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Research Article

Response of Two Strains of Commercial Broilers to Variation in Feeding Strategies: Re-test Feeding Practices of Broiler Farming

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Abstract

A study was conducted to reveal the effect of different feeding strategies on performance and the body composition of two strains of commercial broilers from 1 to 5 wks. of age. This study was also to re-test the grower practical feeding in the field. One hundred- and twenty-day-old chicks of each strain were randomly allocated to eight dietary treatments with a 2 × 4 factorial arrangement. They were fed to a starter diet (S) containing 200 g protein/kg diet and 3120 kcal ME/kg diet and a finisher diet (F) containing 190 g CP and 3300 kcal of ME/kg. Four different feeding strategies were applied, R1- SSSFF, three weeks fed starter diet and 2 weeks fed finisher diets. Similar codes for R2- SSFFF; R3- SSSSF and R4 -SSSSS. They were housed in floor pens (10 birds/m2) on rice husk litter in the open housing system. Lighting was 16 h of light and 8 h of darkness. There were no significant differences of two strains in terms of body weight, and weight gain, but differences on feed intake and FCR. The study also found that today's broilers showed the best performance when feeding all starter diets from post-hatch until 5 wks of age as a standard marketing age. The groups with more starter diets showed improve growth performance and FCR. Breast meat yield was significantly higher in birds fed all starter diets than those fed the other diets, whereas birds fed finisher diets had significantly more abdominal fat than those fed the starter diets. No effect of strains and feeding regimens on thigh records. No interaction between strains and feeding strategies except abdominal fat.

Keywords: Strain; Body Weight; Breast Meat; Abdominal Fat

Introduction

The general influence of the relationship between dietary energy and protein on growth and body composition of meat type poultry is well known [1,2]. It has also been established that if the ratio of dietary calorie to protein becomes wide, there is an increased accumulation of carcass fat at the expense of body water [1,3]. In addition, it has been shown that broilers respond differently to diets varying in energy: protein ratio depending on the degree of fatness of the birds when such diets are introduced [4]. Obese broilers, for example, will consume small amounts of a high protein diet and exhibit very high feed conversion efficiencies [3,5] which can be explained on the grounds that such birds are utilizing lipid reserves as an energy source. Lean birds do not show improved feed efficiency [5-7] due to lack of body fat from which energy is more available than protein [8]. Thus, changing in the proportion of the retention of protein and energy will influence the metabolisable energy content of the body and the efficiency of the weight gain [9]. It has been shown that feed intake is influenced by the degree of fatness [7,10]. The response of broilers to diets differing in energy: protein ratio may depend not only on their body composition status but also on genotype [7,11]. Genotypes may differ in their ability to deposit lipid and then to utilize this lipid reserve. Such information is fundamental for evaluating broiler growth models used to predict the effects of dietary changes on growth and body composition. The identification of the response in body composition of different genotypes to dietary manipulation aimed at generating wide differences in body fatness is an important process characterizing the genotype for growth model prediction purposes. This is due to the remarkable genetic advances regarding the growth rate in broilers. Martinez., *et al*. (2022) 12 in the recent review suggested that body composition is a good instrument to estimate the carcass conformation of broilers and their economic worth. It is means that an appropriate feeding strategy by concerning energy: protein ratio which effect on body composition and offer to a specific genotype is worthwhile to produce expected broiler performance. However, until recently, the feeding practice applied by most of the growers are based on conventional rearing management namely 3 weeks of starter diet feeding and then followed by feeding of the finisher diet. This sort of feeding strategy should be reexamined because today's broilers have significantly changed their genetic potential.

The present study was designed to evaluate the response of commercial broiler genotypes to variation in dietary energy: energy ratios in the form of feeding strategies in implementing starter and finisher diets and the interaction between genotype and nutrition with respect to degree of fattening.

