- **Use Of Agricultural and Animal Industry bye Products for producing more meat and milk to improve the protein quality of Pakistani diet**

Comparative Nutritive value of Decorticated cottonseed cake, Sesame oil cake and Mustard oil cake in Broiler Rations

By

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Many problems faced by the Poultry farmers in this country are related to the feeding of birds in all phases of production in general and growth in particular. The need for large number of eggs and greater quantity of meat demands that chicks should be raised rapidly, intensively, economically and all round the year. As the cost of feeding these birds forms a major item of expenditure in a poultry enterprize, therefore, production of heavy meat type chiekens with properly balanced rations becomes a must. To formulate an economical and balanced poultry ration it is essential to use agricultural animal industry by-products available abundantly and at low prices such as grain husks, oil seed cakes and blood and fish meals. The present research was thus undertaken :

1. To compare the various oil cakes, viz., cottonseed cake (decorticated), sesame oil cake and mustard oil cake, for their nutritive values in broiler rations.
2. To test the feasibility of using blood and fish meals as the only sources of animal protein.
3. To determine if the rice husk could be used as a poultry feed.
4. To compare the Lever Brother's chick mash with the rations prepared at West Pakistan Agricultural University, Lyallpur.
5. To detect if there was any growth depressing effect of oil seed cakes on growing chicks.

Almquist and Grau (1) reported poor growth in chicks on sesame protein when fed alone, due primarily to deficiency of amino acid, lysine. In conjunction with other sources of protein rich in lysine like soybean meal and fish meal, the sesame seed when fed at 20 percent level practically met the chick requirement for all the essential amino acids and was capable of supporting optimal growth rate. Kondra and Hodgson (2) used mustard seed oil meal at levels of 0, 3, 6 and 9 percent to replace an equivalent amount of meat meal in chick starter mash. The chicks maintained a normal rate of growth on each of four rations, indicating that mustard seed oil meal could be used upto 9 percent of the chick mash. Richardson and Blaylock (3) investigated the use of commercial cottonseed meal, low in gossypol, as the sole source of protein for growing chicks. Cottonseed meal was equal in growth promoting quality to soybean oil meal when it was supplemented with vitamin B12 and 0. 2 percent L-lysine. Squibb and Braham (4) reported that the addition of 3 percent blood meal or 0·45 percent lysine to a basal ration of sesame oil meal resulted in significant improvement of growth. It was further observed that blood meal when used at 2 to 4 percent level was most effective in promoting growth, but 8 percent level depressed the growth Fisher (5) conducted a series of tests with growing chicks using rations containing 13 percent or 20 percent protein supplied mainly by cottonseed. In all cases, the cottonseed protein was supplemented with lysine and methionine. It was found that in addition to these two amino acids cottonseed protein was also limiting in threonine, leucine and isoleucine, which were necessary for optimal growth and both pressed and solvent extracted meals were equally deficient in three amino acids. Anderson and Warnick (6) fed chicks on semi-purified rations containg 18 percent protein from cottonseed meal and a mixture of six essential amino acids recognised to be deficient in the meal. Lysine was found to be the most limiting amino acid in the commercial meal. Methionine, isoleucine, threoinine and leucine were also found to be limiting in the order named.

MATERIAL AND METHODS

One hundred and twenty day-old Starbro chicks from P. I. A. Shaver Poultry Breeding Farms, Karachi were used as experimental birds. The experiment was planned as a completely randomised design. The birds were randomly distributed into 12 groups of 10 chicks each. These groups were randomly assigned to 4 experimental rations designated as A, B, C and D (Table 1) in such a way that there were 3 groups of birds under each ration. The chicks were kept in a small experimental room, partitioned into pens of $5' \times 2.5' \times 2'$ dimension each and these were allotted randomly to the groups. The temperature of the room was maintained by means of electric heaters, between 90°F to 95°F in the first week and lowered by 5°F each week. During last two weeks of the experiment, the tempetature was maintained between 70°F to 75°F. Continuous light wes available throughout the experimental period. Saw dust was used as litter which was changed every week.

Table 1.

