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EFFECTS OF DIFFERENT PRE-STARTER DIETS ON BROILER PERFORMANCE, GASTRO INTESTINAL TRACT MORPHOMETRY AND CARCASS YIELD

M. S. Ullah, T. N. Pasha, Z. Ali*, Saima, F. M. Khattak and Z. Hayat**

Faculty of Animal Production and Technology, University of Veterinary and Animal Sciences, Lahore, Pakistan
*Big Feeds (Pvt.) Ltd., Lahore, Pakistan
**Department of Animal Sciences, University of Sargodha, Sargodha

ABSTRACT

An experiment was conducted to examine the effects of different pre-starter diets on the performance, digestive organs and carcass characteristics of broilers. One hundred and fifty day-old broiler chicks were divided into five groups with three replicates having ten chicks each. During first ten days the birds were fed on five experimental pre-starter diets formulated with different metabolizable energy (ME; varied from 2750 to 2850 kcal/kg) and different lysine levels (varied from 1.3 to 1.5%) but with same crude protein level (21%). After 10 days single starter and finisher crumble diets were fed to the birds up to 28 and 35 days of age, respectively. Statistical analysis of live weight, feed intake and feed conversion revealed significant differences ($P<0.05$) among the treatments. Pre-starter diet with ME 2850 kcal/kg and 1.4 % total lysine resulted in optimum performance. Carcass yield, weights of visceral organs and parameters of digestive tract morphometry did not show any significant difference. It may be inferred that a precisely formulated pre-starter diet according to bird's nutrient requirement could trigger growth. Nevertheless, developments of gastro intestinal tract (GIT) and carcass characteristics are independent of nutritional manipulation in pre-starter diets. However, there is a dire need of further experimentation to explore nutrient requirements of broilers at early age.

Key words: Broiler, early nutrition, energy, lysine, gastro intestinal tract.

INTRODUCTION

Early nutrition plays a vital role in early life and productivity of broilers (Knight and Dibner, 1998). In first week of broiler's life maximum growth (approximately 20% of total) occurs (Noy and Sklan, 2001). A strong positive correlation exists between first week live weight and finishing weight at the end of production cycle that intensify the importance of a good start for ultimate better performance in commercial broilers (Nir *et al*., 1993). In the last 10 years, interest in early nutrition research has increased due to the strong correlation between 7-d-old weight and final weight.

In chicks early age, the development of the digestive system is much faster than the rest of the body. The length and weight of the proventriculus, gizzard, liver, pancreas, and intestine (duodenum, jejunum, ileum) significantly increase in the first week of life (Nitsan *et al*., 1991a). Digestion and absorption of nutrients early in life depends primarily on pancreatic enzyme activity (Nitsan *et al*., 1991b). Pancreatic enzymatic reserve (trypsin, chymotrypsin, amylase and lipase) in the chick is weak at hatch. Feed intake stimulate these secretions dramatically which are noticed in the first week of life. The immune system starts to develop during the embryonic phase and continues for the first week after hatching. Feed provides nutrients for the growth and development of both primary and secondary lymphoid organs. The immune system of the hatchling particularly the mucosal immune system requires feed for rapid development. It has been reported that delayed access to feed impairs not only intestinal development but also development of gut-associated lymphoid tissue (GALT) like the bursa of fabricius, cecal tonsils and meckel's diverticulum. So delay in feed and water consumption directly suppresses the immune system (Jull-Madsen *et al*., 2004). The chemical composition of diets, the content of crude protein, amino acids and energy values are the factors that determine the bird's development in early period of life. The interaction of intestinal growth, digestive functions and diet is critical during the post hatch period. Adequate protein availability in the pre-starter phase seems to be essential to increase muscle development in later phases (Hargis and Creger, 1980)

In the past only starter and finisher diets are available for broiler producers. With the advent of early nutrition, farmers demand pre-starter diets for more efficient start of their broiler production. Although, some commercial feed companies are providing broiler pre-starter diets but research on nutrient requirement of broiler for first few days is scanty. We hypothesized that early nutrition in the form of pre-starter diets would initiate broiler growth which eventually affect birds performance at marketable age. Therefore, an experiment was planned to evaluate the effects of different energy and lysine levels along with constant crude protein in pre-starter diets on the performance, digestive tract development and carcass trait of broilers.

