Full Length Research Article
Advancements in Life Sciences – International Quarterly Journal of Biological Sciences

ARTICLE INFO

Date Received: 18/10/2021;
Date Revised: 16/06/2022;
Date Published Online: 31/10/2022;

Authors' Affiliation:
1. Department of Agricultural Sciences, Allama Iqbal Open University, Islamabad.
2. Faculty of Veterinary and Animal Sciences, University of Arid Agriculture, Rawalpindi - Pakistan.
3. Faculty of Veterinary Sciences, University of Veterinary and Animal Sciences, Lahore - Pakistan

***Corresponding Author:**
Muhammad Kamran
Email: drkamran@uaar.edu.pk

How to Cite:
Elahi M, Iqbal MF, Tunio MT, Kamran M, Shah MAA, et al., (2022). Interactive Influence of Nutrient Density and Feeding Pattern on Production Performance of Broiler Breeders. Adv. Life Sci. 9(3): 295-302.

Keywords:
High energy feed; Calcium feeding; Feed cleanup time; Production parameters

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Interactive Influence of Nutrient Density and Feeding Pattern on Production Performance of Broiler Breeders

Mehboob Elahi[1], Muhammad Farooq Iqbal[2], Muhammad Tariq Tunio[1], Muhammad Kamran[2]*, Muhammad Ali Abdullah Shah[2], Irfan Irshad[3], Tehreem Raza Bhatti[2], Qadeer Ahmed Khan[2]

Abstract

Background: In addition to energy and protein, the minerals also play a vital role in the production performance of birds. The present study was conducted to examine the effect of high energy feed and separate calcium feeding on feed cleanup time and production parameters in broiler breeder pullets.

Methods: Nine hundred female birds of the same age (26 week) were divided in nine groups having one hundred birds in each group. Three different dietary treatments were offered. The group A, B and C were given feeds having 2750, 2900, 2950 Kcal ME / kg and 14.5%, 15%, 15.5% CP respectively along with 165, 155 and 150 grams peak feed allowance at 60 % production. The second and third groups were given 10 g separate calcium source in the evening. The experiment continued for a period of twelve weeks.

Results: The feed intake was significantly lower in group C as compared to A and B. A significantly lower feed cleanup time and higher hatchability percentage was observed in group B compared to groups A and C. The FCR eggs was significantly lower for groups B and C compared to group A. The FCR chicks was significantly lower in group B and C compared to group A. The cost of feed to produce chicks was significantly lower for group B compared to group A and C. Feed consumed to produce one chick was higher for group A compared to groups B and C. The feed cost to produce one chick was highest for group A and lowest for group B.

Conclusion: These results suggested that feed B has lowest feed consumption, cost to produce one chick and feed cleanup time while highest hatchability hence it can be used in the broiler breeder industry to decrease the cost of production and increase profitability.

Introduction

Poultry industry is one of the effervescent sectors of agriculture industry in Pakistan. The poultry sector generates income and employment for about fifteen hundred thousand people. In Pakistan, the cheapest source of animal protein is broiler meat. It contributes 10.8 % in livestock growth and 6.1 % in agriculture [1]. The contribution of poultry meat to total meat production of Pakistan is 28 %. The present investment in poultry industry is above Rs. 200 billion. This sector has shown a growth rate of 8-10 % annually which reflects its inherent potential. The total population of broiler in Pakistan is 722.39 million, and layer is 39.86 million while breeding stock is 10.19 million [2].

In Pakistan the poultry growth has been phenomenal for the last 4 decades with an increase in the chicken production. In future it is expected to surpass beef, which has traditionally been the most consumed meat in the country [3].

The poultry industry is successfully developing in Pakistan. The nutrient content of diets along with genetic potential of poultry has played a vital role in the development of poultry industry. Most egg laying hens receive a feeding program based on changing the nutrient density of the diet as feed intake and egg production changes [4]

Several studies showed that the major nutrients in the feed are energy and proteins. It had been reported that 85 % of total feed cost of poultry come from these two components [5]. A study on chicken regarding the effect of dietary energy on feed intake had shown that an increase from 2680 to 2810 Kcal of ME/Kg decreased the feed intake by 4 % [6]. One of the sources that may increase the dietary energy is fat that may significantly decrease the feed intake [7]. Addition of oil in feed increased the dietary energy that may contribute to increase egg weight [8,9,10]. In addition, the increase in protein level tremendously affects the production parameters including egg production percentage, egg weight & mass, feed consumption, and body weight of birds [11].

