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Effect of dietary energy levels on productivity and profitability of laying hen

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Abstract

The studies aimed at examination of the effect of different dietary levels of metabolizable energy on the performance of commercial laying hen and investigate its most economical level. 400 laying hen (strain of line W36) of 36-weeks old were randomly divided into 5 dietary energy levels treatments of 4 replicates each. Results showed that feed intake, energy intake, feed conversion ratio, egg mass weight, cost of feed/egg production and cost of feed/weight gain were significantly different between treatments. By increasing energy content of diet, feed intake decreased (104.24 to 100 g/hen/day) and feed conversion ratio improved (2.11 to 1.95%). Egg weight and cost of feed changed through treatments ($P<0.05$). Body weight increased ($P<0.05$) as the energy content of diet increased but the egg production was not affected. A non-linear model was improved to determine the best level of dietary metabolizable energy that provided the highest income by considering daily energy intake and cost of feed/egg production.

Keywords: Egg Production, Energy Content, Feed Conversion Ratio, Feed Cost

Introduction

Use of scientific tools such as data analyzing is of a great importance in order to plan better profitable breeding programs. Such programs bring about better performance under normal conditions (Grobas, 1999). Poultry industry in Iran improved rapidly during last few years. To guaranty the most return, it is obviously necessary to have economical production system (Nikkhah, 1992). Therefore, obtaining high feed efficiency needs scientific and practical feeding methods (Lesson and Summers, 2001). This would balance feed price to production ratio of each animal (Kubena et al. 1997; Skinder et al., 2001). It is obvious that big part of the consumed feed will be converted to energy to fulfill maintenance and production requirements (Gholian and Salar, 1999). Bohnsack et al. (2002) noted that feeding high energy content diets, would reduce feed intake in poultry but it would not allow them to receive their protein requirements. This fact introduced the term of the most proper energy to protein ratio in poultry. (Balog et al., 2000; Sohail et al., 2003). Since lack of energy during the peak of production may result in severe decline of production, offering high amounts of energy in diets is recommended (Balog et al., 2000). Amount of feed intake in poultry depends on the level of energy they received in the diet, consequently, the balance of nutrients to dietary energy content is an important factor in poultry nutrition (Wu et al., 2005). Almost 2500–2900 Kcal/Kg metabolizable energy content in the diet for layer hens, is an optimal concentration of energy, lower amounts would result in reduced energy intake which will reduce egg mass production, whereas, higher amounts would result in increased body weight and in some cases egg weight instead of egg mass (McDonald, et al., 1995). It should be mentioned that the effective level of energy is different between various breeds (Lippense et al., 2002). Some breeds have lower energy requirements to produce egg (Harms et al., 1999; Lesson and Summers, 2001; Novak et al., 2004). Pinhriro et al. (2004) mentioned that the dietary energy content had a significant effect on feed intake but they also suggested that this was not true in all situations. Parsons et al. (1993) suggested the amount of nutrients (except water) to be organized by considering a proper energy to nutrients ratio in diets and this can be done practically, when a diet is being

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formulated. Formulating a diet in poultry industry ought to be done by considering the fact that the energy level has the highest economical efficiency. Breeders always are interested in achieving the most profitable and economical level of dietary energy in layer hens production (Parsons et al., 1993; Harms et al., 2001). Models reported by Keshavars (1998) were based on this fact. It should be considered that fulfilling the dietary requirements of poultry may guaranty the highest performance of production, but will never guaranty the maximum economical efficiency (Roland et al., 2000; Mcnab and Boorman, 2002). Although low dietary energy content would minimize the cost of feed per egg production unit, it should be increased to maximize benefits (Dimassp et al., 1998; Novak et al., 2004). Dimassp et al. (1998) suggested a model which determined best economic intake of amino acids in layers.

This experiment was conducted to examine the effect of dietary energy content on the performance of laying hens and to fit a model that maximize income and efficiency, and minimize total costs.

