Pakistan J. Zool., vol. 46(5), pp. 1357-1362, 2014.

Effect of Dietary Energy Levels on Growth Performance and Feed Cost Analysis in Japanese Quail

Mubarik Mahmood,[1] Abdur Rahman,[1]* Saima,[1] Muhammad Akram,[2] Talat Naseer Pasha[1] and Makhdoom Abdul Jabbar[1]

[1]Department of Animal Nutrition, University of Veterinary and Animal Sciences, Lahore, Pakistan 54000
[2]Department of Poultry production, University of Veterinary and Animal Sciences, Lahore, Pakistan 54000

Abstract.- Feed cost has a direct influence on routine farm operations. Optimum energy level in the feed results in better performance as well as proves to be cost effective. The present study was conducted to examine the growth and production of meat type quail along with feed cost analysis using different energy levels. Three diets having energy levels of 2900 kcal/kg (Control group), 2700 kcal/kg (B) and 3100 kcal/kg (C) were offered to 600 one-day-old quail chicks for 28 days to examine the carcass quality and growth performance. Birds were divided into 3 groups. Each group was further divided into 4 replicates with 50 birds in each. High energy diet (3100 kcal/kg) resulted in improved body weight gain, increased feed intake and better FCR ($p<0.05$). Liver weight was observed better in high energy diet ($p<0.05$). Dressing percentage was not affected by high energy diet ($p>0.05$) but a numerical difference existed while breast meat percentage was lower in high energy supplemented group ($p<0.05$). It is concluded that higher energy diet resulted in better performance and is more economical as it resulted in low cost per Kg live weight gain of birds.

Key words: Energy levels, weight gain, feed intake, FCR, quail economics.

INTRODUCTION

The poultry sector has shown remarkable improvement during the last three decades. Poultry industry shares 1.12 % in the national GDP of Pakistan and 1.5 million people are employed in this sector. Role of well-balanced ration for poultry is essential to achieve its optimum production potential in terms of meat and eggs. Feed contributes 70% of total cost in poultry. Poultry meat contributes 28.0% of the total meat production of Pakistan and this industry is showing 8-10% annual growth (Economic Survey of Pakistan, 2014).

People all over the world are diverting their attention towards the meat and eggs of other poultry species like quail, ostriches and emus to enhance per capita protein availability for ever increasing human population. Quail farming is gaining much popularity due to unique flavor of its meat (Kayang *et al*., 2004), relatively low investment, resistance to diseases and quick body weight respond to genetic selection (Yalcin *et al*., 1995; Oguz and Minvielle, 2001). To enhance the production and maintain the need of customers, the producers are bound to limit the costs of their products as per requirement of the consumers. This can only be achieved by lowering the cost of production, which is minimized by using economical ingredients, principally the sources of energy. The most necessary nutrient required for growth is energy even though energy itself is not changed into meat or eggs but used as fuel for getting high production. A number of scientists have made efforts to attain the optimum level of energy which provides better growth with minimum possible cost (Dozier *et al*., 2006, 2007; Ghaffari *et al*., 2007). They have proved that by increasing energy level of feed, feed conversion ratio can be improved (Dozier *et al*., 2006, 2007; Ghaffari *et al*., 2007; Jackson *et al*., 1982) but this is true up to a certain limit because the dietary energy and availability of essential nutrients of feed are much related to one another. The amount of feed consumed and ultimately the intake of essential nutrients is affected inversely with energy level (Slagator and Waldroup, 1990). So, energy level more than that of normal will result in deficiency of nutrients availability and will cause high cost of production. At present, the experimental data on modern quail are lacking contrary to chicken broiler.

Current study was planned to check the

* Corresponding author: abdurrehman@uvas.edu.pk
0030-9923/2014/0005-1357 $ 8.00/0

optimum level of dietary energy for growth and other production characters of Japanese quail (*Coturnix coturnix japonica*) with economical production cost.

MATERIALS AND METHODS

This study was conducted at Avian Research and Training (ART) Centre, University of Veterinary and Animal Sciences, Lahore, after the approval from the directorate of Advance Studies of the University for ethical use of birds. Total 600 one-day-old chicks of Japanese quail (*Coturnix coturnix japonica*) were procured from ART Centre, UVAS, Lahore. Chicks were randomly divided into 3 groups in such a way that there were 4 replicates in each group having 50 chicks in each replicate. Feed and water were offered *ad libitum*. The duration of the performance trial was 28 days.