During rearing restricted feeding practices are followed in case of broiler breeder to minimize obesity-related reproductive problems such as lower peak production, erratic ovulation, defective eggs, low fertility, and reduced hatchability and chick quality [12]. In case of broiler breeders the control of body weight after peak production is very critical. It had been noticed that if feed is not managed properly the body weight of the broiler breeders will increase tremendously and may lead to obesity [13]. In most of the cases the birds had been fed with high protein content and that resulted in excessive muscle growth and birds became overweight. The heavy birds need more nutrients for body maintenance hence egg production drops quickly as weight increases. Silva [14] reported that if the birds are uniform in weight, then they should be given peak feed at 30-40 % and in case the weight of the bird is not so uniform then peak feed should be given at 60 % production. Therefore, when egg production started to decrease after peak then it is mandatory to reduce feed intake in order to avoid an increase in body weight.

In addition to energy and protein, the minerals also play a vital role in the production performance of birds. King [15] reviewed that the gross composition of egg is relatively constant. Foods containing calcium are consumed by birds for the formation of eggshells. Calcium is used for provisioning chicks that are mineralizing their skeletal tissues. Calcium is one of the most important nutrient necessary for breeding in birds [16]. The requirements for calcium in diet remain high during early development of chicks, when the mineralization of the skeletons continues [17]. Precocial chicks needs to forage extensively to find calcium-rich foods, whereas altricial chicks are fed calcium rich food by their parents [18]. Dietary calcium is essential for females producing eggs and for mineralization of bone in developing chicks [19]. Swiatkiewicz [20] conducted a study and concluded that minerals added in organic forms should be in lower inclusion levels, which may result in reduce mineral content in poultry excreta.

It has been observed that the broiler breeders tend to delay the feed intake when the birds come into production during hot season. This delayed intake causes some birds to eat more feed and other birds to consume less feed. The birds which consume less feed will face the problems related to nutrient deficiency and the production parameters are affected badly. Babikar [21] reported that the birds adjust their feed intake in hot season according to their energy requirements. The efforts are required to formulate feeds in such a way that all the essential nutrients can be provided to birds in the specific quantity of diet offered. The area of energy and protein variation in poultry nutrition is still confusing and debatable. Keeping in view the importance of dietary energy, protein and calcium for poultry, it is the need of time to investigate the effects of feeding optimum level of dietary protein, energy and separate calcium feeding for better productive performance and profitability in broiler breeder pullets. So the current study was designed to compare the production performance of broiler breeder at two different energy levels in feed and to study the effect of separate calcium feeding on production performance in broiler breeders.

Methods

A total of 900 Arbor Acres pullets aged 25 weeks were kept in three groups (A, B and C). Each group was divided into three replicates and each replicate had 100

female birds with 10 % male birds. The trial was started at start of 26 weeks, when the pullets were in early stage of lay and continued till the end of 37 weeks. The birds of each replicate were kept separately on floor in environmentally controlled house. Two square feet of floor space was provided to each bird. The environmental conditions and the management were same for all replicates.

Three types of feeds (A, B & C) were formulated with varying energy contents containing 2750, 2900 and 2950 K calories of ME respectively. All the other nutrients were adjusted according to energy density of the feed. Group-A was given the feed having 2750 K calories of ME and 14.5% CP. The calcium in this feed was 3.5 %. This group was given 165 g of peak feed allowance at 60 % production to females. The second group i.e. Group-B was given concentrated feed having 2900 K calories of ME and 15.0 % CP. The calcium in the feed was 1.5 %. This group was given 155 g of peak feed allowance to females at 60 % production. The third group i.e. Group-C was given feed having 2950 K calories of ME and 15.5 % CP the calcium in the feed was 1.5 %. This group was given 150 g of peak feed allowance to females at 60 % production. 10 g limestone (34 % pure) was given in the evening to the second and third group in the form of scratch feeding. The market cost of feeds were Rs. 43.92/Kg, Rs. 44.52/Kg and Rs. 44.72/Kg for Feeds A, B and C respectively. The composition of diets is shown in Table-1.

Data Collection

The data for each individual parameter was collected from each replicate on daily basis. The data collected during seven days of a week was added and divided by seven to obtain weekly average. The weekly data was analyzed in the statistics.