Animal and management

Two hundred and forty 1-d-old broiler chickens from two Indonesian commercial strains were housed in floor pens (10 birds/ m^2) on rice husk litter in the open housing system. Each pen was equipped with a hanging feeder and 2 rounded plastic drinkers. They were fed on a feeding plate starting at day old chicks with a commercial diet (starter and finisher) and provided drinking water *ad libitum*. Lighting was 16 h of light and 8 h of darkness. No vaccination against any disease was applied.

Experimental design

Two commercial broiler strains, we code here A and B were used in the study. One hundred- and twenty-day-old chicks of each strain were obtained on the same day. They were divided into four dietary treatments with three replications each of 10 birds and given a crumbled starter diet (S) containing 200 g crude protein (CP) and 3120 kcal of Metabolizable Energy (ME) /kg *ad libitum.* Further periods, they were fed a commercial broiler finisher diet (F) containing 190 g CP and 3300 kcal of ME/kg *ad libitum* during the rearing period. The birds were reared unsexed groups cages until they reached the marketing age (five weeks of age) which is normally applied by the farmers. The experimental design was a factorial arrangement with two genotypes or strains and four feeding regimens: R1 (SSSFF), as a feeding practice of the growers, R2 (SSFFF); R3 (SSSSF) and R4 (SSSSS), 10 birds per replicate. The nutrient composition of the starter and finisher diets are presented in table 1.

Nutrient contents	Starter	Finisher
Moisture (%)	max 14	max 14
Ash (%)	max 8	max 8
Crude protein (%)	20	19
Ether extract (%)	min 5	min 5
Crude fiber (%)	max 5	max 5
Calcium (Ca) (%)	0.80-1.10	0.80-1.10
Phosphor (P) (%)	min 0.5	min 0.45
Aflatoxin (µg/kg)	max 50	max 50
Metabolizable energy (ME)* (kcal/kg)	3020-3120	3300
Essential amino acids		
Lysine (%)	min 1.20	min 1.05
Methionine (%)	min 0.45	min 0.4
Methionine + cysteine (%)	min 0.80	min 0.75
Threonine (%)	min 0.75	min 0.18
Tryptophan (%)	min 0.19	min 0.65
The composition of complete feeds was analyzed and declared by the manufacturer of the feeds except *. ME referred to [13].		

Table 1: The chemical composition of commercial diets.

Measurement

Body weight of broilers was recorded individually at the beginning of the experiment and then at 7, 14, 21, 28 and 35 days of age. Feed intake was determined by calculating the differences between feed offered and remaining feed on the feeder. Feed conversion ratio (FCR) was calculated as the ratio between feed intake (FI) and weight gain (WG) by considering in the calculation of dead chickens. Breast meat yield (BM) was measured by removing the breast meat to the left and right with the boneless. Abdominal fat (AF) was defined as fat around the abdomen, around vent and covering the gizzard. On day 35, as the end of the experiment, broilers whose body weights were similar to the group average were selected from each of the replicate groups in each treatment. After being fasted for 12 h, birds were stunned with a sharp knife, scalded into water of 60°C for 1-1.5 min, and de-feathered manually to determine the weight and percentage carcass, thighs, breast meat (BM) and abdominal fat (AF). Dressing percentage was calculated by the difference of live weight and dressed weight (including giblets) and expressed in percentage [14] Thigh (upper and lower) was removed from the dressed carcass.

Statistical analysis

A completely randomized design with two factors consisting of four feeding strategies and two strains and 3 replicates was used in the statistical analysis. Data were processed by analysis of variance (ANOVA) following the procedure of the General Linear Model (GLM) of SPSS version 20 [15]. A Duncan post-hoc test was used to analyze the difference among groups when significance ($p < 0.05$).

Results and Discussion

Growth performance

Data on body weight, feed intake, feed conversion, and weight gain of two different strains from hatching until the age of 35 days are presented in Table 2. This study demonstrated that feeding with various starter and finisher diets affected all growth performances except WG. However, significant differences in FI and FCR, but not WG and BW due to different strains were found. Strain by feeding regimens interaction was not significant at 35 d of age for body weight, weight gain, feed intake, and feed conversion. This is in agreement with results of [16] who found that performance of Cobb 500 and Ross 308 depended on the nutritional program. Heavy chick weight after hatching determines subsequent performance. Feeding the starter diet for a greater proportion of the growing period are desirable.