Composition of Experimental Rations

Ingredients	Rations A %	B %	C %	D* %
Yellow maize (ground)	42	42	42	Lever Brother's
Juar (ground)	20	20	20	chick mash
Rice husk	3	3	3	
Lucerne (Alfalfa) leaf meal	7	7	7	
Fish meal	8	8	8	
Blood meal	7	7	7	
Cottonseed cake (decorticated)	8	-	-	
Mustard oil cake	-	8	-	
Sesame oil cake	-	-	8	
Bone meal	3·5	3·5	3·5	
Codliver oil	1·0	1·0	1·0	
Premixes (Coopavite E)	0·5	0·5	0·5	
Total :	100·0	100·0	100·0	
Crude protein%	22·1	21·01	22·31	
Crude fibre %	5·06	5·15	4·68	
Calcium %	2·140	2·124	2·285	
Phosphorus %	1·736	1·656	1·784	

* Composition not known.

The birds were fed the allotted rations **ad libitum** for a period of 8 weeks. Fresh and clean water was made available to the birds at all times. The daily feed offered was recorded and the refused feed was weighed at the end of each week and then the weekly feed consumtion was calculated. Each group of the chicks was weighed at the commencement of the experiment and at weekly intervals thereafter. The weighing was done by the same person and at the same time. Sulphamezathin 33·3 percent was added at the rate of 1 ounce per gallon of drinking water for 3 consecutive

days at the third week of age as a prophylactive measure against coccidiosis. The data collected were subjected to statistical analysis using analysis of variance and Duncan's Multiple Range Test (7, 8).

RESULTS AND DISCUSSION :.

The summary of data on growth, feed consumption and feed efficiency of chicks fed different experimental rations is shown in the Table 2.

Table 2
SUMMARY OF GROWTH, FEED CONSUMPTION AND FEED EFFICIENCY

	RATIONS			
	A	B	C	D
No. of chicks	30	30	30	30
Average initial weight (gms)	33.9	33.6	34.3	34.0
Average final weight (gms)	1182.4	1167.7	1268.9	993.8
Average total gain in weight (gms)	1148.53	1134.10	1234.66	959.80
Days on feed	56	56	56	56
Average daily gain in weight (gms)	20.50	20.25	22.0	17.13
Average feed consumed per chick (gms)	2791.7	2807.9	2735.7	2676.0
Average daily feed consumed per chick(gms)	49.8	50.1	48.8	47.7
Average feed efficiency	2.42	2.47	2.21	2.78

As is evident from the data given in table 2, the chicks raised on ration A, B and C gained highly significantly ($P < 0.01$) more weight than those fed on ration D (Lever's chick mash). Although there were apparent differences in the weight gains of chicks fed ration A, B and C (20.5, 20.25 and 22.04 grams respectively), but the differences were statistically non-significant. The heavy breed broiler chicks have been reported to weight 2.74 pounds at 8 weeks of age (9). The average weight of the chicks used in this study at 8 weeks of age, fed rations A, B

and C was 2.6, 2.6 and 2.8 pounds respectively, indicating thereby that the birds fed the three experimental rations grew quite satisfactorily. This shows that three oil seed cakes (decorticated cottonseed, mustard oil cake and sesame oil cake) when combined with blood meal and fish meal can support on optimum growth in chicks. The quality of the aforementioned vegetable proteins might have been improved through supplementary action of animal protein like those of blood meal and fish meal when used simultaneously in broiler rations. Best growth was observed with birds fed on ration C containing sesame oil cake. Cottonseed cake (decorticated) when incorporated at a level of 8 percent into the mixed rations promoted good growth but was not comparable to that observed with sesame oil cake ration. According to Morrison (10) the percentage of amino acids like Arginine, Glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, tyrosine and valine in cottonseed cake and sesame oil meal are 3.3, 2.4, 0.9, 1.5, 2.2, 1.6, 0 5, 1.9, 1.1, 0.5, 1.0, 1.8 and 4.3, 4.0, 1.1, 1.6, 2.8, 1.2, 1.2, 2.0, 1.6, 0.6, 2.0. 2.2 respectively. He further reported that cottonseed cake has wider nutritive ratio as compared to sesame oil meal (1:1.2 Versus 1:0.8). Similarly the sesame cake protein has better digestibility as compared to that of cottonseed cake (39.4% Versus 31.3%). The better growth observed with birds fed the ration supplemented with sesame oil meal could be explained on the basis of its better quality of protein as compared to that of cottonseed cake. The quality of protein source depends on both the digestibility of its protein as well as the amino acid contents of the source thereby increasing its nutritive ratio. As is clear from the chemical composition of the two sources, sesame oil meal has better assortment of almost all the amino acids and narrower nutritive ratio as compared to cottonseed cake. The comparatively lower growth rate observed with chicks fed on ration containing cottonseed cake may be further attributed to some residual gossypol in the meal used in this study.

