences in mean egg weight among periods were statistically significant ($P < 0.01$). Lowest egg weights were recorded during the first period. Egg weight progressively increased upto the fifth period. The differences in egg weight among periods 1, 3, 4 and 5 were statistically significant. Similarly, egg weights during the second period differed significantly from that of 4th and 5th periods; likewise the eggs laid during the third period were significantly lower in weight than those of the fifth period. However, the differences in mean egg weights between periods 4 and

5 were comparable (Table 13).

Internal egg quality

Mean values of per cent albumen, per cent yolk and per cent shell are separately shown in tables 8, 9 and 10. Statistical analysis of the data on per cent albumen (Table 13) showed no significant differences due to diets, but the differences among periods were significant ($P < 0.01$). Eggs laid by the experimental birds during the first and second periods had significantly more per cent albumen than the rest of the experimental periods. However, there was no significant difference in per cent albumen among eggs laid during periods 3, 4 and 5.

Statistical analysis of the data on per cent yolk after angular transformation is presented in table 13. Per cent yolk was found comparable in the different dietary treatments, but there were significant difference among periods in per cent yolk. Per cent yolk in periods 1 and 2 was significantly less when compared to periods 3, 4 and 5. The differences observed among periods 3, 4 and 5 were not found to be significant.

No abnormal yolk or albumen conditions were observed and yolk colour was more or less uniform in eggs studied from all groups.

Statistical analysis of the data on per cent shell of random eggs studied is presented in table 13, after angular transformation. The analysis showed that the group fed diet I had lower per cent shell than the groups fed diets II, III and IV. These differences were found to be significant ($P < 0.01$). Group fed diet II differed significantly from group fed diet III with regard to this trait. Neverthless, there were no significant differences in per cent shell of eggs among periods.

Economic aspect of using rubber seed meal

Cost of feed per dozen eggs produced was worked out and presented in table 14. Cost of feed per dozen eggs was Rs 2.54, Rs 2.30, Rs 2.13 and Rs 2.52 for diets I, II, III and IV respectively.

Mortality

One bird died during the entire experimental period. This belonged to the control group.

Table 3. Hen-day egg production (per cent) as influenced by the different diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	71.43	76.98	75.79	72.32	67.86	72.88^{b}
2	61.16	83.48	82.14	83.04	76.79	77.32^{b}
3	71.83	82.54	69.84	73.41	50.79	69.68^{ba}
4	71.03	71.43	50.79	48.01	50.40	58.33^{a}
Mean for periods	68.86^{a}	78.61^{a}	69.64^{a}	69.20^{a}	61.46^{a}	

Means carrying at least one similar superscript do not differ significantly ($P < 0.05$)

C.D. for diets = 12.04

Table 4. Mean daily feed consumption (g) as influenced by different dietary treatments.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	119	107	126	146	161	132^{a}
2	114	111	126	149	161	132^{a}
3	107	100	109	130	111	111^{b}
4	116	91	96	101	121	105^{b}
Mean for periods	114^{a}	102^{a}	114^{a}	132^{b}	139^{b}	

Means carrying at least one similar superscript do not differ significantly.

C.D. for diets = 15.58

C.D. for periods =17.43

Table 5. Feed efficiency (kg feed/dozen eggs) as influenced by the different diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	1.99	1.67	2.00	2.42	2.85	2.19^{a}
2	2.23	1.60	1.85	2.15	2.52	2.07^{a}
3	1.79	1.46	1.87	2.13	2.62	1.97^{a}
4	1.96	1.53	2.70	2.83	2.89	2.38^{a}
Mean for periods	1.99^{c}	1.57^{d}	2.11^{bc}	2.38^{b}	2.72^{a}	

Means carrying at least one similar superscript do not differ significantly ($P \angle 0.01$)

C.D. for periods = 0.331

Table 6. Body weight maintenance of pullets (g) as influenced by the different diets.

Diet	Average initial body weight	Gain/loss in body weight					Average final body weight	Mean for diets
		First period	Second period	Third period	Fourth period	Fifth period		
1	1330	-50	-30	-20	30	-30	1230	-20^{a}
2	1260	60	-10	-10	30	40	1370	22^{a}
3	1350	-20	-70	60	10	-90	1240	-22^{a}
4	1270	50	-130	-40	10	40	1200	-14^{a}
Mean for periods	1303	10^{a}	-60^{a}	-25^{a}	20^{a}	-10^{a}	1260	

Means carrying at least one similar superscript do not differ significantly ($P < 0.05$).