MATERIALS AND METHODS

Birds and housing: The experiment was conducted in an environmental control broiler house. One hundred and fifty day-old broiler chicks (Hubbard classic) were purchased from a local commercial hatchery and divided into five groups with three replicates having ten chicks each. Birds were housed in the shed from day one to 35th day on floor pens measuring (60×150 cm) which was covered by a sawdust bedding of 1 inch thickness. All the chicks were initially weighed and randomly assigned to different groups. The birds had free access (*ad libitum*) to feed and drinking water round the clock and light was maintained for 24 hours a day throughout the entire experimental period. The house temperature was maintained at 35°C/ 95F during the first week of age and a weekly reduction of 3°C was practiced until 25°C/ 75F temperature was attained.

Experimental diets: Five experimental diets were formulated using MIXIT Win least cost feed formulation software. Different metabolizable energy levels (varied from 2750 to 2850 kcal of ME/kg) with different lysine levels (varied from 1.3 to 1.5%) but same crude protein level (21%) were employed. “A” represents diet containing 2750 kcal/kg metabolizable energy, 21 % crude protein and 1.4 % total lysine; “B” denotes diet containing 2800 kcal/kg metabolizable energy, 21 % crude protein and 1.4 % total lysine; “C” symbolizes diet containing 2850 kcal/kg metabolizable energy, 21 % crude protein and 1.3 % total lysine; “D” stands for diet containing 2850 kcal/kg metabolizable energy, 21 % crude protein and 1.4 % total lysine and “E” refers to diet containing 2850 kcal/kg metabolizable energy, 21 % crude protein and 1.5 % total lysine. Compositions and nutrient profiles of pre-starter diets are given in Table 1. The chicks were offered pre-starter crumble diets for a period of 1 to 10 days. After 10 days, single starter and finisher crumble diets were fed to the birds up to 28 and 35 days of age, respectively (Table 2). Proximate compositions of experimental rations were analyzed (AOAC, 2000) and found in close agreement with the calculated values.

Data collection: Weekly body weight gain, feed intake and feed conversion ratio were recorded. Mortality was recorded on daily basis. On day 10th and at the termination of the experiment i.e. day 35th, chicks were slaughtered (one bird from each replicate) and the organs; heart, lungs, liver, spleen, bursa fabricius, along with digestive tract and intestine were weighed. Dressing percentage, digestive tract volume, intestinal volume and intestinal length were also measured.

Statistical Analysis: Experiment was conducted employing Complete Randomized Design (CRD). The data thus generated was analyzed using one way analysis of variance technique (Steel *et al.*, 1997). In case of significant differences among treatment (P< 0.05), means were compared using Duncan’s Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Live weight: The mean values for live weight per bird on different experimental rations from 1-35 days are shown in Table 3. The maximum body weight per bird i.e., 1571.3 g was gained by the birds fed on diet “D” (ME=2850kcal/kg; lysine=1.4%) while the minimum body weight per bird i.e., 1430 g was observed by the birds fed on diet “E” (ME=2850kcal/kg; lysine=1.5%). Statistical analysis of live weight showed significant differences (P<0.05) among different treatments. Duncan’s grouping confirmed that treatment “D” was significantly different (P<0.05) from treatments “A”, “C” and “E” whereas, diet “B” exhibited non-significant differences with other experimental diets.

Weekly comparison of live weights of birds fed different rations from first to fifth week displayed that ration “B” attained maximum body weight for first three weeks while treatment “D” achieved highest weight during the last two weeks (Figure 1). When we plotted these data it was established that diet “D” has consistently improved live weight over the period and finished with maximum performance followed by diet “B”. Concentration of lysine with respect to different metabolizeable energy (ME) levels of diet seems critical for broiler performance especially in compensatory growth after starter phase. Birds showed highest accomplishment on lysine 1.4 % with ME 2800 kcal/kg and above in pre-starter diets. In the light of present results 1.4 percent total lysine with 2850 kcal/kg is found the best combination as for as live weight is concerned.