The ration B containing mustard oil cake gave poor growth response as compared to rations A and C containing cottonseed cake and sesame oil cake respectively. This may be explained on the basis of inferior quality of mustard protein due to its lower digestible protein and wider nutritive

ratio than the other cakes, viz., cottoseed cake and sesame oil cake (digestible protein ; 23 Versus 31.3 and 39.4 percent and nutritive ratio 1:1.9 Versus 1·12 and 1:0.8 respectively).

The differences in feed consumption in chicks fed ration A, B, C or D were non-significant.

The groups of chicks fed rations containing decorticated cottonseed cake, mustard oil cake or sesame oil cake had highly significantly ($P < 0.01$) better feed efficiencey than those fed on Lever's chick mash. Amongst the rations containing cakes the feed conversion value of ration C was significantly ($P < 0.01$ and $P < 0.05$) better than that of ration B and ration A. However, ration A and B did not differ significantly in their feed conversion values. The better feed efficiency values of experimental rations are explained again on the quality of proteins of the cakes. Hence the sesame oil cake being the best in both the growth promoting as well as improved feed conversion values can very conveniently be used as a source of proteins in broiler ration.

SUMMARY

An experiment on 120 day-old Starbro chicks was conducted to study the comparative nutritive value of decorticated cottonseed cake, sesame oil cake and mustard oil cake. The experiment was planned as a completely randomised design. The experimental ration consisted basically of yellow maize (42%), Juar (20%), rice husk (3%), lucerne leaf meal (7%), fish meal (8%), blood meal (7%), bone meal (3·5), cod liver oil (1·0%), premixes (0·5%). Cottonseed cake (decorticated), mustard oil cake and sesame oil cake were added to the rations A, B and C respectively at 8 percent level. The three experimental rations were compared with Lever's chick mash. The chicks were fed the allotted rations **ad libitum** for a period of 8 weeks. The chicks fed on rations A, B and C gained highly significantly more weight than those fed on Lever's chicks mash. There was an apparent difference in the average daily gain in weight of the chicks fed rations A, B and C, but the

differences were statistically non-significant. The differences in feed consumption in the chicks fed either ratians A, B, C or D were non-significant. The chicks on rations containing decorticated cottonseed cake, mustard oil cake and sesame oil cake had highly significantly ($P < 0.01$) better feed efficiency than those feed on Lever's chick mash. The feed conversion value of ration C (containing 8 percent sesame oil cake) was significantly ($P < 0.05$) better than that of ration A or B and it was proved to be the best and most efficient ration.

The use of cakes like decorticated cottonseed cake, mustard and sesame oil cakes can be recommended as sources of vegetable protein in broiler's ration provided they are blended with some sources of animal protein such as blood meal and fish meal. As only one level i. e., 8 percent was tried in this experiment so more work needs to be done to find out the best and optimum level of the oil cakes in growing chicks ration. However, the present study could not reveal any depressing effect on broiler chicks growth.

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Replacement of Cereal (Sorghum) with Rice-Polishings in Broiler Ration.

by

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INTRODUCTION :

Poultry industry is passing through crisis due to inconsistant increase in prices of feed ingredients. Since the feed costs about sixty per cent of the total recurring expenditure in poultry raising, the use of cheaper but efficient feed ingredients to develop low cost poultry ration is, therefore, required.

Cereals like Sorghum and maize, which constitute major portion (60-60 per cent) of poultry rations, are becoming extremely expensive in Pakistan. Due to the rise in cereal prices it is difficult for the farmers to continue feeding of cereals upto this level.

