Responses of Choice-Fed Red Jungle Fowl and Commercial Broiler Chickens Offered a Complete Diet, Corn and Soybean

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ABSTRACT : Equal number of red jungle fowl (JF) and commercial broiler chickens (CB), raised in battery cages, were provided a single complete diet (control) or a choice of a complete diet, ground corn and ground soybean from 21 to 56 days of age. There were significant genotype × feeding regimen interactions for several traits measured suggesting CB and JF responded differently to the two feeding regimens. The single fed CB had better growth and feed conversion ratios (FCR) than those under choice feeding. However, the body weight and FCR of JF were not affected by feeding regimen. While the single fed and choice-fed JF consumed similar amount of protein during days 21 to 55, the protein intake of the choice-fed CB was lower than the control. From days 21 to 55, irrespective of genotype, choice-fed chicks consumed less energy than their single fed counterparts. Regardless of genotype, the trend in the proportion of each feed consumed was similar with complete diet>corn>soybean. In conclusion, while choice-fed JF were capable to select nutrient necessary for maximum growth, choice feeding was detrimental to growth and feed conversion ratio in CB. ***(Asian-Aust. J. Anim. Sci. 2001. Vol 14, No. 12 : 1758-1762)***

Key Words : Choice Feeding, Growth Performance, Jungle Fowl, Broiler Chickens

INTRODUCTION

A review of literature indicates that laying hens, pullets, growing broilers and growing turkeys given a choice between foods were able to adjust their nutrient intake which allowed them to grow and produce (Hughes, 1984; Forbes and Shariatmadari, 1994; Forbes, 1995). On a commercial scale, however, the success of choice feeding in optimizing production performance has been inconsistent (Cowan and Mitchie, 1978; Mastika and Cumming, 1987). Although broiler chickens took slightly longer to reach market weight, Forbes (1995) indicated that choice feeding was efficient financially as it may reduce feed costs. Ramlah and Halim (1994) reported that choice feeding of complete feed and corn reduced feed cost by 15% in broiler chickens. Because feed is the more expensive than any other input applied to the production of broilers, choice feeding may offer a feasible strategy for achieving efficiency and reducing production cost.

Ability of birds to self-select a balanced diet may be governed by palatability of the feed, previous experience and social factors (Hughes, 1984; Forbes, 1995). Genetics has also been shown to have a major impact on diet selection. Noble et al. (1993) and Picard et al. (1993) demonstrated that discrimination among diets differing in essential amino acid content was more sensitive in fast-growing chickens than in chickens selected for egg production. It is generally considered that the domestic fowl shows a reduced responsiveness to the nutritional consequences of their food intake when compared with their ancestor, the jungle fowl, especially in relation to protein and energy regulation (Hughes, 1984). This is hardly surprising, since in the wild state it is essential for birds to possess innate ability to control nutrient intake. On the contrary, today's commercial broilers and laying hens that have undergone intense selection for economic traits were developed on a complete diet. There is, however, no quantified information on the response of red jungle fowl to choice feeding under intensive management systems. Thus, the objective of this research was to compare the effect of choice feeding a complete food, corn and soybean on the growth performance of red jungle fowl and commercial broiler chickens.

MATERIALS AND METHODS

Red jungle fowl (JF) and commercial broilers (Arbor Acre) (CB) of both sexes were used in the study. The JF breeding stock was originally captured from the secondary forests and oil palm plantations in peninsular Malaysia and were assumed to be genetically pure. Purity of the JF was assessed by gross characteristics, namely shape and size of the bird, colour of plumage, colour of the shank, and earlobes, pattern of arrangements of the tail feathres, and size and thickness of the comb (Vidyadaran, 1987). The stocks were maintained as a closed flock at Universiti Putra Malaysia.

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At hatch (day 0) chicks (40 CB; 40 JF) were wingbanded and weighed to the nearest gram. The chicks were assigned at random within genotype in groups of eight into 10 battery cages with wire floors (1220 cm^2/chick). The cages were housed in conventional open-sided house with cyclic temperatures (minimum, 24°C; maximum, 34°C) The relative humidity was between 80 to 90%. All chicks were vaccinated against Newcastle disease (days 7 and 21) and fowl pox (day 21). The birds were fed standard broiler starter (crumble form) and finisher (mash) diets (table 1) from days 0 to 20 and 21 to 55, respectively. Water was available at all times and lighting was continuous.