Daily Feed Intake

All the broiler breeder pullets were fed 130 g feed daily at the stage of 25 weeks. The feed quantity was increased on daily basis keeping in view of production increase. The peak feed allowance was decided as 165 g for treatment A, 155 g for treatment B and 150 g for treatment C. The peak feed was given at 60 % daily production. Feed quantity was calculated, and scale was formulated to increase feed for every single percent increase in production. This increased amount of feed was given on daily basis. After the flock has reached peak feed, the quantity of feed was maintained until production reached maximum and maintained. The feed quantity was reduced in correspondence decrease in production. The feed quantity was decreased @ 1 g for every 2 % decrease in production.

Feed Cleanup Time

Feed was offered to all birds in replicates at 05:00 am on daily basis. A stopwatch was used to determine the time between feed offered and cleaned by the birds.

S. No.	Ingredients	Feed-A	Feed-B	Feed-C
1	Corn (%)	66.419	70.158	73.550
2	Rice polish (%)	04.000	04.000	00.907
3	Soyabean meal Indian (%)	18.411	15.094	19.097
4	Sunflower meal 25% (%)	00.000	04.000	00.000
5	Limestone (%)	09.025	03.451	03.461
6	Di calcium phosphate (%)	00.720	00.720	00.720
7	Salt (%)	00.290	00.290	00.290
8	Sodabicarb (%)	00.220	00.220	00.220
9	L-lysine Hcl (%)	00.080	00.080	00.080
10	Methionine hydroxy analogue (%)	00.170	00.170	00.170
11	Choline chloride (%)	00.090	00.090	00.090
12	Vitamin premix (%)	00.400	00.400	00.400
13	Corn gluten 60 (%)	00.160	1.312	01.000
14	L-Threonine (%)	00.010	00.010	00.010
15	L-Tryptophan (%)	00.005	00.005	00.005
	Total	100	100	100
	DM (%)	88.320	87.730	87.590
	Ca (%)	03.500	01.500	01.500
	P (%)	00.218	00.219	00.217
	CP (%)	14.500	15.000	15.500
	ME (Kcal/kg)	2750	2900	2950

Table 1: Experimental Diets and Composition

Feed Conversion Ratio (FCR)

Feed conversion ratio was calculated for the entire 12 weeks' trial. The feed quantity given on daily basis was summed up and recorded as the whole feed consumed by one hen for 12 weeks. The total hatchable eggs produced were divided on number of hens placed in the trial for each replicate and the resultant value was eggs produced per hen house. The FCR was calculated by dividing the total feed consumed by one hen by number of eggs produced per hen.

Similarly, the FCR per chick produced was calculated by dividing the total feed consumed by one hen by the number of chicks produced per hen.

Egg Production

Eggs were collected manually from each individual pen on daily basis. Every day eggs were collected at every two hours' interval, six times a day. Total eggs collected in the day were divided on the number of female birds housed in that pen and percentage was calculated on daily basis.

Egg Weight

The eggs collected during second collection daily were weighed by using digital scale. This egg weight was measured in grams and was recorded on daily basis.

Hatchability

The hatchable eggs were separated from market eggs. Later on these eggs were shifted to hatchery for incubation. At the time of hatch, the chick number was counted. The percentage hatch was calculated by dividing the chick number to hatchable eggs incubated.

Body Weight

The body weight in grams of females was taken on last day of every week. The birds were weighed 8 hours after feeding and a sample of 5 % from each pen was taken. The weight of all individual birds from one pen was added and was divided on the number of birds to obtain average. The average weight was recorded on weekly basis.

Feed Cost to produce Eggs and Chicks

The daily feed quantity of each individual replicate for every week was added to get weekly feed consumed. The weekly feed quantities were added up for each 4 weeks analysis and separately for total 12 week analysis. Feed cost per dozen hatchable eggs was calculated by multiplying the FCR per dozen eggs with per kg feed cost of respective treatment.

Statistical Analysis

The daily data of feed intake, feed clean up time, feed conversion ratio, egg production, egg weight, hatchability and body weight were converted to weekly basis. The percentage data obtained for production and hatchability was transformed into numerical data by applying Arcsine square root transformation procedure before analyzing. The weekly data was analyzed using ANOVA technique in CRD [22]. The differences were evaluated by applying Tukey test at P value of 0.05.