Rice polishings, a by-product of rice industry, is abundantly produced in the country and is almost three times cheaper than the cereals. It contains comparable quantities of protein and other nutrients with ample quantities of B-Vitamins. The project was thus planned to explore the possibilities of replacing cereal (sorghum) with rice-polishing and to study its feasibility in broiler rations.

Review of Literature :

Maqsood *et al.* (1958) observed that rice-polishing contained moisture 8.76, protein 12.84, Nitrogen free extract 33.37, crude fibre 20.03 and 10.7 per cent oil. Ogra *et al.* (1966) fed day old chicks a standard mash with 55 per cent cereal grains

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and fish meal etc., while cereal grains were reduced in diets containing different proportions of rice-polishings. It was noticed that all the experimental feeds containing rice-polishing gave better growth and better feed efficiency and cost was less for per unit gain. *Rao et al.* (1966) conducted a research on chicks fed on standard mash and cheaper rations comprising of rice-polishing. The mash with rice-polishing was as palatable as the standard mash and gave similiar live weight gain. The feed with rice-polishing cost about 30 per cent less than the standard mash. Malik and Ichhponani (1969) gave diets to chickens with 31 to 61 per cent rice-polishing with maize meal and barley meal. All the experimental diets other than the one with 31 per cent rice-polishing and 30 per cent maize gave significantly better growth than the control. Malik *et al.* (1970) observed that the 8 weeks old pullets which were given upto 61 per cent rice-polishing, gained less weight and ate more than those fed maize and barley, but matured at the same age. Hamid (1975) prepared and fed four rations by replacing the cereals with rice-polishing. Weight gain was less and feed efficiency was also poor on ration containing 59.5 per cent rice-polishing. Feed consumption was more on ration having 59.5 per cent rice-polishing.

Materials and Methods :

One hundred and twenty days-old broiler chicks were randomly divided into fifteen experimental units each comprising of 8 chicks. Three such experimental units were alloted to each of the experimental rations *viz.*, A, B, C, D and E. Ration A (control) contained 40 per cent sorghum which was replaced by 10.6, 21.2, 31.8 and 42.4 per cent rice-polishing in rations B, C, D and E respectively. All the rations were isocaloric and isoniturogenous. The rations were offered *ad libutum* for a period of 8 weeks. The body weight and average feed consumption of individual chick was recorded at weekly intervals. The composition of the experimental rations is given in Table 1.

Table 1—Composition of Experimental Rations (Percentage).

Ingredients	A	B	C	D	E
Sorghum	40.0	30.0	20.0	10.0	—
Rice-Polishing	—	10.6	21.0	31.8	42.4
Corn Yellow	23.0	23.0	23.0	23.0	23.0

Sesame meal	8.0	8.0	8.0	8.0	8.0
Cotton seed meal	7.0	7.0	7.0	7.0	7.0
Molasses (cane)	3.0	3.0	3.0	3.0	3.0
Blood meal	6.0	6.0	6.0	6.0	6.0
Meat meal	4.0	4.0	4.0	4.0	4.0
Fish meal	4.0	4.0	4.0	4.0	4.0
Bone meal	1.7	1.3	1.0	0.5	0.2
Rice husk	2.3	2.0	1.4	1.0	0.6
Lime stone	—	0.1	0.4	0.7	0.8
Common salt	0.4	0.4	0.4	0.4	0.4
Synthetic methionine	0.1	0.1	0.1	0.1	0.1
Nutripole	0.5	0.5	0.5	0.5	0.5
Total	100.0	100.0	100.0	100.0	100.0
Crude protein %	21.24	21.21	21,17	21.13	21.11
Crude fibre %	4.00	4.10	4.08	4.15	4.21
M. E. cal/Kg	2996.54	2996.54	2996.54	2996.54	2996.54
Calcium %	1.30	1.25	1.29	1.28	1.25
Phosphorus %	0.498	0.499	0.508	0.500	0.310

Results and Discussion :

The data on gain in weight, feed intake, feed efficiency and dressing percentage have been summarized in Table 2. The analysis of variance of weight gain and feed intake is shown in Table 3 and analysis of variance of feed efficiency and dressing percentage is shown in Table 4 respectively.

Table 2—The performance of broiler chicks fed different experimental rations.