Several authors [17-20] reported the differences between genotypes in BW are to be dependent. It means that different strain performs the body weight as its potential genetic for growth. As shown in Table 2, productive performance from day 1 to 35 of the experiment indicated that the MB202 group showed the lower BW compared with the CP707. Feed intake revealed significant differences (p<0.05) between treatments, with the MB202 group showing the higher feed intake compared with the CP707 groups. Regarding feed conversion ratio, the CP707 group (1.452) showed more efficient (p<0.05) compared with the MB202 group (1.493).

Effects of feeding regimens, all productive performances were affected by the treatments (p <0.05). Feeding with all starter diets (R4) offered the heaviest BW and WG whilst the FI and FCR were the least. The following R4 which performed higher was R3 and R1, and then the lowest was R2 group. Although there was no interaction between strain and feeding regimens observed, a tendency for a greater BW (g) in R4 compared with other groups was evident no matter the strains. It means that feeding a starter diet longer than recommended management (3 wks. long as R1) during starter period resulted in improved body weight. In other words, feeding starter diets during the starter phase should be more concerned for broilers.

Regarding feed intake itself, this study revealed energy content significant differences (p < 0.05) between feeding treatments, with the R4 group presenting the lowest feed intake compared with the R1, R2 and R3 groups. Considering feed conversion ratio, the R4 group performed the most efficient FCR compared with the other feeding treatments significantly (P < 0.05). Data on BW and WG also revealed that R4 performed the highest BW (1977 g) and the R2 groups showed the lowest (1933 g). As for WG, the R3 was statistically similar to the R1 group. Thus, current broilers which were intensively selected for rapid growth rate, they need an appropriate feeding strategy to show their genetic potential. Previous studies showed that the protein or amino acids of current broilers was found to be greater than [21] recommendation as reported by [22-25]. It has been acknowledged that essential *amino acid recommendations* for *broilers* in 24 the *NRC* (1994) are largely based on experimentation conducted several decades ago. Today's broilers have shorter slaughter lives due to selection pressure which resulted in increased overall eviscerated body weight [26]. When referring to Table 3 from which we obtained the calculated lysine and methionine intakes, it obviously showed that essential amino acids (EAA) in developing meat muscle is important. Looking at daily methionine and lysine intakes (g/d) in the two strains and four dietary regimen groups during the starter and grower phases, it showed that moderate intake of both essential amino acid is enough to improve gain. According to [25] that there is need to change the nutrient requirements based on the particular strain to improve the feed efficiency of improved broilers. We might agree that the nutritional plan with high EAA concentration is more recommended for the starter phase than for finisher phase. Thus, this study found that a diet containing high protein and essential amino acids is required for broilers from day old to at least 4 to 5 wk. Previous research has shown that protein retention was very closely related to lysine concentration [26-28]. Gains and breast meat yield were improved to be due to an adequate supply of lysine [23,29-31].

Factors	Feed intake (FI)(g/bird/wk)	FCR (g/g)	Weight Gain (WG) (g/bird/wk)	Body Weight (BW)(g)
STRAIN (S)				
A	597^{a}	1.493^{b}	400	1990
B	585^{b}	1.452^{a}	403	1997
SEM	3.46	0.98	3.53	5.252
Feeding regimens (F)				
R1 (SSSFF)	622^{a}	1.559^{a}	399^{b}	1947^{b}
R2 (SSFFF)	620^{a}	1.573^{a}	394^{b}	1933^{b}
R3 (SSSSF)	570^{b}	1.411^{b}	404^{a}	1953^{b}
R4 (SSSSS)	553^{b}	1.362^{b}	406^{a}	1977^{a}
SEM	4.89	0.98	4.99	7.428
Strain and Feeding interaction				
A X R1	631	1.578	400	1948
A X R2	631	1.614	391	1928
A X R3	571	1.420	402	1954
A X R4	556	1.366	407	1978
B X R1	614	1.543	398	1946
B X R2	609	1.538	396	1938
B X R3	569	1.405	405	1951
B X R4	551	1.360	405	1976
SEM	6.92	0.98	7.061	10.504
Probability				
S	0.026	0.031	0.844	0.393
F	0.000	0.000	0.039	0.001
S x F	0.441	0.477	0.924	0.883
Note : R1: SSSFF	R3:SSSSF			
R2: SSFFF	R4:SSSSS			
$^{a-b}$ Means with different letters in the same column differ at p<0.05.				

