Journal of Poultry Sciences and Avian Diseases

Journal homepage: www.jpsad.com

JPSAD

Effects of various levels of metabolizable energy in pre-starter diets of broiler chickens on growth performance

Shadi Sedgh-Gooya[1], Ahmad Mohebbifar[1], Mehran Torki[1*], Loghman Soleimani Baghshah[1], Abdolreza Kamyab[2]

[1] Department of Animal Science, College of Agriculture and Natural Resources, Razi University, Kermanshah, Iran
[2] CEO and Owner at ImEx Gulf, Inc. Plano, Texas, USA

*** Corresponding author email address**: torki@razi.ac.ir

Article Info

Article type:
Original Paper

How to cite this article:
Sedgh-Gooya, S., Mohebbifar, A., Torki, M., Soleimani Baghshah, L., & Kamyab, A. (2024). Effects of various levels of metabolizable energy in pre-starter diets of broiler chickens on growth performance. *Journal of Poultry Sciences and Avian Diseases*, *2*(2), 8-12.
http://dx.doi.org/10.61838/kman.jpsad.2.2.2

ABSTRACT

The pre-starter diet is critical for providing adequate nutrition to newly hatched chicks, whose digestive systems are not yet fully developed to handle solid feeds. Different levels of dietary energy can impact the growth and development of broilers. Hence, providing the right energy to meet their requirements is necessary. A study was conducted to examine the effect of different levels of metabolizable energy (ME) (3025, 2904, and 2783 kcal/kg) in the pre-starter diet (1 to 10 days) of broiler chickens on their growth performance traits. The experiment involved 450 broilers of the Ross 308 breed, divided into three treatments and six replications. The results of the study showed that reducing dietary energy levels increased the feed intake (FI) and body weight (BW) of broiler chickens, although it did not affect their feed conversion factor (FCR). Based on the results of the current study, reducing the recommended energy levels by up to 5% had no negative impact on growth performance. This can be useful in reducing the feed expense in broiler production.

Keywords: *Broiler, metabolizable energy, growth performance, dietary energy.*

1 Introduction

Broiler chickens require a pre-starter diet during their first week of life to support growth and development due to their immature digestive system (1, 2). Manipulating this diet can modify chicken development (3), but there is limited information on the effects of early nutrition and the composition of the pre-starter diet. Due to faster growth rates, broiler chickens are now being slaughtered at earlier stages of development, which requires less feed to achieve their final weight, thus reducing production costs. However, genetic programs for growth have led to increased feed intake (FI) and more significant fat deposition due to ad libitum access to food. This has resulted in modern strains of fast-growing broilers having more potential to develop abnormalities such as leg and carcass deformities, reproductive abnormalities, and even death (4, 5). As a result, it is necessary to provide adequate nutrition to meet

Article history:
Received 03 February 2024
Revised 06 March 2024
Accepted 16 March 2024
Published online 01 April 2024

the new poultry requirements, particularly regarding energy levels, which is a limiting factor for ingestion and is used in different metabolic processes involving maintenance to maximum productive potential expression. Therefore, the accuracy of metabolizable energy (ME) determination is crucial in achieving optimal performance of poultry, as it can reflect in weight gain and feed conversion ratio (FCR) improvement (6, 7). High-energy diets improve weight gain and FCR but can also increase abdominal fat (8-10). However, studies have shown that high energy levels may not necessarily result in better growth post-hatch due to the immaturity of the digestive tract (11). To achieve optimal growth, the intestinal mucosa, crypt depth, and villus height need time to develop (12, 13) and enzyme secretions such as lipase, trypsin, and amylase (14, 15). Bile salt and lipase secretions may limit fat absorption during the post-hatch period (16), indicating that the digestive tract may not be able to utilize high energy levels during this time (1). This is supported by a study that showed that the absorption of oleic acid, an unsaturated fatty acid, was high in post-hatch chicks when consumed in moderate amounts. However, an increased lipid intake led to a decrease in absorption percentage (17). Excess energy can be harmful, so finding the right balance is crucial to meet the growth demands of the chicks. Therefore, this study aims to evaluate the performance of broiler chicks aged 0 to 10 days old, fed with diets containing different ME values, in terms of FI, FCR, and body weight (BW).