During the research trial of 28 days, three experimental diets (A, B, C) were formulated. All diets were iso-nitrogenous according to the standards prescribed by NRC (1994). Diet A (control) provided the energy 2900 kcal/kg; diet B possessed 2700 kcal/kg, while energy value of diet C was 3100 kcal/kg. The birds were maintained in cages throughout the trial and crumbs feed was offered *ad libitum*. All other standard managemental practices were carried out during the whole duration of the trial. Formulation and nutrient composition of diets are presented in Tables I and II, respectively.

Experimental parameters

Nutrient composition of the diets and illeal fecal samples was calculated by performing Weende analysis on diet samples using AOAC (2000) methods and Metabolisable Energy (ME) of treatment diets was calculated using Carpenter and Clegg equation (Leeson and Summer, 2005).

$$ME\ (kcal/kg) = 53 + 38\ [(crude\ protein,\ \%) + (2.25 \times ether\ extract,\ \%) + (1.1 \times starch,\ \%) + (sugar,\ \%)]$$

All one-day-old chicks were weighed individually on the first day and then weekly to calculate body weight gain. Weekly feed consumption was recorded. Feed conversion ratio was calculated using weight gain and feed consumption. After 28 days, 5 birds from each replicate were randomly picked and slaughtered to study dressing percentage, liver weight and breast meat percentage. The dressing percentage was calculated without liver, heart, gizzard and spleen weight. A comparison among the cost of feed per kg live weight of various experimental groups was made to evaluate economics viability of using different energy levels.

Table I.- Ingredient composition (%) of diets in different groups.

Ingredient	A	B	C
Corn grain	21.27	30.00	39.10
Rice polish	02.00	08.96	-
Rice tips	26.76	11.87	14.00
Molasses	01.00	03.35	01.00
P.B.P meal	02.00	02.00	03.00
Soybean meal	23.55	25.00	20.86
Corn gluten 60%	03.00	03.00	05.00
Sunflower meal	07.00	07.00	-
Canola meal	-	00.30	-
Cotton seed meal	07.41	05.00	09.00
Fish meal	01.00	00.60	02.00
Ca carbonate	01.39	01.74	01.62
Premix	01.00	01.00	01.00
Lysine	00.11	00.06	00.14
D L methionine	00.07	00.11	00.05
Oil	02.00	-	03.20
D.C.P	00.44	-	00.03

Table II.- Nutrient composition (%) of diets in different groups.

Nutrient	A	B	C
D.M	89.66	89.57	90.25
C.P	24	24	24
M.E. (k cal/kg)	2900	2700	3100
C.F	5	5	4.29
E.E	3.38	4.45	3.69
Methionine	0.55	0.55	0.55
Lysine	1.1	1.1	1.1
Linoleic acid	0.72	1.17	1.02
Calcium	0.9	0.9	0.9
Phosphorus	0.65	0.7	0.65

Statistical analysis

The data thus obtained was subjected to statistical analysis by using completely randomized design through ANOVA Technique (Steel *et al.*,

1997) considering diets as categorical factors. The difference among the treatment means were compared by using Duncan's Multiple Range (DMR) Test (Duncan, 1995)

RESULTS AND DISCUSSION

Significantly ($p<0.05$) higher weight gain was observed in group C having energy level of 3100 kcal/kg as compared to other groups as shown in Table III. It was perhaps due to more feed intake along with more intakes of calories and CP. The energy levels of feed showed a direct relationships with body weight gain when energy of feed was increased from 2700 kcal/kg to 3100 kcal/kg. Similar results were observed by Fan *et al.* (2008) who performed a 42 days trial on ducks and evaluated the energy level which best fits for growth parameters of the ducks, showed increase in body weight with increase in energy from 2600 to 3100 kcal/kg. Holsheimer and Veerkamp (1992) also conducted experiment and got the results supporting the above statement by showing that 3200 kcal/kg energy in feed gave better weight gain as compared to that of 2880 kcal/kg in male broiler. However, Min *et al.* (2007) gave a bit different results. They studied the effect of dietary energy on Gosling growth performance and carcass traits and found that birds on a diet with 11.87, 12.37, and 12.87 MJ of ME/kg exhibited greater body weight gain than those on a diet with 10.87 and 11.37 MJ of ME/kg, despite the body weight gain was almost same among 11.87, 12.37 and 12.87 MJ of ME/kg of diet. Rosa *et al*. (2007) also reported increase in weight gain using high energy level upto 3450 Kcal/kg in broilers.