Table 7. Average egg weight (g) as influenced by the different experimental diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	44.18	48.07	50.23	52.60	54.14	49.84^{a}
2	43.80	46.36	46.15	47.50	48.91	46.54^{b}
3	43.60	43.86	48.31	48.53	47.93	46.45^{b}
4	44.31	43.72	44.76	47.83	48.54	45.83^{b}
Mean for periods	43.97^{a}	45.50^{a}	47.36^{b}	49.12^{bc}	49.88^{c}	

Means carrying at least one similar superscript do not differ significantly ($P < 0.01$)

C.D. for diets = 1.91

C.D. for periods = 2.14

Table 8. Per cent albumen as influenced by the experimental diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	64.00	63.20	64.00	62.80	59.00	62.60^{a}
2	63.30	62.80	60.80	59.60	59.60	61.22^{a}
3	63.80	62.00	59.60	60.00	59.80	61.04^{a}
4	63.40	63.10	59.70	61.60	61.80	61.92^{a}
Mean for periods	63.62^{a}	62.77^{a}	61.02^{b}	61.00^{b}	60.05^{b}	

Means carrying at least one similar superscript do not differ significantly (P ∠ 0.01)

C.D. for periods = 1.83

Table 9. Per cent yolk as influenced by the experimental diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	26.50	25.80	26.00	26.90	29.80	27.00^{a}
2	25.90	26.60	28.40	29.10	29.30	27.86^{a}
3	25.10	26.40	29.50	28.40	28.50	27.58^{a}
4	25.80	25.90	29.20	27.00	27.20	27.02^{a}
Mean for periods	25.82^{a}	26.17^{a}	28.28^{b}	27.85^{b}	28.70^{b}	

Means carrying at least one similar superscript do not differ significantly ($P \leq 0.01$)

C.D. for periods = 1.05

Table 10. Per cent shell as influenced by the experimental diets.

Diet	First period	Second period	Third period	Fourth period	Fifth period	Mean for diets
1	9.50	11.00	10.00	10.30	11.20	10.40^{a}
2	10.80	10.60	10.80	11.30	11.10	10.92^{b}
3	11.10	11.60	10.90	11.60	11.70	11.38^{c}
4	10.80	11.00	11.10	11.40	11.00	11.06^{c}
Mean for periods	10.55^{a}	11.05^{a}	10.70^{a}	11.15^{a}	11.25^{a}	

Means carrying at least one similar superscript do not differ significantly ($P \angle 0.01$).

C.D. for diets = 0.436

Table 11. Analysis of variance for the body weight maintenance for different treatments and periods.

Periods	Source of variation	df	SS	MSS	F
1	Due to treatments	3	1144776.65	381592.21	2.62^{ns}
	Error	31	4506883.35	145383.33	
	Total	34	5651660.60		
2	Due to treatments	3	59512.22	19837.40	2.56^{ns}
	Error	31	240127.78	7746.05	
	Total	34	299640.00		
3	Due to treatments	3	37672.21	12557.40	2.61^{ns}
	Error	31	148727.79	4797.67	
	Total	34	186400.00		
4	Due to treatments	3	1717.97	572.65	0.08^{ns}
	Error	30	209305.56	6976.85	
	Total	33	211023.53		
5	Due to treatments	3	102000.09	34000.03	2.14^{ns}
	Error	30	475226.39	15840.87	
	Total	33	577226.48		

ns = non significan

Table 12. Analysis of variance for the different characters studied among layers.

Factor	Source of variation	df	SS	MSS	F
1. Hen-day egg production	Due to diets	3	986.63	328.88	4.31*
	Due to periods	4	592.37	148.09	1.94 ns
	Error	12	915.76	76.31	
	Total	19	2494.76		
2. Feed consumption	Due to diets	3	2935.0	978.33	7.65**
	Due to periods	4	3434.3	858.58	6.71**
	Error	12	1534.5	127.88	
	Total	19	7903.8		
3. Feed efficiency	Due to diets	3	0.4623	0.1541	3.2927 ns
	Due to periods	4	2.9919	0.7480	15.9829**
	Error	12	0.5612	0.0468	
	Total	19	4.0154		

ns = non significant.
* = Significant at 5% level.
** = Significant at 1% level.

Table 13. Analysis of variance for the various egg quality factors studied.