2 Materials and Methods

2.1 Chicks and experimental design

Four hundred and fifty-day-old broiler chicks (Ross 308) were purchased from a local hatchery and weighed (43 ± 0.35 g). They were then randomly allocated to one of three treatments with six replicates of 25 chickens, based on a completely randomized design, during the first ten days of their lives. The pens, measuring 1.50 m wide × 1.50 m long, were equipped with a pan feeder, nipple drinkers, and wood shavings as litter. The standard breeding practices (18) were followed to maintain an average room temperature of 27°C and an average humidity level of 45%. The broiler chickens were exposed to 23 hours of light and 1 hour of darkness for the first seven days, followed by 18 hours of light and 6 hours of darkness until the end of the experiment, which lasted for ten days. The chickens were given access to feed and water ad libitum throughout the trial period. Vaccination was carried out according to the regional vaccination program and timed based on the optimal maternal antibody levels. No medication was administered to the birds during the entire experimental period.

2.2 Diets

In this experiment, three diets were used, each with different levels of ME (100%, 95%, and 90%). To meet the 100%, 95%, and 90% specifications of Ross 308, the dietary ME levels used were 3025, 2904, and 2783 kcal/kg, respectively. The experimental diets were provided during the pre-starter phase, lasting 1 to 10 days. The diets were adjusted according to Aviagen's broiler nutrition specifications (18) and met NRC requirements (19). Table 1 shows the formula and chemical composition of the dietary treatments.

Table 1. Experimental diet composition and calculated nutritional composition

Ingredient %	ME 100%	ME 95%	ME 90%
Corn	50.892	50.602	46.574
SBM	39.751	39.797	40.429
Soybean Oil	4.278	3.000	3.000
Limestone	1.173	1.172	1.165
Dicalcium Phosphate	2.412	2.413	2.422
Common Salt	0.269	0.269	0.275
NaHCo3	0.108	0.108	0.101
Min+Vit Premix [a]	0.500	0.500	0.500
DL-Methionine	0.337	0.337	0.342
L-Lysine HCl	0.209	0.208	0.198
L-Threonine	0.071	0.071	0.070
Inert Filler	0.000	1.522	4.124

Nutritional Composition (Calculated)			
A_{men} kcal/kg	3025	2904	2783
CP%	22.762	22.762	22.757
Lys Total (TFD[b] Lys) %	1.4.3 (1.270)	1.404 (1.270)	1.404 (1.270)
MET Total (TFD Met)%	0.663 (0.635)	0.662 (0.635)	0.665 (0.638)
M+C Total (TFD M+C)%	1.025 (0.940)	1.025 (0.940)	1.025 (0.940)
THR Total (TFD Thr)%	0.931 (0.830)	0.931 (0.830)	0.931 (0.830)
TRP Total (TFD Trp)%	0.278 (0.237)	0.278 (0.237)	0.280 (0.239)
Arg Total (TFD Arg%)	1.509 (1.385)	1.510 (1.385)	1.517 (1.392)
Iso Total (TFD Iso)%	0.968 (0.887)	0.968 (0.887)	0.972 (0.891)
Leu Total (TFD Leu)%	1.841 (1.698)	1.841 (1.698)	1.829 (1.687)
Val Total (TFD Val) %	1.064 (0.954)	1.064 (0.954)	1.063 (0.954)
Available P%	0.5	0.5	0.5
Ca%	1.05	1.05	1.05
Crud Fiber%	3.998	3.993	3.926
(Na+K)-(Cl) meg/kg	255.725	255.747	255.199

[a]Mineral & Vitamin premix provided per kilogram of diet: 80 mg Mn (from MnSO4·H2O), 70 mg Zn (from ZnO), 50 mg Fe (from FeSO4·7H2O), 8 mg Cu (from CuSO4·5H2O), 1.5 mg I (from Ca (IO3)2·H2O), and 0.35 mg Se (from Na selenite), 12,500 IU vitamin A (from retinyl acetate), 3,700 IU cholecalciferol, 40 IU vitamin E (from DL-α-tocopheryl acetate), 0.03 mg vitamin B12, 6.4 mg riboflavin, 55 mg niacin (as nicotin amide), 30 mg pantothenic acid (as calcium pantothenate), 3.5 mg menadione (from menadione dimethyl-pyrimidinol), 1.2 mg folic acid, 3 mg thiamine, 7.5 mg pyridoxine, 0.3 mg biotin, 560 mg choline (as choline chloride 60%), and 80 mg ethoxyquin.