The reason of better performance of birds fed on diet “D” may be the highest feed intake of these birds during the first week. It is established that broilers performance is closely related to feed intake during the first 7 days which significantly affect final live weight (Lilburn, 1998). Findings of this study is in close agreement with the previous outcomes of Kidd *et al.* (1998) who reported that dietary lysine in the starter and grower-finisher diets significantly (P<0.05) affect live performance in commercial broilers. Some other previous researchers also demonstrated the positive correlation (P<0.05) of pre-starter diets with marketable live weight of broilers (Saki, 2005; Hooshmand, 2006). However, in contrast to these findings Leeson *et al.* (1996) found that *ad libitum* feeding diets with variable metabolizeable energy did not cause significant differences in broilers performance.

Feed intake: Table 3 shows the mean values for feed intake per bird on different experimental treatments from

1-35 days. The maximum amount of feed i.e., 2843 g was consumed by the birds fed on diet "E" (ME=2850kcal/kg; lysine=1.5%) while the minimum feed intake i.e., 2518 g was consumed by the birds fed on diet "C" (ME=2850kcal/kg; lysine=1.3%). Feed intake revealed significant differences (P<0.05) among the treatments.

A linear decrease in feed intake was witnessed with the increase in ME level of diets. However, on maximum ME (2850 kcal/kg) feed intake significantly increased with increasing total lysine. Graph of feed intake of birds during different weeks of age illustrated that birds receiving maximum energy and total lysine (diet E) consumed more feed as compared to other birds during the last three weeks (Figure 2). Whereas, diet "C" although having same ME as in diet "E" exhibited consistently minimum feed intake after the first week. Difference in feed consumption may be due to different levels of total lysine. Difficulty in adaptation from nutrient dense diet to a moderately lower nutrient diet may be another reason for differences in feed consumption as same starter and finisher rations were given to all birds after first 10 days.

Feed intake is a critical factor determining broilers performance especially body weight gain with the compensatory growth (Lilburn, 1998). Thus enhanced feed consumption achieved through any feeding program particularly focused on early nutrition can maximize birds' (González-Alvarado *et al*., 2007; Valencia *et al*., 2009).

Feed conversion: The mean values for feed conversion on different experimental treatments from 1-35 days are shown in Table 3. The best feed conversion (1.73) was observed by the birds fed on diet C (ME=2850kcal/kg; lysine=1.3%) but it was average group in body weight during fifth week. Treatment E (ME=2850kcal/kg; lysine=1.5%) was worst in feed conversion i.e., 1.98 and also poor in body weight at the end of fifth week. Statistical analysis of feed conversion revealed significant difference (P<0.05) among different experimental diets. According to Duncan's grouping, treatments "B" "C" and "D" had non-significant differences among themselves but significantly different (P<0.05) from treatments "E" whereas, diet "A" exhibited non-significant differences with all other experimental diets. Consolidated data on feed conversion showed that treatment "E" had poor feed conversion throughout the period except first week in spite of maximum nutrient density. This finding is in close agreement with the results of Kidd *et al.* (1998) who reported that dietary lysine in the starter and grower-finisher diets significantly (P<0.05) affect live performance, mortality, and breast meat in commercial broilers.

Mortality: Mortality percentage (data not presented) was independent of dietary treatments and statistical analysis revealed non-significant difference among the different experimental diets.