Materials and Methods

The experiment was conducted on a commercial layer farm located in Makian Shahr, Iran. 400 White Leghorn hybrid chickens (Line W36) were allotted by completely randomized design into 5 dietary treatment groups of 4 replicates each. The diet treatments were formulated to give different levels of metabolizable energy contents: 2750, 2800, 2850, 2900 and 2950 Kcal/kg metabolizable energy/kg dry matter of feed for T1, T2, T3, T4 and T5, respectively.

Diets were formulated according to the breeding manual of hyline layers (2005). Total nutrients to energy ratio were the same in all diets. The examined traits include egg mass weight (EMW), egg production (EP), egg production percentage (EPP), feed intake (FI), feed conversion ratio (FCR), energy intake (EI), feed costs/egg production (FCE) and feed costs/ live weight (FCBW).

Statistical analysis

Evaluation of the effect of energy content on the performance traits

Statistical model was as follows:

$$X_{ij} = \mu + a_i + a_{ij}$$

Where; X_{ij}: observations, μ: total mean, a_i: effect of the energy level of diet, a_{ij}: error.

Data was analyzed using SPSS software. Means were compared by Duncan multiple range test.

Evaluation of the most economic ratio

The most economical level of energy which likely produces the maximum return, could be determine in accordance to the feeding costs and price of egg produced. To examine the relation between energy intake and egg production, a square degree model was used:

$$EMW= \alpha_i + \beta_i \times E + \gamma_i \times E^2$$

Where; EMW is the egg mass weight (g), E is the energy content of feed (Kcal/g DM), β_i and γ_i are the estimated parameters; $\alpha_i$is the intercept which modifies parameters. First, this model fitted without involving α_i but the results were not fitted to the theoretical bases. Involving α_i to the model modified estimated parameters, consequently model became better fitted. In order to calculate physical maximum profit, the used function was:

$$PM= (P \times EMW) - (C \times E)$$

Where; PM is the physical maximum profit, P is the price of one kilogram egg (Rials), EMW is the egg mass weight (g), C is the price of one unit energy (Rials) and E is the energy intake for production (Kcal/day). [The current C and P were 0.9282 and 10.20 Rials, respectively, 1 US$ = 0.008 Rial).

Results

Results of the performance traits are summarized in table 1. It is obvious that different levels of energy affected most of these traits. T1 had the lowest FI and FCR but the other traits were higher than T1. T5 had lower EI. Table 2 shows the results of the economic non-linear model and the results of maximum physical non-linear model. It summarizes the economic measures of production and cost of production. It shows that producing 51 gram egg (in average) would cost 250.8 Rials and physical benefit of egg production was about 248.8 Rials.

Discussion

It is observed that FI decreased as the energy content increased. Gorbas (1999) reported that 33 Kcal/kg decrease in ME, resulted in 1 percent decline in FI, however, he mentioned that increasing energy from 2680 to 2819 (Kcal/kg) lowered FI by 4 percent. Lewis et al. (1994) mentioned that chickens received 1848 Kcal/kg had 9.7 percent higher FI than when they received 2046 Kcal/kg energy. Mcnab and Boorman (2002) reported the same results. It is also found that EI increased as the energy content of the diet treatment increased. Bohnsnack et al. (2002) studied the effect of different levels of energy on the performance traits and egg composition during the first phase of production and they reported that by increasing the energy content of the diet, FI decreased and EI was constant. Balog et al. (2000) suggested that in commercial layers, if FI is lower than 100 gm/day, adding 2 percent fat into diets would improve appetite and consequently EI would increase. The present results showed that dietary treatments did not have any effect on the egg production percentage and increasing the energy content of the diet did not change the egg production. Results reported by Harms et al. (2000) were in agreement with the current findings. In the present study, egg mass increased gradually as the energy content of diets increased. Wu et al. (2005) and Harms et al. (2001) reported that egg mass was affected not only by energy level but also by nutrient concentration. Mean of live weight increased as the energy level rose and T3 had the highest weight. Harms et al. (2000), Bohnsack et al. (2002) and Sohail et al. (2003) mentioned that supplementing ration with corn oil or poultry Fat, increased the egg weight. Some authors suggested that enrichment of ration by fat would increase egg weight (Bowes et al., 1998; Keshavarz, 1998; Harms et al. 2000; Wu et al., 2005). FCR significantly decreased when the energy content of ration increased. Chickens that received T1 had the lowest FCR. Wu et al. (2005) reported similar results. Chicks grew heavier as they received higher energy content diets. T1 and T5 had the highest and lowest body weights, respectively. Harms et al. (1999) mentioned that energy had an effect on body weight since the nutrients of diet such as protein were also affected. Parsons et al. (1993) reported that increasing protein of diet would increase body weight of chickens. Picard et al. (1999) suggested that the optimum body weight and weight gain considerably improved by increasing energy content of diets. The current results showed that the effect of energy was significant on the calculated cost of egg production. Decreasing FI resulted in increased feeding costs and therefore the cost of production.