Description	RATIONS				
	A	B	C	D	E
Average weight gain per chick (Kg)	1.239	1.224	1.217	1.255	1.274
Average feed consumed per chick (Kg)	3.071	3.177	3.292	3.555	3.607
Feed efficiency (feed/gain)	2.48	2.60	2.71	2.82	2.83
Dressing percentage	60.14	59.13	57.33	59.04	58.18

Table 3—Analysis of Variance of Weight gain and feed intake.

		Weight Gain					Feed Intake		
S.O.V.	D.F.	S.S.	M.S.	F. Ratio	S.O.V.	D.F.	S.S.	M.S.	F. Ratio
Ration	4	0.0065	0.0061	0.67N.S.	Ration	4	0.6556	0.1639	15.76**
Error	10	0.0242	0.0024		Error	10	0.1036	0.0104	
Total	14	0.0307			Total	14	0.7592		

N.S=Non-significant **=Highly significant

Table 4—Analysis of Variance of Feed Efficiency and Dressing Percentage.

		Feed Efficiency					Dressing Percentage		
S.O.V.	D.F.	S.S.	M.S.	F. Ratio	S.O.V.	D.F.	S.S.	M.S.	F. Ratio
Rations	4	0.2715	0.0679	8.08**	Rations	4	13.58	3.40	0.60N.S

Error	10	0.0844	0.0084	Error	10	57.02	5.70
Total	14	0.3559		Total	14	70.60	

** = Highly significant N.S = Non-significant

Weight Gain :

The average weight gain of chicks fed on rations A, B, C, D and E were 1.239, 1.224, 1.217, 1.255 and 1.274 Kg, respectively. Analysis of variance showed non-significant difference among the weight gain of birds fed different rations. However, apparently the weight gain was more with 31.8 and 42.4 per cent rice-polishing rations and this could be due to improved palatibility at higher levels of rice-polishing which led to more feed intake resulting in more weight gain. These results are in accordance with those of Ogra *et al.* (1966), Rao *et al.* (1966) and Malik and Ichhponani (1967) who observed better growth of chicks using higher levels of rice-polishing.

Feed Intake :

The average feed consumption of chicks fed on ration A, B, C, D and E was 3.071, 3.177, 3,292, 3.555 and 3.607 Kg, respectively. Highly significant differences were observed among feed consumption of different rations. Chicks raised on rations B and D consumed significantly more feed than those fed on other rations. This increased intake at higher levels of rice-polishing might be due to improved palatability of feed- The results are in agreement with those of Rao *et al.* (1966), Malik *et al.* (1970) and Hamid (1975) who observed more feed consumption at higher levels of rice-polishing in broiler rations.

Feed Efficiency :

Feed efficiency values were 2.48, 2.60, 2.71, 2.82 and 2.83 for rations A, B, C, D and E respectively. The statistical analysis revealed highly singificant differences among the feed efficiency values of different experimental rations. Chicks fed on rations A and B showed significantly better feed efficiency than those fed on rations C, D and E. The results are in accordance with Hamid (1975) and not in line with Ogra *et al.* (1966) who observed better feed efficiency in rations containing higher levels of rice-polishing.

Dressing Percentage :

The average dressing percentage was 60.14, 59.13, 57.33, 59.04 and 58.18 in chicks fed on rations A, B, C, D and E respectively. Statisticaily non-significant difference was observed inrespect of dressing percentage.

Economics of the Experimental Rations :

The average cost of feed to raise one chick amounted to rupees 4.15, 4.07, 3.98, 4.09 and 3.90 in rations A, B, C, D and E, respectively. The results revealed that Rations E (42.4 per cent rice-polishing) was comparatively more economical than the rations containing cereals.

SUMMARY :

An experiment involving one hundred and twenty days-old broiler chicks was carried out to study the feasibility of using rice-polishing in the broiler rations. Forty per cent sorghum was replaced by 10.6, 21.2, 31.8 and 42.4 per cent rice-polishing.

Better growth was observed in chicks fed on 42.4 per cent rice-polishing while feed consumption of feed efficiency was found better in control rations and the rations containing lower levels of rice-polishing. As the rations containing 42.4 per cent rice-polishing showed better growth, more acceptibility and was more economical than other rations, so it was concluded that rice-polishing can successfully replace cereals upto 42.4 per cent level in broiler rations, without any adverse effect.