Dressing percentage and organs weights: The mean values for dressing percentage and weights of different organs at fifth week of age of broilers fed on different experimental treatments are shown in Table 4. Maximum dressing percent was seen by the birds fed on "D" (ME=2850kcal/kg; lysine=1.4%) followed by diet "B" (ME=2800kcal/kg; lysine=1.4%) while the minimum dressing percentage was observed by the birds fed on diet "E" (ME=2850kcal/kg; lysine=1.5%). Statistical analysis of dressing percentage revealed non-significant difference (P>0.05) among the treatments. The results of the present study are in line with the findings of Yagoub and Babiker (2008) who revealed that there was non-significant difference (P>0.05) in dressing percentage among different treatments.

The maximum bursa of fabricius weight was seen by the birds fed on diet "B" (ME=2800kcal/kg; CP=21%; lysine=1.4%) and minimum was found in treatment "E" (ME=2850kcal/kg; lysine=1.5%). Liver weight was found maximum by the birds fed on diet "E" (ME=2850kcal/kg; lysine=1.5%) and minimum was found in treatment "D" (ME=2850kcal/kg; lysine=1.4%). Spleen weight was found maximum by the birds fed on diet "C" (ME=2850kcal/kg; lysine=1.3%) and minimum was found in treatment "E" (ME=2850kcal/kg; lysine=1.5%). Heart weight was found maximum by the birds fed on diet "A" (ME=2750kcal/kg; lysine=1.4%) and minimum was found in treatment "B" (ME=2800kcal/kg; lysine=1.4%). Statistical analysis of organ weights of bursa, liver, spleen, and heart at 35 days of age revealed non-significant difference (P>0.05) among the treatments. It means that different pre-starter diets had no influence on development of primary immune organs like bursa of fabricius. The results of the present study are in line with the findings of Hooshmand **(**2006**)** who observed non-significant (P>0.05) differences for abdominal fat, and organs weight (except for liver) due to different feeding programs for broilers. In contrary to that Dibner *et al.*, (1998) reported significance of early nutrition on development of primary immune organs like bursa of fabricius.

Gastro intestinal tract morphometry: Table 5 shows mean values for digestive tract weight, digestive tract volume, intestinal weight, intestinal volume and intestinal length at 35 days of age for different experimental treatments. The maximum digestive tract weight and intestinal length were found in treatment "D", i.e 178.52 g/kg and 159.42 cm/kg of body weight while minimum digestive weight and intestinal length were found in treatment "B" and "E", 172.85 g/kg and 143.60 cm/kg of body weight respectively. Intestinal weight was found maximum in treatment "A" and minimum in treatment

"E". Volume of digestive tract was found maximum in treatment "C" and minimum in treatment "E".

Table 1: Composition and calculated analysis of experimental pre-starter diets

Ingredients	Experimental Diets[1]				
	A	**B**	**C**	**D**	**E**
Corn	58.22	59.94	58.59	58.80	59.01
Soybean meal	31.72	35.56	36.08	35.79	35.49
Sunflower meal	5.57	-	-	-	-
Bone ash	2.34	2.35	2.35	2.36	2.36
Marble chips	0.02	0.01	-	-	-
MHA[2]	0.44	0.47	0.47	0.47	0.47
L-Lysine	0.35	0.29	0.14	0.28	0.42
L-Threonine	0.13	0.13	0.12	0.13	0.13
Sodium chloride	0.22	0.22	0.22	0.22	0.22
Vegetable oil	-	0.04	1.03	0.96	0.90
Vitamin & mineral mix[3]	0.99	0.99	1	1	1
Total	100	100	100	100	100
Calculated analysis					
ME (kcal/kg)	2750	2800	2850	2850	2850
CP %	21	21	21	21	21
Ether extract %	2.24	2.27	3.21	3.15	3.09
Linoleic acid %	1.29	1.32	1.82	1.79	1.75
Crude fiber %	4.59	3.79	3.79	3.78	3.76
Total ash, %	5.58	5.46	5.47	5.46	5.45
Calcium %	1	1	1	1	1
Available phosphorus %	0.45	0.45	0.45	0.45	0.45
Sodium %	0.2	0.2	0.2	0.2	0.2
Potassium %	0.87	0.89	0.89	0.89	0.89
Chloride %	0.21	0.20	0.20	0.20	0.20
Lysine %	1.4	1.4	1.3	1.4	1.5
Methionine %	0.70	0.71	0.71	0.71	0.71
Meth+Cyst %	1.05	1.05	1.05	1.05	1.05
Threonine %	0.9	0.9	0.9	0.9	0.9
Tryptophan %	0.26	0.26	0.26	0.25	0.25
Arginine %	1.42	1.41	1.42	1.41	1.40

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.
[2]MHA= methionine hydroxyl analog
[3]Vitamin and minerals are provided as per Hubbard specification.