Results

Daily Feed Intake, Feed Clean Up Time and Feed Conversion Ratio

Daily Feed Intake:

The results from week 26-37 are shown in table-2. The data indicated that during first four weeks (26-29), the group that received the highest energy content (group C) showed

Feed Conversion Ratio (Per Dozen Egg)					
Weeks of study	**A 2750**Kcal/kg	**B 2900**Kcal/kg	**C 2950** Kcal/kg	**± S.E.M.**	**P-Value**
26-29	6.80	6.39	6.62	0.160	0.640
30-33	4.51[a]	4.36[b]	4.22[c]	0.042	0.000
34-37	4.68[a]	4.47[b]	4.45[b]	0.040	0.001
Overall (26-37)	5.12[a]	4.87[b]	4.88[b]	0.047	0.015
Feed Conversion Ratio (chicks)					
26-29	0.79	0.71	0.74	0.020	0.360
30-33	0.43[a]	0.41[b]	0.41[b]	0.003	0.002
34-37	0.44[a]	0.42[b]	0.42[b]	0.004	0.001
Overall (26-37)	0.51[a]	0.48[b]	0.48[b]	0.005	0.003

Table 2: Effect of Varying Energy Diets on Feed Conversion Ratio (Per Dozen Eggs and Chicks)

significant (P<0.05) reduction in feed intake as compared to group A and B (150.7, 147.94 & 142.88 for A, B & C respectively). The data for daily feed intake from week 30-33 showed that the birds in group B had significantly lower (P<0.05) feed intake than group A and group C. The data for 34-37 week showed that the group C had significantly lower feed intake (P<0.05) as compared to A and B.

Feed Intake					
Weeks of study	**A (Kcal/kg) 2750**	**B (Kcal/kg) 2900**	**C (Kcal/kg) 2950**	**± S.E.M.**	**P-Value**
26-29	150.7[a]	147.94[b]	142.88[c]	1.180	0.000
30-33	164.7[a]	155.00[b]	149.79[c]	2.200	-
34-37	162.49[a]	155.09[b]	148.80[c]	2.060	0.010
Overall (26-37)	159.3[a]	152.68[b]	146.95[c]	1.790	0.010
Cleanup Time					
26-29	26.2	28.38	27.29	0.520	0.250
30-33	79.02[a]	48.82[b]	60.42[b]	4.510	0.001
34-37	134.60[a]	72.26[b]	85.77[b]	10.140	0.002
Overall (26-37)	79.94[a]	50.16[b]	57.83[b]	4.730	0.001

Table 3: Effect of Varying Energy Diets on Feed Intake and Cleanup Time

In all cases both the test diet (high energy diet with separate calcium feeding) gave much improved results regarding to feed intake as compared to normal diet. The overall analysis of feed intake data for all the 12 weeks (table-3) also showed that birds fed with highest energy content (Group C) consumed the least feed quantity (146.95 g) which is significantly lower (P<0.05) than the birds of group A (159.33 g) and B (152.68 g). The feed intake remained lower (P<0.05) in pullets fed high energy diet C (2950 Kcal/kg) than that of other diets. The feed intake was also lower in diet B (2900 Kcal/kg) than that of diet A. So by increasing energy gradient in diet the feed intake was reduced.

Feed Cleanup Time:

The overall analysis of feed cleanup time data showed that the birds which were fed with diet B took the minimum time to clean up the total feed which is lower (P<0.05) than the group A and group C.

The results of week 26-29 did not show any significant difference (P>0.05) in all the three groups for feed clean up time. However, during week 30-33 and week 34-37 a noteworthy difference (P<0.05) in feed cleans up time by both test groups as compared to group A was noted. During week 30-33 feed clean up time was significantly low (P<0.05) for group B and C as compared to control group A (table-3). No difference (P>0.05) was found between group B and C during this period. Similar results were observed for 34-37 week. The overall comparison showed that the feed cleanup time of group B and C was significantly different (P<0.05) from group A. The feed cleanup time was found lower (P<0.05) in pullets fed high energy diet B (2900 Kcal/kg) than that of other diets. Similarly, it was also lower in diet C (2950 Kcal/kg) than that of diet A. So, by increasing the energy content of feed, a reduction in feed cleans up time was observed.

Feed Conversion Ratio:

The comparison of three feeding diets for feed conversion ratio is shown in table-4. The data showed that the feed conversion ratio per dozen eggs from week

26-29 in test diets did not differ significantly (P>0.05) from control group. However, the data for week 30-33 revealed that the FCR per dozen eggs was significantly different (P<0.05) in all the three groups. The birds fed with diet C (high energy diet) showed the lowest ratio as compared to A and B, whereas the birds fed with diet B showed the lower ratio as compared to control group indicating that both the test diets are more effective in producing more eggs while consuming less feed quantity as compared to control diet.