There was significant ($p<0.05$) difference in feed intake of group C as compared to other dietary groups. Maximum feed intake was shown by the group C that was offered feed with higher energy followed by the group A and B. Usually birds eat to fulfill their requirements and in this study high feed intake is might be to fulfill other nutrients like protein. Lipstein *et al.* (1975) also reported that birds would try to eat and meet their particular requirement for protein and essential amino acids. In another experiment it was observed that birds eat to fulfill their energy requirements (Leeson and Caston, 1993). Contrary to this Leeson *et al.* (1996) found that when broiler was fed with diet having 2700, 2900. 3100 and 3300 Kcal/kg it showed decrease in feed intake and better FCR with increasing energy levels.

Table III.- Growth performance and carcass characteristics of Japanese quail raised on different ME levels.

	ME level ((Kcal/Kg)		
	A (2900)	**B (2700)**	**C (3100)**
Feed intake	391.75±2.86[b]	382.50±1.50[b]	408.50±5.04[a]
Weight gain	165.40±4.73[b]	159.25±6.22[b]	182.85±5.90[a]
FCR	2.37±0.04 [a]	2.41±0.09 [a]	2.23±0.01 [a]
Dressing	56.57± 1.62 [a]	55.58±2.57 [a]	59.65±2.03 [a]
Breast meat	35.26±0.77 [a]	34.80±0.78 [a]	31.84 ±0.78 [b]
Liver weight	3.8±0.13 [b]	4.05± 0.21 [b]	4.80±0.21 [a]

Means in the same columns sharing similar superscripts are not significantly different ($p>0.05$)

Best feed conversion ratio was exhibited by group C (3100 kcal/kg M.E) followed by group A (2900 Kcal/kg) and then group B (2700 Kcal/kg) as explained in Table III. Similar results were observed by Fan *et al*. (2008) who performed the trial on ducks and evaluated the energy level which best fits for growth parameters of the ducks. Kaura *et al.* (2008) also supported the statement and checked out the immunity along with performance in relation to feed energy and essential amino acids, in heavy weight line of quail. Feed conversion ratio showed direct relation ($P<0.01$) with dietary ME level. Elangovan *et al*. (2004) conducted a study to evaluate the effect of feed-grade enzyme supplementation in diets with varying levels of energy on the performance of growing and laying Japanese quails. He offered three treatments diets of energy levels 2900 kcal, 2700 kcal and 2500 kcal kg^{-1} along with two enzyme levels *i.e.*, 0 and 0.5 g kg^{-1} of diet. At the end of fourth week of age, High energy diets *i.e.*, containing 2900 and 2700 kcal ME/kg showed better weight gain, FCR and relatively lower feed intake as compared to the third one *i.e*. having 2500 kcal ME/kg.

The group C showed higher value of carcass followed by group A and B. There was a non significant difference ($p>0.05$) among all groups although small numerical difference was there indicating an improved trend in group C as shown in Table III. Tang *et al.* (2007) also demonstrated the same results by studying the dietary metabolizable energy and lysine on carcass characteristics and meat quality in Arbor Acre broilers. They showed that dressing percentage increased ($p<0.05$), with increasing dietary energy level. Carcass weight and yield of breast muscle remained unaffected by changes in dietary energy or lysine content.

The group C showed lesser value ($p<0.05$) regarding breast meat percentage as compared to group A and B (Table III). Numerically higher value ($p>0.05$) was observed in control group A while B was intermediate. Contrary to this Tang *et al.* (2007) observed that carcass weight and yield of breast muscle remained unaffected by changes in dietary energy or lysine content. This might be because birds consume more diet to fulfill energy requirements hence consuming more lysine.

The average liver weight in terms of g/bird in Japanese quail of different experimental groups is shown in Table III. The significant increase in liver weight observed in birds fed with feed of ME 3100 kcal/ kg (group C) was perhaps attributed to more burdens on liver in sense of digestion of energy rich compounds. Maiorka *et al.* (2004) manipulated the amino acids instead of protein with variable energy levels of 3200 or 2900 kcal ME/kg. In this study they concluded that birds fed with the high energy diet showed more abdominal fat and more liver size as compared to those that were offered the low energy diet, due to more burden of high energy diet on liver. Summers *et al.* (1992) also performed a similar experiment using different energy levels and reported low abdominal fat percentage by decreasing energy level in diet.