Factor	Source of variation	df	SS	MSS	F
1. Egg weight	Due to diets	3	49.29	16.43	8.56**
	Due to periods	4	96.68	24.17	12.59**
	Error	12	23.03	1.92	
	Total	19	169.00		
2. Per cent albumen	Due to diets	3	7.62	2.54	1.76 ns
	Due to periods	4	34.11	8.52	5.96**
	Error	12	17.28	1.44	
	Total	19	59.01		
3. Per cent yolk (After angular transformation)	Due to diets	3	0.62	0.20	0.37 ns
	Due to periods	4	12.68	3.17	6.21**
	Error	12	6.17	0.51	
	Total	19	19.47		
4. Per cent shell (After angular transformation)	Due to diets	3	2.14	0.71	7.10**
	Due to periods	4	1.22	0.30	3.00 ns
	Error	12	1.26	0.10	
	Total	19	4.62		

ns = non significant.

** = Significant at 1% level.

Table 14. Summary of results showing overall performance of birds during the entire experimental period (140 days).

Factor		Experimental diets: Diet I (control)	Diet II (10% rubber seed meal)	Diet III (15% rubber seed meal)	Diet IV (20% rubber seed meal)	Mean
Average hen-day egg production	(%)	72.88	77.32	69.68	58.33	69.55
Average daily feed consumption per bird	(g)	132	132	111	105	120
Average feed efficiency	(kg)	2.19	2.07	1.97	2.38	2.15
Average final body weight	(kg)	1.23	1.37	1.24	1.20	1.26
Average egg weight	(g)	49.84	46.54	46.45	45.83	47.17
Percentage albumen		62.60	61.22	61.04	61.92	61.84
Percentage yolk		27.00	27.86	27.58	27.02	27.22
Percentage shell		10.40	10.92	11.38	11.06	10.94
Feed cost per kg *	(Rs)	1.16	1.11	1.08	1.06	1.10
Feed cost per dozen eggs	(Rs)	2.54	2.30	2.13	2.52	2.37

* Cost of rubber seed meal - Rs.850/- per tonne.

DISCUSSION

DISCUSSION

Hen-day egg production

Best egg production was recorded for the group fed 10 per cent rubber seed meal in their diet followed by those fed 0, 15 and 20 per cent rubber seed meal in that order. This shows that addition of rubber seed meal in layer diets at 10 per cent level partially replacing groundnut cake is advantageous over using groundnut cake alone as the vegetable protein source. Eventhoug the statistical analysis did not reveal any significant differences among these values, the apparent differences are rather appreciable. It may be seen that the diet containing 15 per cen rubber seed meal compared fairly well with the control diet in respect of egg yield as the numerical differences in per cent production between the two groups is rather small. However, the diet with 20 per cent rubber seed meal seems to have exerted a depressing influence on egg production. The group fed rubber seed meal at this level laid only much lesser eggs on a hen-day basis thereby showing that the inclusion of rubber seed meal at 20 per cent level in layer diet is detrimental to optimum egg production. The results also suggest that the type and kind of rubber seed meal as is employed in this trial could be used with advantage in layer rations upto 15 per cent.

The improved egg production obtained with 10 per cent rub seed meal might possibly be due to the mutual supplementary eff of amino acids in both groundnut cake and rubber seed meal at t right proportions. At higher levels of rubber seed meal, probably this balance is disturbed thereby adversely affecting the production capabilities of laying chicken. Neverthless, as the 15 per cent level of incorporation did not bring about any significant decline in egg yield, and in the light of economy and shortage of conventional protein concentrates, this level can be safely recommended. The very low egg production registered by the birds fed rubber seed meal at 20 per cent level might be due to the comparatively low availability of critical amino acids especially methionine from their diet. Rajaguru (1971) reported that egg production was not affected when rubber seed meal was added upto 40 per cent of layer ration supplemented with methionine.

The birds were in 30 per cent production at the commencement of the trial. The egg production which was 68.86 per cent during the first period went upto 78.61 per cent in the second period during which the experimental birds peaked. In the third period, there was decline in egg production as is expected after peaking. The third and fourth periods maintained almost the sam per cent production which again went down during the fifth perio However, the numerical differences in per cent egg production between the periods were not statistically significant and follo ed the natural trend in pullet year production. This, therefore suggests that inclusion of rubber seed meal in the diet exerted no deleterious influence on the normal production pattern of laying birds.