The data for 34-37 week showed that the FCR per dozen eggs remained lower (P<0.05) for group B and C as compared to A, however no difference was found in group B and C. The overall comparison of FCR per dozen eggs showed that a significant lower FCR (P<0.05) was found for group B and C as compared to group A.

Regarding feed conversion ratio per chick the pattern was found to be the same as that was obtained for FCR per egg i.e. bird fed with high energy diets showed the lowest ratio. The data for 26-29 week showed no significant difference (p>0.05) among all groups. The results of 30-33 week showed that the FCR chicks was significantly lower (P<0.05) for group B and C as compared to group A. Again the significant difference (P<0.05) can be easily seen from Table-6. The results for week 34-37 were also recorded. The data showed that the FCR for chicks was found to be significantly lower (P<0.05) for group B and C as compared to group A. The overall analysis of FCR chicks showed significant lower FCR (P<0.05) for both the test diets B and C as compared to Control A. The significant difference can be easily seen in table-5.

The FCR per dozen eggs and to produce per chick remained lower (P<0.05) in pullets fed high energy diet B (2900 Kcal/kg) and C (2950 Kcal/kg) than that of control diet A (2750 Kcal/kg).

Egg Production and Egg Weight

Egg Production:

The week wise comparison of egg production had been shown in table-7. Results indicated that egg production from week 26-29 did not differ significantly (P>0.05) in all the three diets. All the test diets behaved the same way as that of control diet. The results of data obtained in 30-33 week showed an increase (P<0.05) in egg production for group C as compared to group A and B. The group which was fed with diet B showed similar results with other diets A and C. In conclusion the peak egg production was found in weeks 30-33. Again the test diet was seemed to be more effective than the control diet. Likewise the results of weeks 34-37 had also shown no significance (P>0.05) in egg production percentage in all the three groups. The total analysis of all the 12 weeks (Table-6) had shown that egg production in group B was higher than group A and C. However, this difference was not statistically significant (P>0.05).

Egg Weight:

The data of week 26-29 had shown that the egg weight remained comparable for all the three groups feeding with control diet as well as test diet. These results indicated significant difference in egg weight (P<0.05). The egg weight of A was higher than B and C while that of group B was same as of A and C. The significant difference can be seen from table.7. The data was also analyzed for week 30-33. The data indicated significant differences in egg weight (P<0.05). The weights of eggs in test groups were found to be good enough for production of chicks as the control group so the chicks produced would be of same good weight. The egg weight for 34-37 week remained higher (P<0.05) in group B as compared to group A and group C. The total analysis of all the 12 weeks (table-7) indicated no significant difference (P>0.05) among all groups. There it is easily seen that the egg weight of the test groups did not significantly change. These values are found to be exactly similar in all three cases indicating that the high energy and separate calcium feeding did not affect the eggs weight of broiler breeders, hence the results are comparable to control group. The weights of eggs in test groups were found to be good enough for production of chicks as the control group so the chicks produced would be of same good weight.

Egg Production Percentage					
Weeks of study	**A (Kcal/kg) 2750**	**B (Kcal/kg) 2900**	**C (Kcal/kg) 2950**	**± S.E.M.**	**P-Value**
26-29	46.35	49.48	46.11	0.794	0.150
30-33	65.54^{b}	66.56^{ab}	67.16^{a}	0.294	0.040
34-37	63.28	64.40	63.92	0.234	0.140
26-37	57.84	59.62	58.39	0.365	0.110
Egg Weight					
26-29	53.11^{a}	52.34^{ab}	52.86^{b}	0.140	0.030
30-33	58.84^{a}	58.07^{b}	58.46^{ab}	0.120	0.004
34-37	60.31^{b}	61.51^{a}	60.42^{b}	0.190	0.000
Overall (26-37)	57.42	57.31	57.25	0.042	0.230

Table 4: Effect of Varying Energy Diets on Egg Production percentage and Egg weight

Weeks of study	**A (Kcal/kg) 2750**	**B (Kcal/kg) 2900**	**C (Kcal/kg) 2950**	**± S.E.M.**	**P-Value**
26-29	54.36^{b}	56.28^{a}	55.79^{a}	0.304	0.001
30-33	68.25^{b}	69.14^{a}	67.95^{b}	0.193	0.004
34-37	70.00^{b}	71.20^{a}	70.08^{b}	0.197	0.000
26-37	63.58^{b}	64.93^{a}	64.08^{b}	0.207	0.001