Table 2: Average BW, FI, WG and FCR of two strains of commercial broilers fed with various feeding strategies from 1 to 5 wks. of age.

Strain	Feeding strategies	Methionine		Lysine	
		Total (g)	Per day (g)	Total (g)	Per day (g)
	R1	13.18	0.377	26.59	0.760
MB202	R2	12.89	0.368	33.94	0.970
	R3	12.27	0.351	32.51	0.929
	R4	12.53	0.358	33.40	0.954
CP707	R1	12.83	0.367	33.89	0.968
	R2	12.45	0.356	32.78	0.937
	R3	12.20	0.349	32.34	0.924
	R4	12.40	0.354	33.06	0.945
Note : R1: SSSFF		R3: SSSSF			
R2: SSFFF		R4: SSSSS			

Table 3: Calculated methionine and lysine intake of two strains of commercial broilers for 5 weeks of rearing.

Strain and carcass parameters

The results in Table 4 indicate that all carcass parameters were not affected (P < 0.05) by strain. CP707 broilers were slightly heavier dressed weight and lower AF; however, MB202 broilers had slightly higher breast yields. Feeding regimens on commercial standard diets affected dressing percentage, BM, AF (p < 0.05) except Thigh. Feeding R4 with all starter diets or more starter diets showed the higher dressed percentage (78.1%), and BW, the lowest AF compared with R2, and R3. Strain by feeding regimens interaction was not significant at 35 d of age for carcass parameters except abdominal fat.

The effect of dietary protein on growth rate and fat accumulation of broilers is well documented [23,32-34]. In this study, it was also shown that feeding finisher diets (R2, R3 and R4) during 5 wks. had similar dressed percentage (DP) and BW groups whilst R1 was the highest, but abdominal fat was the higher for groups by feeding more finisher diets. On the contrary, in this work observed the increase in breast yield with increasing in dietary protein is in line with most reported studies [35,36]. This suggests that during the growing period, high dietary protein is needed to promote growth muscle.

In terms of abdominal fat, this study revealed a significantly considerable increase in abdominal fat was observed in both strains given the SF although the degree of response varied. This supports the findings of [37] who similarly observed an effect on carcass composition of energy: protein ratio in the starter diet. A high fat deposition at 35 d of age was found in birds given a high-energy starter diet for the first 3 wks. post-hatch. They showed responses of broilers of different genetic backgrounds to a range of dietary energy: protein ratios were dependent on the age at which such diets were introduced. Feeding behavior in response to dietary nutrient composition determined the ultimate outcome in terms of effects on growth, efficiency or carcass composition as modified by genotype.