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NUTRITIONAL EVALUATION OF SOME COMMERCIAL BROILER FEEDS

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The nutritional quality of some commercial feeds was measured chemically and biologically in growth tests with broiler chicks. The protein, fat, crude fibre, ash and nitrogen free extract of commercial feeds ranged from 18.1–24.2, 4.0–4.7, 3.2–5.1, 8.9–14.9 and 45.6–49.1 per cent, respectively. The average weight gain, feed efficiency, dressing percentage, shank and keel length varied between 1325.8–1968.1 g; 2.2–2.9, 54.5–59.5%, 11.0–11.9 cm and 10.1–11.1 cm, respectively. All the commercial feeds gave satisfactory results, however Gamma feed having 24.2, 21.8% protein and 3095, 3058 Kcal (ME)/kg in starter and finisher rations respectively gave best results in terms of growth and feed efficiency.

INTRODUCTION

In recent years, the formulation of poultry rations has been taken up as a proposition, because the feed costs amonnt to 60 per cent of the total poultry production expenses. Such an expenditure can only be reduced with economical yet well baianced rations. With the introduction of commercial feeds, the poultry production in the country have increased to a considerable extent. Though formula feeds are available on competitive cost but there are no standards for their evaluation, thus often resulting in poor quality. In view of the importance of poulty industry and high cost of commercial feeds, the feed standard naturally becomes a pre-requisite alongwith the legislation for their quality control. Some work has already been done to test the quality of some commercial feeds (Khan, 1972; Sharif, 1976). However, the nutritive value of some other commercial feeds introduced recently in the market is unknown. The present investigations were thus designed to assess the nutritive value of these commercial feeds, chemically and biologically in broiler chicks.

MATERIALS AND METHODS

One hundred and fifty day old broiler chicks of Ross–I strain were randomly distributed into 15 groups of 10 birds each. These groups were then randomly assigned to five experimental rations so that three groups of ten birds

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each were fed on each ration. Four commercial feeds viz., Niaz, Chenab, Gamma and Aves were purchased from the local market and were designated as B, C, D and E, respectively. Ration A (Table 1) was formulated according to the recommended requirements (NRC, 1977) which served as control. The birds were fed the allocated starter and finisher rations *ad libitum* for five and three weeks, respectively. The daily feed offered was recorded where as feed refused was weighed at the end of each week and the weekly feed consumption was calculated by difference. Each group of the chicks was weighed at the commencement and at weekly intervals during the trial.

Table 1. Composition of control rations

Ingredients	Starter (%)	Finisher (%)
Maize grain	35.0	40.0
Rice (broken)	10.0	4.0
Wheat bran	8.0	–
Rice polishings	15.0	30.0
Maize glutten meal (60% protein)	6.0	4.0
Guar meal (Toasted)	10 0	8.0
Blood meal	6.0	4.0
Fish meal	5.0	5.0
Molasses, cane	2.5	2,5
Dicalcium phosphate	0.5	0.5
Ground Lime Stone	1.5	1.5
Premix	0.5	0.5
Total	100 0	100.0

At the end of eight weeks, three birds from each group were taken randomly and slaughtered to determin Dressing percentage and measure the lengths of shank and keel bones. All the experimental rations were analysed chemically according to standard methods (A.O.A.C. 1970). Metabolizable energy was calculated according to Miller and Payne (1959). The data collected were thus subjected to statistical analysis using analysis of variance technique (Steel & Torrie, 1960).

Table 2. Chemical composition of experimental rations

Rations	A		B		C		D		E	
	S*	F**	S	F	S	F	S	F	S	F
Crude protein (%)	22.2	20.6	21.7	21.1	22.7	22.0	54.2	21.8	21.2	18.1
Fat (%)	3.5	3.8	4.6	4.4	4.4	4.2	4.1	4.0	4.7	4.5
Crude Fibre (%)	3.4	3.3	4 2	5.1	3.6	3.7	3 2	3.2	4.5	4.6
Ash (%)	10.9	11.8	8.9	13.2	11.8	12.3	10.1	9.7	13.6	14.9
Nitrogen free extract (%)	50.5	52.2	49.1	45.6	48.2	47.3	48.2	47.9	46.9	47.6
Metabolizable energy (K cal/kg)	3083	3124	3084	2905	3065	2992	3094	3058	2985	2876

* Starter

** Finisher

RESULTS AND DISCUSSION

Chemical Composition : The average value for the chemical composition of control and commercial feeds are given in Table 2.