Buvanendran and Siriwardene (1970) demonstrated that rubber seed meal could be incorporated in layer diets upto 25 per cent level. However, Rajaguru (1971) opined that rubber seed meal could be used in layer ration even upto 40 per cent without affecting egg production adversely when supplemented with methionine. The better results reported by the above workers from Sri Lanka might be due to the difference in composition of the meal itself and/or on account of added methionine in rubber seed meal supplemented diets. The depressing effect of rubber seed meal cannot be explained on the basis of limited information gathered from this study. However, as reported by Buvanendran (1971) one reason might be the presence of free fatty acids in rubber seed meal. Another possible factor might be the hydrocyanic acid content of rubber seed meal, but this is unlikely to produce harmful effects, since some of the hydrocyanic acid is rapidly detoxicated in the lungs and a greater part of it is converted to thiocyanate and is excreted with urine (Dawson and Messenger, 1932; Garner, 1967 and Radeleff, 1970). The conversion of cyanide to thiocyanate ion is by an enzymatic process which is accelerated by thiosulfate and by some sources of available sulphur (Radeleff,1970). For this reaction, naturally, sulphur from sulphur containing amino acids is made use of, leading to methionine deficiency (Ross and Enriquez, 1969). It has been reported that methionine deficiency causes lowering of egg production (Leong and McGinnis, 1952). It would therefore be more appropriate to surmise that amino acid imbalance especially the low availability of methionine is a more likely reason for lowered performance of hens than the influence of free fatty acid content.

Feed consumption

Average daily feed consumption per bird during the entire experimental period differed significantly ($P < 0.01$). Highest feed consumption was observed among birds fed diets I and II while the groups fed diets III and IV consumed significantly lesser quantity of feed. Hens fed the control diet and the diet containing 10 per cent rubber seed meal consumed equal quantum of mash, on an average, indicating that this particular level of incorporation of rubber seed meal in the diet had no adverse effect on feed intake. But at 15 per cent and 20 per cent levels, rubber seed meal adversely affected feed intake of birds. There was progressive reduction in feed consumption as the level of incorporation was increased. It appears from the results that rubber seed meal in layer diets above 10 per cent level exerts a depressing influence on feed intake, possibly affecting the palatability of the diet and/or due to a probable higher energy content of the diet. It may be mentioned here that the rubber seed meal used in the study had a higher oil content. Reduced feed intake as a result of enhanced levels of rubber seed cake in the diets of broilers and growers has been reported by Rajaguru and Wettimuny (1971) who advanced the probable reason for this drawback as due to an unidentified factor. In a very early report, Morrison (1957) had opined that rubber seed meal was not much palatable.

The differences in quantities of feed consumed during periods also differed significantly ($P < 0.01$). Feed intake during the first three periods was comparable and differed greatly from that during the last two periods. The reduced feed consumption during the early periods may be due to the higher environmental temperature prevailed as these periods coincided with summer. With the onset of monsoon and the resultant reduced atmospheric temperature, the experimental birds consumed more feed during the last two periods as is the normal case. Neverthless, differences in feed consumption between experimental periods were not evidently influenced by rubber seed meal in the rations.

Feed efficiency

Mean values of feed efficiency for the entire experimental period among various dietary treatments were comparable and did not differ significantly. However, numerical differences were observed among groups fed different diets. The group that received 15 per cent rubber seed meal in their diet showed the highest efficiency followed by other groups viz., the group that received rubber seed meal at 10 per cent level, the control group and the one that received rubber seed meal at 20 per cent level in the diet in that order. The best efficiency observed in the group fed rubber seed meal at 15 per cent level was due to lower feed consumption by birds in this group rather than higher rate of lay, since both the control group as well as the group fed rubber seed meal at 10 per cent level laid higher number of eggs than this group. However, the apparent poor feed efficiency exhibited by birds fed rubber seed meal at 20 per cent level in the ration could be attributed entirely to their very low egg yield. As the feed required to produce a dozen eggs does not vary appreciably in relation to the level of rubber seed meal in the diets, inclusion even upto 20 per cent level in the ration may appear safe as far as this trait is concerned. However, reduced egg production at this level poses a serious drawback to be considered in this regard. Thus it appears safe both in terms of egg production and feed efficiency to recommend a level of 15 per cent of rubber seed meal in rations meant for layers.