The results also showed that egg weight was higher when PM calculated rather than economic model fitted. It seems that reaching maximum physical egg weight would need more energy and cost. Physical benefit was lower than economic benefit and this means that breeders recommendations try to increase economic benefit, consequently, they would reach to both optimum EI and return. Wu et al. (2005) reported similar results. Skinder-Nober et al. (2001) showed that energy of ratio and FI had square-degree relation which means with high energy content diets, FI would be constant. Results reported by Roland et al. (2000) and Novak et al. (2004) were in agreement with the results of this article. According to this study, the economical level of energy is different and it depends on the FI and cost of feed maximum amount of profit does not occur when the production is highest.

Table 1: Production performance traits of the experimental groups

Treatment	FI (g/hen/day)		EI (g/day)		EPP (%)		EP (g/hen/day)		EMW (g)		FCR		FCE (Rial/kg)		FCBW (g)	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
T1 (2950kcal/kg)	100.00^{d}	0.76	295.00^{ab}	2.28	83.70	0.77	51.35^{a}	0.72	61.08^{a}	0.60	1.95^{d}	0.03	273.80^{a}	2.07	154^{a}	9.12
T2 (2900kcal/kg)	101.10^{c}	1.00	293.15^{bc}	2.90	83.27	3.37	50.67^{ab}	2.17	60.85^{a}	0.17	2.00^{cd}	0.07	269.65^{b}	2.07	129^{b}	12.96
T3 (2850kcal/kg)	102.37^{b}	0.25	291.75^{cd}	0.71	83.20	1.75	49.82^{ab}	0.79	59.9^{b}	0.32	2.05^{bc}	0.03	265.65^{c}	0.66	107^{c}	6.78
T4 (2800kcal/kg)	103.40^{a}	0.26	289.50^{de}	0.74	83.80	0.55	49.40^{b}	0.78	59.00^{c}	0.64	2.09^{ab}	0.03	262.80^{c}	3.73	88^{d}	10.61
T5 (2750kcal/kg)	104.27^{a}	0.09	286.70^{e}	0.28	84.07	0.15	49.28^{b}	0.22	58.67^{c}	0.29	2.11^{a}	0.01	255.60^{d}	0.24	73^{e}	6.55

Different letters in each column represent the difference between means (P<0.05)

FI: feed intake; EI: energy intake, EPP: egg production percentage, EP: egg production FCR: feed conversion ratio, EMW: egg mass weight FCE: feed costs/egg production, FCBW: feed costs/ live weight

Table 2 Economical and maximum physical models parameters

Economic energy (gr/hr/day)	296.2
Economic egg weight (g)	51.3
Economic benefit (Rial)	250.8
Results of maximum physical non-linear model	
Energy intake to reach maximum physical egg mass weight (g/day)	300.3
Egg mass weight to reach maximum physical egg weight (g)	51.7
Physical benefit (Rial)	248.8

The best economic efficiency should estimate when cost of feed & market price involved. Also, it is recommended to use a non-liner model to formulate a ration.

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