Statistical analysis of digestive tract weight, digestive tract volume, intestinal weight and intestinal length at 35 days of age revealed non-significant difference (P>0.05) among the treatments. Likewise, Uni *et al*. (1999) reported mass and length of the small intestines independent of dietary treatments. However the results disagree with Mateos *et al*., (2002) and Gracia *et al*., (2003) who observed dietary effects on gastrointestinal tract (GIT) development. Reason of this disagreement may be the use of different feed technologies like enzyme addition and heat processing employed by these previous researchers, respectively to improve digestibility of broiler diets for the accelerated development of GIT.

Table 2: Composition and calculated analysis of broiler starter and finisher diets

Ingredients	Broiler Starter[1]	Broiler Finisher[2]
Corn	55.15	61.91
Soybean meal	14.39	14.61
Sunflower meal	10	13
Rapeseed meal	8	3.11
Rice polish	-	2
Wheat bran	6.90	-
Bone ash	0.85	0.67
Marble chips	0.96	1.10
MHA[3]	0.13	0.15
L-Lysine	0.43	0.26
Phyzyme	0.01	0.01
Sodium chloride	0.19	0.19
Molasses	2	2
Vitamin & mineral mix[4]	0.99	0.99
Total	100	100
Calculated analysis		
ME (kcal/kg)	2700	2850
CP %	19.28	18.37
Ether extract %	2.60	2.84
Linoleic acid %	1.363	1.48
Crude fiber %	5.87	5.38
Total ash	5.61	5.26
Calcium %	0.95	0.9
Available phosphorus %	0.4	0.35
Sodium %	0.18	0.18
Potassium %	0.79	0.72
Chloride %	0.23	0.23
Lysine %	1.25	1.05
Methionine %	0.45	0.45
Meth+Cyst %	0.81	0.81
Threonine %	0.75	0.71
Tryptophan %	0.24	0.22
Arginine %	1.21	1.17

[1]Starter feed offered from 11 to 28 days
[2] Finisher feed offered from 29 to 35 days
[3]MHA= methionine hydroxyl analog
[4]Vitamin and minerals are provided as per Hubbard specification

Table 3. Live weight, feed intake, and feed conversion of broilers at fifth week of age

Dietary Treatment[1]	Live weight (g)	Feed intake (g)	Feed conversion (g/g)
A	1447.66[a]	2778.66[bc]	1.92[ab]
B	1517.00[ab]	2710.33[b]	1.78[a]
C	1445.33[a]	2518.00[a]	1.73[a]
D	1571.33[b]	2761.00[bc]	1.75[a]
E	1430.00[a]	2843.00[c]	1.98[b]

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.
[a-c]Means within a column not sharing a common superscript differ significantly (P<0.05).

Table 4. Dressing percentage and organs weights of broilers at fifth week of age

Dietary Treatment[1]	Dressing percentage	Organ weights (g/kg)			
		Bursa	Liver	Spleen	Heart
A	68.68	1.74	29.02	1.06	6.09
B	69.48	2.10	28.48	1.10	4.83
C	68.99	1.64	28.42	1.51	5.45
D	70.10	1.43	26.90	1.11	5.22
E	67.37	1.37	29.13	1.01	5.22

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.