Body weight maintenance

The differences in mean body weight of experimental birds at the close of the trial were not significant and were comparable. Also there were no significant differences in mean weight of birds among the dietary treatments, due to periods. The gain or loss in body weight of experimental birds was more or less uniform and was not affected by the dietary treatments. However, the group fed rubber seed meal at 10 per cent level showed a numerically increased body weight over other groups. This again leads to a reasonable conclusion that at this level, the amino acids in the diet are better balanced. The apparent low average body weight of birds fed rubber seed meal at 20 per cent level might possibly be due to their low feed consumption coupled with an amino acid imbalance in their diet. Neverthless, as the differences are statistically not significant, it can be assumed that the biological value of rubber seed protein is almost comparable with that of groundnut cake.

Egg weight

Best egg weight was recorded by the birds in the control group and while the birds in other groups laid eggs with significantly lower weights. However, the differences in mean egg weight among the groups fed rubber seed meal were negligible. These results indicated that rubber seed meal contained some factor or factors which exerted a depressing influence on egg weight irrespective of the level of incorporation, the degree of depression not being proportionate with the rubber seed meal content in the feed. Decreased egg weight as a result of feeding rubber seed meal to White Leghorn hens has been reported by Rajaguru (1971), at and above 20 per cent level. Eventhough the incorporation of this protein source at 10 and 15 per cent levels has been found advantageous with regard to egg production, feed consumption, feed efficiency and body weight maintenance, its adverse impact on egg weight is a serious matter of concern. Therefore, it is suggested that further research of this type should aim at identifying and eliminating the actual factor responsible for lowering the egg weight. As indicated earlier, the decreased methionine availability may be the probable reason for lowered egg weights among hens in the treatment groups. The importance of this critical amino acid for egg weight has been well documented (Leong and McGinnis, 1952; Mueller, 1967 and Harms et al. 1967).

The difference in mean egg weight from period to period followed the normal pattern of egg weight maintenance in pullet year production. Egg weight which was the lowest during the first period progressively improved and reached the optimum level during the fourth period and did not increase further. This increase in successive periods with advancement of lay is natural (Romanoff and Romanoff, 1949) and therefore is not likely to be due to the inclusion of rubber seed meal in the layer diets.

Internal egg quality

Albumen.

Condition of albumen of eggs was uniformly alike pointing to the fact that rubber seed meal in the diet had no effect whatsoever on the albumen condition or clarity. The mean values of per cent albumen of eggs broken out from different experimental groups were comparable and were unaffected by the inclusion of rubber seed meal in the diets. Generally, albumen content of all eggs studied was higher as *should be expected* in pullet eggs during the initial period. Larger percentages of albumen during initial laying stages is a well accepted characteristic of the laying hen (Romanoff and Romanoff, 1949). Per cent albumen which was highest during the first period of the experiment gradually decreased towards the fifth period following the natural pattern.

Yolk.

Yolk condition and colour of yolks from eggs broken out during the course of this study were more or less uniform indicating that there was no factor in rubber seed meal which could influence these characters. Mean yolk percentages in all the groups were almost alike and were not affected by the dietary treatments. However, the increase in yolk size from the beginning to the close of the experiment was normally expected and appeared to have no relation with rubber seed meal in the ration. Yolk size which was smallest during the first period progressively increased towards the fifth period which again followed the normal characteristic as reported by Romanoff and Romanoff, 1949.

Shell.

In spite of the fact that inclusion of rubber seed meal depressed egg weight at all levels of incorporation, the weight of shell was favourably affected. Birds in the control group laid eggs with lesser shell percentage, while per cent shell progressively increased in eggs from hens fed the diet containing 15 per cent rubber seed meal. Neverthless, at 20 per cent rubber seed meal in the diet, no further enhancement in shell percentage was observed. Birds fed rubber seed meal in their diets at all levels laid eggs with significantly higher shell percentage than those laid by the birds in the control group irrespective of the fact that all the birds were supplied with calcium supplement free choice besides adequate amounts of calcium, phosphorus and vitamin D in the diets.

As the essential nutrients for effective shell formation were equally available for the experimental birds, the increased shell weight of eggs laid by the rubber seed meal fed birds might possibly be due to an unidentified factor in the rubber seed meal which favours conditions of shell formation. However, these findings are in contrast to the observation made by Rajaguru (1971). No definite conclusion can be drawn about this improvement in per cent shell based on the limited data available from this study.