Table 5: Effect of Varying Energy Diets on Hatchability Percentage

Hatchability Percentage

The weekly analysis had shown that during week 26-29 the birds fed with test diet that is diet B and C showed an increase in hatchability percentage (P<0.05) as compared to control group A. The analysis was continued for week 30-33 and then for week 34-37. The results indicated that during weeks 30-33 the

hatchability percentage was significantly increased (P<0.05) for the birds fed with diet B as compared to A and C. The results of data obtained in 34-37 week indicated significantly high (P<0.05) hatchability for group B as compared to A and C. The overall analysis of hatchability data (week 26-37) again indicated increase in hatchability (P<0.05) for group B as compared to group A and group C. The hatchability was found to be higher (P<0.05) in pullets fed high energy diet B (2900 Kcal/kg) than that of other diets. Hence by increasing energy gradient in diet the hatchability was increased.

Weeks of study	A (Kcal/kg) 2750	B (Kcal/kg) 2900	C (Kcal/kg) 2950	± S.E.M.	P-Value
26-29	3194^{ab}	3308^{a}	3174^{b}	24.960	0.030
30-33	3492	3442	3496	12.250	0.120
34-37	3702^{a}	3465^{b}	3634^{a}	36.560	0.000
Overall (26-37)	3463	3405	3435	12.050	0.140

Table 6: Effect of Varying Energy Diets on Body Weight (g) of Broiler Breeder Pullets

Body Weight of the Female

The week wise comparison of body weight of the female bird had shown that during week 26-29 the body weight of the bird was significantly lower (P<0.05) for group C as compared to group A and B. The body weight of group B was higher than A and C while that of group A was similar to B. The data obtained during week 30-33 had shown that there was no significant difference (P>0.05) in the body weight of the bird in all the three groups fed with diet A, B and C. However, the analysis of week 34-37 showed that the body weight of the birds in the group B was significantly lower (P<0.05) as compared to group A and C which was similar in both groups. The overall body weight of birds during the whole trial period (week 26-37) had not shown any significant difference (P>0.05). In addition, the body weight of the bird affects the egg production.

Weeks of study	A (Kcal/kg) 2750	B (Kcal/kg) 2900	C (Kcal/kg) 2950	± S.E.M.	P-Value
26-29	298.69	284.51	295.92	6.900	0.730
30-33	197.94^{a}	194.23^{a}	188.80^{b}	1.410	0.001
34-37	205.60^{a}	199.06^{b}	198.82^{b}	1.220	0.005
Overall (26-37)	225.07	216.85	218.45	1.640	0.070

Table 7: Effect of Varying Energy Diets on Cost of Dozen Hatchable Eggs

Weeks of study	A (Kcal/kg) 2750	B (Kcal/kg) 2900	C (Kcal/kg) 2950	± S.E.M.	P-Value
26-29	34.64	31.78	32.79	0.850	0.440
30-33	19.12^{a}	18.54^{b}	18.31^{b}	0.130	0.010
34-37	19.40^{a}	18.51^{b}	18.74^{b}	0.140	0.002
Overall (26-37)	22.43^{a}	21.22^{b}	21.64^{ab}	0.200	0.010

Table 8: Effect of Varying Energy Diets on Cost of Chicks

Feed Cost to Produce Eggs and Chicks

The results for the cost of feed to produce dozen hatchable eggs during week 26-29 did not show any significant difference (P>0.05). During weeks 30-33 the cost of feed to produce dozen hatchable eggs was found to be lower (P<0.05) for group C as compared to group A and B, which was same. During the weeks 34-37 the feed cost of group B and C was lower (P<0.05) to produce dozen hatchable eggs as compared to control group A. The overall comparison of feed cost showed no significant difference among all groups A, B and C.

The results for the cost of feed to produce chicks during week 26-29 did not differ significantly (P>0.05). During week no 30-33 the cost of feed to produce chick was significantly lower (P<0.05) for group B and C as compared to group A, which was higher. During the week no 34-37 again the feed cost of group B and C was significantly lower (P<0.05) to produce chicks as compared to group A. The overall comparison of feed cost had shown significant difference (P<0.05) for group A as compared to group B and C (table.11), it was higher for group A while in case of group B it was similar to group A and B.