Significantly ($p<0.05$) higher calories intake was observed among group C as compared to other treatments A and B (Table IV). Similar results were summarized by Sinurat and Balnave (1985) who reported the effect of dietary amino acids and metabolisable energy on the performance of broilers kept at high temperatures. They noted slightly more calories intake when M.E was increased in diet. Similar findings were reported by Touchburn *et al.* (1980) who noted that there was significant difference ($p>0.05$) in feed consumption and calories intake while feeding different energy levels of feed. Higher ($p<0.05$) protein, methionine and lysine intake was observed in group C having 3100 Kcal/kg ME as compared to group A and B which might be due to more feed intake in group C. Methionine and lysine intake possessed linear relationship with energy as the energy level increased from 2700 Kcal/kg ME to 3100 Kcal/kg ME. Higher calcium intakes ($p<0.05$) was observed in group C followed by A and B. Similarly higher phosphorous intake was recorded in group B followed by C and A which might be attributed with feed intake difference and utilization of specific nutrient by the birds in different groups.

Table IV.- Nutrient intakes by Japanese quail fed with different levels of ME.

Nutrients / treatment	ME Levels (gm)		
	Group A	Group B	Group C
ME	1136.08 ± 8.31^{b}	1032.75 ± 4.05^{c}	1266.35 ± 15.62^{a}
CP	94.02 ± 0.68^{b}	91.8 ± 0.36^{b}	98.04 ± 1.21^{a}
Calcium	3.52 ± 0.02^{b}	3.44 ± 0.01^{b}	3.67 ± 0.045^{a}
Phosphorus	2.35 ± 0.02^{c}	2.67 ± 0.01^{a}	2.45 ± 0.03^{b}
Methionine	1.9 ± 0.01^{b}	1.91 ± 0.007^{b}	2.04 ± 0.03^{a}
Lysine	3.92 ± 0.03^{b}	3.82 ± 0.02^{b}	4.08 ± 0.05^{a}

Means in the same columns sharing similar superscripts are not significantly different ($p>0.05$)

Table V.- Economics of experimental diets.

	Group A (2900 Kcal/Kg)	Group B (2700 Kcal/Kg)	Group C (3100 Kcal/Kg)
No. of birds	200	200	200
Cost of feed/kg(Rs)	37	36	39
Feed consumed/bird (kg)	0.39	0.38	0.41
Cost of feed/bird (Rs)	14.46	13.75	15.91
Total cost of feed (Rs)	2892	2750	3182
Average live weight (kg)	0. 16	0.15	o.18
Total live weight gain (kg)	32.6	30.6	36.4
Feed cost/kg live wt. (Rs.)	88.71	89.86	87.41

Economics of each experimental diet is shown in Table V. Feed cost per kg live weight in group C was relatively low as compared to other groups. So group C was observed as more cost effective and economical.

CONCLUSIONS

It is concluded from the results that, energy levels of 3100 kcal/kg is best as far as the growth and cost benefit are considered. Dense energy diet has resulted in improved performance. It is recommended to formulate the quail diet containing high energy (3100 Kcal/Kg) to enhance the production efficiency with least cost.

REFERENCES

AOAC, 2000. *Official methods of analysis* 17th ed. AOAC International, Maryland, vol. **4**, pp. 1-41.

DOZIER, W.A., CORZO, A., KIDD, M.T. AND BRANTON, S.L., 2007. Dietary apparent metabolizable energy and amino acid density effects on growth and carcass traits of heavy broilers. *J. appl. Poult. Res*., **16**:192–205.

DOZIER, W.A., PRICE, C.J., KIDD, M.T., CORZO, A., ANDERSON, J. AND BRANTON, S.L., 2006. Growth performance, meat yield, and economic responses of broilers fed diets varying in metabolizable energy from thirty to fifty-nine days of age. *J. appl. Poult. Res*., **15**:367–382.

DUNCAN, D.B., 1955. Multiple range and multiple F tests. *Biometrics,* **11**:1.

ELANGOVAN, V.A., MANDAL, A.B. AND TYAGI, P.K., 2004. Effects of enzymes in diets with varying energy levels on growth and egg production performance of Japanese quail. *J. Sci. Food Agric*., **84**:2028–2034.

ECONOMIC SURVEY OF PAKISTAN, 2014. Agriculture chapter. 2. P.23.

FAN, P.H., XIE, M., WANG, W.W., HOU, S.S. AND HUANG, W., 2008. Effects of dietary energy on growth performance and carcass quality of white growing pekin ducks from two to six weeks of age. *Poult. Sci*., **87**:1162-1164.

GHAFFARI, M., SHIVAZAD, M., ZAGHARI, M. AND TAHERKHANI, R., 2007. Effect of different levels of metabolizable energy and formulation of diet based on digestible and total amino acid requirements on performance of male broiler. *Int. J. Poult. Sci.,* **6**: 276-279.

HOLSHEIMER, J.P. AND VEERKAMP, H.C., 1992. Effect of dietary energy, protein, and lysine content on performance and yields of two strains of male broiler chicks. *Poult. Sci*., **71**: 872-879.