[b]True Fecal Digestible Amino acid

2.3 Measurement

The experiment involved measuring the weight of broilers at the beginning and end of 10 days. Data on residual feed and BW were collected at the end of the experiment to determine FI and FCR on a per-pen basis. Mortality rates were monitored daily, and any bird that died during the entire experimental period was included in the data.

2.4 Statistical analyses

The statistical analysis system (20) was used to analyze all data obtained from the trials based on a completely randomized design. Duncan's multiple range test (21) was employed to determine differences among treatment means. The model used was $Y_{ij} = \mu + \alpha_i + e_{ij}$, where Y_{ij}, μ, α_i, and e_{ij} represent measured characteristic, overall mean, effect of experimental diet, and random error term.

3 Results

The results for the use of varying levels of ME in the diet of broiler chickens between days 1 and 10 are displayed in Table 2.

Table 2. The effect of different levels of metabolizable energy on the growth performance of broilers from 1 to 10 days of age

		ME (%)			
Productive performance	100	95	90	SEM	*p*-Value
Daily feed intake (g/ chick/ day) 0 – 10 days of age	223.83[c]	234.4[b]	256.38[a]	1.342	0.001
Gain: feed (g/g) 0 – 10 days of age	0.69	0.70	0.69	0.015	0.69
Body weight (g/chick) 10 days of age	155.03[c]	166.20[b]	177.33[a]	3.512	0.001

Means within a row with no common superscript are significantly different ($p < 0.05$).

*Standard error of mean.

As indicated by Table 2, the different energy levels influenced the FI and BW of the broilers significantly ($p< 0.05$). The diet containing 90% of ME had the highest FI and BW (256.38 and 177.33, respectively). Also, the diet containing 95% of ME had more FI and BW than the diet containing 100% of ME. Moreover, the experimental treatments did not significantly affect the FCR of the chickens ($p > 0.05$).

4 Discussion

The study found that reducing the dietary ME levels of broiler chickens in their first ten days of life increased their FI and BW but did not affect their FCR. There are few studies on low ME levels in pre-starter broiler chickens, and most of them have tested low energy levels from 10 days of age onwards. Similar results were reported by a study that found that FI was influenced by energy density. However, FCR and BW did not change significantly with energy levels during the first seven days after hatching in broilers (17). Leeson et al. (22) examined the effects of different ME levels on broilers' performance in the pre-initial growth phase and found that the lowest level (2,850 kcal ME/kg) provided the best performance. Moreover, in previous studies conducted on older birds, it was reported that there is a correlation between increasing energy density and decreased FI (10, 23). According to Lemot et al. (1), if the diet's energy density increases during the first week of a chick's life, the bird's ability to assimilate the nutrients in the food may be limited.

In contrast, one study found that energy content did not impact FI during the first four rearing days (11). Another experiment revealed that a 100 kcal/kg reduction in the dietary ME level of the pre-starter (2900 kcal/kg) might not be enough to observe changes in growth performance, including BW, FI, and FCR (24). Additionally, the author points out that broiler chickens usually consume food only to meet their energy requirements after they reach 14 days of age, as their digestive systems are not fully developed until then, which is not consistent with the result of the current study (25). In a previous study conducted on broilers (26), it was found that the level of energy (2,870, 3000, and 3,100 kcal/kg) in the pre-starter period did not have a significant effect on the BW of broilers at seven days of age. However, the broilers fed with a diet containing 3,000 kcal/kg energy showed improved FCR at seven days of age, and those fed with a diet containing 3,100 kcal/kg energy showed a significant decrease in FI. It is important to note that the age, breed of broiler chickens, and the composition and amount of energy in the diet can all contribute to the difference in results observed in different tests. Therefore, further studies are necessary to determine the exact effect of different energy levels in the pre-starter diet on the performance traits of broiler chickens.

5 Conclusion

It has been concluded that reducing the energy of the pre-starter ration for broiler chickens aged 1 to 10 days to 2783 kcal/kg improved BW due to an increase in FI. However, it did not affect the FCR.

Acknowledgements

The authors appreciate Razi University for supporting the current study financially.

Conflict of Interest

The authors have no conflict of interest to be declared.

Author Contributions

All authors contributed equally.

Data Availability Statement

The datasets generated during and analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.

Ethical Considerations

The Animal Ethics Committee of Razi University (Kermanshah, Iran) approved all experimental protocols based on animal welfare guidelines.

Funding

This research received no external funding. Razi University provided the research facilities necessary for accomplishing this investigation.

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