Economics

The feed cost for producing dozen eggs for the different dietary treatments indicated that the incorporation of rubber seed meal, irrespective of the levels, recorded lower cost over the control group. However, among the groups fed rubber seed meal, the feed cost was lowest for the group fed 15 per cent rubber seed meal followed by the 10 per cent rubber seed meal fed group. The group that received 20 per cent rubber seed meal in the diet demonstrated almost same cost of production as that of control.

It is pointed out that in spite of the poor production by birds on 20 per cent rubber seed meal the feed cost of producing dozen eggs was not much different from that of control. Generally, rubber seed meal added diets were found to be economical at all levels of incorporation. However, the lowered egg weights observed with the feeding of rubber seed meal at all levels, poses a serious drawback which requires consideration.

Mortality

There was only one death among all the experimental birds during the entire period of study. This loss was suffered by the control group. Evidently, the incorporation of rubber seed meal in rations did not affect laying house mortality. The hydrocyanic acid content of the meal did not interfere with the livability of birds thereby suggesting that rubber seed meal can be safely included in layer rations at levels used in this study.

S U M M A R Y

S U M M A R Y

A feeding trial of 20 weeks duration was carried out during February to July 1977 with rubber seed meal at 0, 10, 15 and 20 per cent levels to study the feeding value of the same using thirty-six S.C. White Leghorn hens maintained in individual laying cages. The entire period of study was divided into five, 28-day periods.

Hen day egg production, feed consumption, feed efficiency, body weight maintenance and egg quality traits such as egg weight, per cent shell, per cent albumen and per cent yolk were calculated for each period and analysed. The following conclusions were drawn at the end of the experiment.

1. Rubber seed meal at 10 per cent level apparently improved egg production over control whereas at 20 per cent level, it appeared unsuitable in layer ration. At 15 per cent level the egg production was comparable to that of control.

2. Feed consumption was significantly less ($P < 0.01$) in 15 per cent and 20 per cent rubber seed meal fed groups than the control and birds on diet with 10 per cent rubber seed meal. Birds in the latter treatment groups consumed equal quantum of feed on an average.

3. Feed efficiency was not affected by different dietary treatments.

4. Inclusion of rubber seed meal in the ration had no particular effect on body weight maintenance of experimental birds.

5. Egg weight was significantly depressed among birds fed rubber seed meal ($P < 0.01$) in their diets.

6. Other egg quality traits like per cent albumen and per cent yolk were not significantly affected by feeding of rubber seed meal.

7. Per cent shell was significantly more ($P < 0.01$) in birds fed different levels of rubber seed meal.

8. Incorporation of rubber seed meal at 10 and 15 per cent levels worked out to be economical in layer rations.

9. Livability was not affected by the feeding of rubber seed meal.

In the light of the above findings it appears reasonable to conclude that rubber seed meal could be used as an alternate source of vegetable protein in place of groundnut cake and that it could be incorporated upto 15 per cent in the layer ration without adversely affecting the economic productive traits.

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FEEDING VALUE OF RUBBER SEED MEAL FOR LAYING HENS

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ABSTRACT

An investigation was carried out to study the feeding value of rubber seed meal for layers in view of its exploitation as a newer unconventional protein source for poultry.. Thirty-six, S.C. White Leghorn pullets aged 20 weeks were housed in individual cages on four dietary regimes. One group was fed a basal diet containing groundnut cake as the vegetable protein source and formed control, while the other groups were fed experimental diets containing rubber seed meal at 10, 15 and 20 per cent levels partially replacing groundnut cake. Major economic characters like hen-day egg production, feed consumption, feed efficiency, body weight maintenance, egg weight, egg quality and livability were studied for five, 28-day periods. The results obtained during the course of investigation are presented and discussed. Incorporation of rubber seed meal at 10 per cent was found to be superior as far as hen-day egg production and feed intake were concerned. Feed efficiency and body weight maintenance were not significantly affected by different dietary treatments. Egg weight was significantly depressed among birds fed rubber seed meal in their diets. Per cent yolk and per cent albumen showed no change attributable to treatments. However, the per cent shell increased in rubber seed meal fed groups. The group fed with 10 per cent rubber seed meal in the diet excelled the other three groups based on the overall performance, while, the feed cost per unit production favoured the 15 per cent rubber seed meal fed group. Laying house mortality was not at all influenced by feeding rubber seed meal. It was concluded that inclusion of rubber seed meal as a protein concentrate in layer diet is useful upto 15 per cent level. However, its adverse effect on egg size has been pointed out as a probable drawback