JACKSON, S., SUMMERS, J. D. AND LEESON, S., 1982. Effect of dietary protein and energy on broiler performance and production costs. *Poult. Sci.*, **61**:2232–2240.

KAURA, S., MANDALA, A.B., SINGH, K.B. AND KADAMA, M.M., 2008. The response of Japanese quails (heavy body weight line) to dietary energy levels and graded essential amino acid levels on growth performance and immuno-competence. *Int. J. Livest. Sci.,* **117**:255-262.

KAYANG, B.B., VIGNAL, A., INOUE-MURAYAMA, M., MIWA, M., MONVOISIN, J.L., ITO, S. AND MINVIELLE, F., 2004. A first generation micro satellite linkage map of the Japanese quail. *Anim. Genet.,* **35**: 195-200.

LEESON, S. AND SUMMERS, J.D., 2005. *Commercial poultry nutrition* 3rd ed. Pp. 80 University Books, Guelph, Canada.

LEESON, S. AND CASTON, L.J., 1993. Production and carcass yield of broilers using free-choice cereal feeding. *J. appl. Poult. Res.,* **2**:253-258.

LEESON, S., CASTON, L. AND SUMMERS, J.D., 1996. Broiler response to energy or energy and protein dilution in the finisher diet. *Poult. Sci*., **75**:522-528.

LIPSTEIN, B.S., BORNSTEIN, AND BARTOV, I., 1975. The replacement of some of the soybean meal by the first-limiting amino acids in practical broiler diets 3 Effects of protein concentrations and amino acid supplementations in broiler finisher diets on fat deposition in the carcass. *Br. Poult. Sci*., **16**:627-635.

MAIORKA, A., DAHLKE, F., SANTIN, E., KESSLER, M.A. AND PENZ, M.A., 2004. Effect of energy levels of diets formulated on total or digestible amino acid basis on broiler performance. *Rev. Bras. Cienc. Avic*., **6**:87-91

MIN, N.Y., HOU, S.S., GAO, Y.P. AND HUANG WAND, F.Z., 2007. Effect of dietary crude protein and energy on gosling growth performance and carcass trait. *Poult. Sci*., **86**: 32-5791.

NRC, 1994. *Nutrient requirements of poultry*: Ninth Revised Edition, pp. 45.

OGUZ, I. AND MINVIELLE, F., 2001. Effects of genetics and breeding on carcass and meat quality of Japanese quail: A review Proceedings of XV European symposium on the quality of poultry meat, WPSA Turkish branch, 9-12 September Kusadasi-Turkey.

ROSA, P.S., FARIA FILHO, D.E., DAHLKE, F., VIEIRA, B.S., MACARI, M. AND FURLAN, R.L., 2007. Effect of energy intake on performance and carcass composition of broiler chickens from two different genetic groups. *Braz. J. Poult. Sci*., **9**:117-122.

SINURAT, A.P. AND BALNAVE, D., 1985. Effect of dietary amino acids and metabolisable energy on the performance of broilers kept at high temperatures. *J. Br. Poult. Sci*. **26**:117-128.

SLAGTOR, P.J. AND WALDROUP, P.W., 1990. Calculation and evaluation of energy amino acid ratios for the egg production type hen. *Poult. Sci*., **69**: 1810-1822.

STEEL, R.G.D., TORRIE, J.H. AND DICKEY, D.A., 1997. *Principles and procedures of statistics: A biometrial approach*. 3rd Ed. McGraw Hill Book Co. Inc., New York, USA, pp. 481.

SUMMERS, J.D., SPRATT, D. AND ATKINSON, J.L., 1992. Broilers weight gain and carcass composition when fed diets varying in amino acid balance dietary energy and protein level. *Poult. Sci.,* **71**: 263-273.

TANG, M.Y., MA, G.Q., CHEN, X.D. AND JI, C., 2007.

Effect of dietary metabolisable energy and lysine on carcass characteristics and meat quality in Arbor Acre broilers. *Asian-Australian J. Anim. Sci.,* **20**:1865-1873.

TOUCHBURN, S., SIMON, J. AND LECLERCQ, B., 1980. Evidence of a glucose-insulin imbalance and effect of dietary protein and energy level in chickens selected for high abdominal fat content. *J. Nutr*., **111**:325.

YALCIN, S., OGUZ, I. AND OTLES, S., 1995. Carcass characteristics of quail (*Coturnix coturnix japonica*) slaughtered at different ages. *Br. Poult. Sci.,* **36**: 393-399.

(Received 14 June 2014, revised 24 June 2104)