Discussion

Finding of this study regarding feed intake reduction due to high energy is in line to Guangbing [23] who reported that with increase in dietary energy level, the feed intake was significantly reduced in commercial Leghorn pullets. Similarly, results of present study are also supported by Valkonen [24], Guangbing [23], Peguri and Coon[25] who reported significantly decreased feed intake with increase in dietary energy. This indicates that the poultry feed intake is mainly controlled by dietary energy of the feed.

However, few workers reported differently in previous published literature. In a study by Gunawardana [26], it was documented that the dietary energy did not affect significantly feed intake in pullets. The reason of dissimilarity might be due to different stage of production.

Results indicated that feed conversion ratio decreased when the bird fed with diet containing higher concentration of energy. Results are in line with Gunawardana [26] who studied the effect of different concentrations of dietary energy and protein on production performance of scavenging crossbred hens in rural area of Bangladesh which is situated in tropical areas. However, results are not in agreement with Tarasewicz [29] who indicated that group of birds fed with lowest ratio of metabolizing energy to crude protein percentage showed the lowest feed conversion ratio as compared to control group.

Regarding egg production our results are consistent with Gunawardana [26] and Wu who reported that with increase in dietary energy there is an increase in the egg production, however, the egg weight had not been affected. Similarly the results of current study are in line with Bu [30] who reported significant improvement

(P<0.01) in egg production by increasing the energy gradient of diets.

Regarding egg weight, the results of current study were in accordance with Rezvani [31] who reported that the egg weight was not affected by varying the energy level in diets. Similarly, the results of current study are in line with Peebles [32] who reported that supplementation of oil for increasing the energy content of diets did not affect the egg weight of birds.

However, when the egg weights were considered, our results were inconsistent with Guangbing [5] who reported with an increase in dietary energy an increase in egg weight was observed. Possible reason for inconsistency may be the age of birds during study.

Regarding hatchability percentage, the results are consistent with Enting [33] and Reis [34]. Enting [33] reported that low density diets have significant effect on hatchability. Reis [34] concluded that hatchability increased up to 3 percent when broiler breeders received limestone particles in the afternoon. The results are inconsistent with Peebles [32] who reported that different energy levels in diets have no effect on hatchability. The difference in our study may be is that we have studied different levels of ME as well as CP keeping in consideration the proper ratio of energy and protein as in poultry feeding proper ratio of energy and protein must be maintained for optimum performance. It was previously reported that the heavy weight bird produces fewer eggs than light weight bird [35]. The main focus in the broiler breeder production is that bird may not gain much weight. In fact, weight increase should be minimum so that bird may produce more eggs. These results indicated that the body weights of the bird had not been affected by high energy and separate calcium feeding diet and thus remained constant in control group as well as in test groups. These results are consistent with Guangbig [23] who also reported that varying energy in diets had no effect on body weight. Regarding feed cost to produce eggs and chicks, the results of current study are consistent with Eila [36] who reported that different metabolisable energy levels have significant effect on cost of feed to produce eggs and weight gain. Cost of feed to produce eggs decreased significantly (p<0.05) with increase in energy level in feed.

The current findings are not in agreement with the results of Shahbaz and Khan [37] who reported feed cost was lowered (p>0.01) per kg of body weight in chicks given low energy diets. Minimum feeding cost was observed in the female birds which were given ration having 16 % CP and 2700 Kcal of ME. The possible reason for inconsistency is that his work is on native Desi chickens during growth phase. He studied the cost effect on weight gain of Desi birds while our focus is on the production of hatchable eggs from commercial broiler breeders. The difference of genetics may have effect on the parameter studied.

The present study was conducted to examine the effect of high energy feed and separate calcium feeding on feed cleanup time and production parameters in broiler breeder pullets. It was concluded on the basis of findings that feed B having ME 2900 Kcal/Kg and CP 15 % with 10 g limestone can be used in broiler breeder pullets as efficient diet for better production and profitability.

Competing Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Author Contributions

Muhammad Farooq Iqbal and Muhammad Ali Abdullah Shah: Designed the study, Mehboob Elahi: Executed the experiment, Muhammad Tariq Tunio: Supervise the study, Irfan Irshad: analyzed the data. Mehboob Elahi and Muhammad Kamran: Write a primary draft. Tehreem Raza Bhatti and Qadeer Ahmed Khan: Edit the manuscript.

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