The protein contents of the starter and finisher ratinos ranged from 21.2 to 24.2% and from 18.1 to 22.0%, respectively. Highest protein contents were found in ration D (starter) and B (finisher) Where as fat content appeared to lie between 4.0 and 4.7% in the commercial starter and finisher feeds. Lowest values were observed in the control ration. The fibre content ranged from 3.2 to 5.1% in the starter and finisher rations, highest level was however found in ration B (finisher). The ash content varied from 8.9 to 14.9% while nitrogen free extract was highest in control ration (52.2%) and lowest in ration B (45.6%).

Biological effieiency : The data on weight gain, feed intake, feed efficiency, dressing percentage, shank and keel length are given in Table 3.

Table 3. Performance of broiler chicKs fed various experimental starter and finisher rations for 8 weeks

Description	RATIONS				
	A	B	C	D	E
Average weight gain per chick (g)	1470.2	1325.8	1932.6	1968.1	1583.7
Average feed consumed per chick (g)	4092.1	3869.1	4693.9	4352.9	4344.6
Feed efficiency	2.8	2.9	2.4	2.2	2.7
Dressing percentage	55.5	54.5	59.5	57.5	54.5
Average shank length (cm)	10.1	11.8	11.9	11.6	11.0
Average keel length (cm)	10.1	10.4	11.1	10.5	10.1

Weight Gain :

The maximum average gain in weight per chick fed experimental starter and finisher rations was observed on ration D (1968.1g) and minimum on ration B (1325.8 g). The chicks fed rations D and C gained significantly ($P<0.01$) more weight than those on rations A, B and E. The heavy breed broiler chicks have been reported to weigh 1244 g at 8 weeks of age (Heuser, 1655). The

resuits of the present study revealed that the average gain in weight of broiler chicks fed rations A, B, C, D and E was 1470.2, 1325.8, 1932.6, 1368.1 and 1583 7 g respectively at 8 weeks of age. It was evident that the birds fed commercial and control feeds gave satisfactory growth and the best results were obtained with ration D. The results agreed with the findings of Lewis *et al.* (1963), who reported best performance of chicks fed on starter and finisher rations containing 24 and 20% protein respectively.

Feed Consumption :

The highest feed consumption of chicks on starter and finsher rations was on ration C (4693.9 g) and lowest on ration B (3869.1 g). The differences in feed consumption among various groups were significant ($P<0.01$), however, the chicks fed ration B consumed significadtly ($P<0.01$) less than all other rations.

Feed Efficiency :

The feed efficiency of different rations ranked from high to low in the following order, ration D (2.2), ration C (2.4), ration E (2.7), ration A (2.8) and ration B (2.9). The feed conversion values of rations D and C were significantly ($P<0.01$) better than those of ration E, A and B. The feed efficiency of ration D varied significantly from ration C. The best feed efficiency of ration in the present study might be due to better assortment of essential nutrients. The present findings agree with those of Doughlas and Harms (1960); Wisman (1966), and Qureshi (1967), who reported improved feed efficiency with increased protein in the rations.

Carcass Quality :

Table 3 shows the average dressing percentage (excluding skin and internal organs) of birds fed various experimental rations. The low dressing values found in the present study might be due to skinning of birds. The dressing percentage of birds reared on ration C was significantly ($P<0.01$) better than all other rations. The birds on ration C had also longer shank and keel lengths (Table 3). Although the birds on ration C and D had similar body weight but it appeared that the internal organs of chicks on ration D gained more weight as compared to chicks fed ration C.

Economics of Experimental Rations :

The profit per chick amounted to Rs. 13.00, 9.3, 19.2, 20.2 and 13.2 in case of rations A, B, C, D, and E, respectively. The results revealed that ration D gave maximum return and proved more economical. In general, the performance of the chicks on all the commercial feeds was satisfactory.

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