Table 5 Gastro intestinal tract morphometry of broilers at fifth week of age

Dietary Treatment[1]	Digestive tract weight (g/kg)	Digestive tract volume (ml/kg)	Intestine weight (g/kg)	Intestine volume (ml/kg)	Intestine length (cm/kg)
A	175.51	163.54	97.76	95.13	150.76
B	172.85	169.79	97.38	98.83	144.34
C	178.08	173.61	97.10	111.70	151.74
D	178.52	170.83	96.86	101.25	159.42
E	174.08	161.99	93.29	97.66	143.60

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.

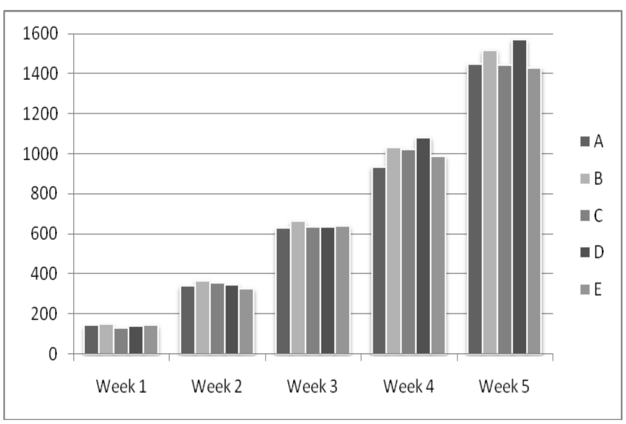

Figure 1 Weekly live weight of birds fed on different experimental rations

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.

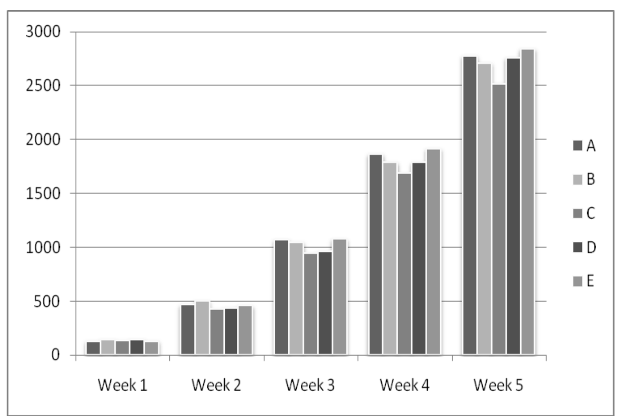

Figure 2 Weekly feed intake of birds fed on different experimental diets

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.

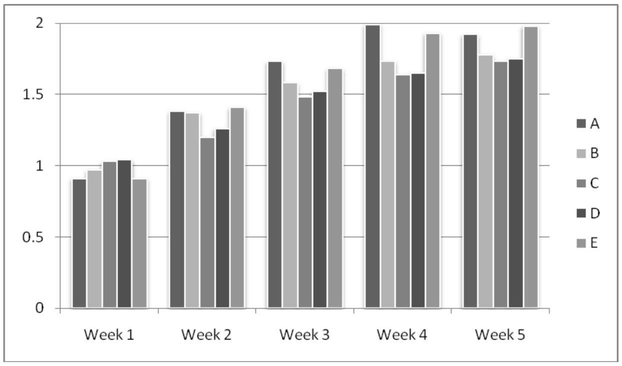

Figure 3 Weekly feed conversion of birds fed on different experimental rations

[1]A= diet containing 2750 kcal/kg metabolizable energy, and 1.4 % total lysine; B= diet containing 2800 kcal/kg metabolizable energy, and 1.4 % total lysine; C= diet containing 2850 kcal/kg metabolizable energy, and 1.3 % total lysine; D= diet containing 2850 kcal/kg metabolizable energy, and 1.4 % total lysine and E= diet containing 2850 kcal/kg metabolizable energy, and 1.5 % total lysine.

Conclusion: It may be concluded from the present trial that pre-starter diets with higher energy and optimum lysine level can improve production performance of broilers. However, digestive tract morphometery and carcass yield have not significantly affected by different pre-starter diets. Further research to explore post hatch nutrient requirements and their effect on production parameters is needed.

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