Treatment	Body weight (g)	Eviscerated part (%)	Breast Meat (%)	Thigh (%)	Abdominal Fat (%)
STRAIN (S)					
MB202	1990	76.1	28.9	32.5	1.2
CP707	1997	78.0	28.5	32.3	1.2
SEM	5.252	0.20	0.10	0.3	0.0
Feeding regimens (F)					
R1	1947^{b}	77.7^{b}	28.2^{b}	32.5	1.4^{b}
R2	1933^{b}	77.4^{b}	28.2^{b}	32.2	1.6^{a}
R3	1953^{b}	77.1^{b}	28.2^{b}	32.5	0.9^{c}
R4	1977^{a}	78.1^{a}	29.2^{a}	32.6	0.8^{d}
SEM	7.42	0.20	0.20	0.40	0.0
MB202X R1	1948	77.4	28.5	32.6	1.3^{a}
MB202X R2	1928	77.2	28.5	32.2	1.8^{a}
MB202X R3	1954	77.1	28.2	32.6	0.9^{b}
MB202X R4	1978	78.1	29.3	32.7	0.8^{b}
CP707X R1	1946	77.9	27.3	32.4	1.4^{a}
CP707X R2	1938	77.6	28.0	32.1	1.5^{a}
CP707X R3	1951	78.2	29.1	32.4	1.1^{a}
CP707X R4	1976	82.0	29.1	32.5	0.8^{b}
SEM	10.50	0.30	0.30	0.6	0.0
Probability					
S	0.393	0.197	0.047	0.65	0.082
F	0.001	0.009	0.000	0.873	0.000
S x F	0.883	0.896	0.775	0.997	0.000
Note: R1: SSSFF: R2: SSFFF: S = Starter R3: SSSSF; R4: SSSSS F = Finisher					

Table 4: Carcass parameters of two strains of commercial broilers fed with various feeding strategies from 1 to 5 wks. of age.

In the present study, reduced abdominal fat deposition was observed in birds on the all SS or more S than F diets. A study of [38] suggested that fat deposition could be reduced significantly by feeding the starter diet for a greater proportion of the growing period. Changing the bird from a diet with a low Calorie: Protein (CP) to a high C:P ratio, or *vice versa* resulted in rapid and considerable change in the degree of fatness. Lysine and sulfur amino acid (SAA) were shown to have a specific effect on carcass composition. The reduction in abdominal fat with an all-starter diet containing high protein and high lysine amino acids reduced fat deposition is also consistent with the well-accepted negative relationship between feed protein and carcass fat [29].

Present study also showed that the 12.0 g lysine /kg diet as a starter feed at minimum level formulated by the manufacture gave maximum breast meat and lowest abdominal fat for feeding 5 wks. Lysine and sulfur amino acid (SAA) were shown to have a specific effect on carcass composition. The reduction in abdominal fat with an all-starter diet containing high protein and high lysine amino acids reduced fat deposition is also consistent with the well-accepted negative relationship between feed protein and carcass fat [35,36,39].

According to [2] body composition (BC) broiler can be predicted and calculated by understanding BC dynamics. And that starter protein provides higher calorific values and finisher had the lowest calorific values, interpreting that feeding starter feed containing higher protein during the growth period is better than finisher feed. The protein: fat ratio was the highest at day 1 and decreased gradually until day 60. The BC in terms of water, protein, and fat changes with age, water being reduced and protein and fat increased towards d 60 [2]. In the present study, reduced abdominal fat deposition was observed in birds on the SSSSS and SSSSF or SSFFF diets. Thus, fat deposits are greatly affected by energy level during the finisher period. A study of [34] suggested that fat deposition could be reduced significantly by feeding the starter diet for a greater proportion of the growing period. It has been long reported that considerable variation in the amount of abdominal fat deposited by commercial broiler strains at 4 and 8 wks. of age. The accumulation of fat at 4 wks. was primarily due to genetic variation whereas beyond this age, variation in abdominal fat was due principally to dietary effects. The physiological mechanism of the body's muscles develops due to lysine and methionine is due to these amino acids to stimulate the pancreas to secrete further insulin to enter the blood which affects glucagon to dissolve fatty acids and amino acids stored in the body and encourage protein synthesis and the development of body muscles (40 Handique., *et al*. 2019).

Conclusion

This study concluded that strain differences in different feeding strategies were apparent although not significant. Strain response differently in FI and FCR. Feeding 5 weeks of the starter diet during rearing in current broilers offered the best performances both production and carcass parameters. Maximum breast meat and lowest abdominal fat found by feeding high protein diets. Feeding practices by implementing starter and finisher diets should be no longer used. Essential amino acids remain to be considered in getting expected performance of broiler feeding.

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