At 21 days of age, equal number of chicks were fed either a single complete broiler finisher diet or free choice among complete broiler finisher diet, ground corn, and ground soybean. The diets were analysed for crude protein according to the methods of Association of Official Analytical Chemists (1984). In cages in which choice feeding was provided, each diet was randomly assigned to 2 troughs (6 troughs per cage). Sufficient space (7.5 cm/chick) was allowed so that all chicks could eat each diet simultaneously. When a single complete diet was fed (control), it was provided in six troughs.

Table 1. Composition of the experimental diets (% unless otherwise stated)

Ingredients	Starter (days 0 to 20)	Finisher (days 21 to 55)
Ground yellow corn (3,132 kcal; 9.65% crude protein)	53.89	46.55
Soy bean meal (2,971 kcal; 41.6% crude protein)	36.19	25.00
Rice bran	-	11.00
Wheat bran	-	5.00
Fish meal	3.00	8.00
Palm oil	3.73	2.60
60% choline chloride	0.25	-
Sodium chloride	0.20	0.25
Dicalcium phosphate	1.15	0.30
Limestone	1.30	1.00
DL-methionine	0.18	0.10
L-lysine	-	0.10
Vitamin-mineral premix[1]	0.10	0.10
Composition by analysis		
Crude protein	22.00	20.10
Composition by calculation		
ME, kcal/kg	3,000	3,115

[1] Supplied per kg diet: Fe 100 mg; Mn 110 mg; Cu 20 mg; Zn 100 mg; I 2 mg; Se 0.2 mg; Co 0.6 mg; santoquin 0.6 mg; vitamin A 6,667 IU; vitamin D 1,000 IU; vitamin E 23 IU; vitamin K3 1.33 mg; cobalamin 0.03 mg; thiamin 0.83 mg; riboflavin 2 mg; folic acid 0.33 mg; biotin 0.03 mg; pantothenic acid 3.75 mg; niacin 23.3 mg; pyridoxine 1.33 mg.

Body weights were determined individually on days 0, 21 and 56. Feed consumption from days 0 to 20 and days 21 to 55 was recorded per cage and feed conversion ratio (FCR) was calculated as g feed ingested per g live weight gain and corrected for mortality. Protein and energy intakes from days 21 to 55 were estimated by multiplying the amount of feed consumed and the respective protein and energy contents of each diet.

Statistical analyses were done by ANOVA with the aid of General Linear Models procedure of SAS software (SAS Institute, 1991). The significance level was fixed at $p<0.05$. Body weight, feed intake, FCR, and energy and protein intakes data were analysed statistically with genotype, feeding regimen and the interaction between them were the main effects in a factorial arrangement in a fixed model. The intake of each diet from days 21 to 55 in the choice feeding setting was measured by the consumption of each diet expressed as a percentage of total intake. Prior to analysis, body weights were transformed to common logarithms. Mortality data were subjected to chi-square analysis.

RESULTS

Body weight, feed intake and FCR from days 0 to 21 are presented in table 2. From days 0 to 21, the CB had greater body weight, higher feed intake and better FCR than their JF counterparts. There was a significant genotype × feeding regimen interaction for body weight on day 56 (table 3). While feeding regimen had no effect on the body weight of JF, CB fed a single complete diet were heavier than those provided choice feeding. Similarly, irrespective of feeding regimen, JF had similar FCR from days 21 to 55 whereas the FCR of CB under free choice feeding was poorer than controls. Mortality rates were similar for single-fed (5%) and choice-fed (7.5%) CB. On the contrary,

Table 2. Effect of genotype on body weight, feed consumption and feed conversion ratios (feed/gain) from 0 to 21 days of age

Parameter	Genotype: Commercial broilers	Genotype: Jungle fowl	Pooled SEM
Body weight (g/bird)			
day 0	45[a]	20[b]	0.2
day 21	733[a]	98[b]	3.1
Feed consumption (g/bird)			
days 0-20	1,006[a]	158[b]	4.1
Feed conversion (feed/gain)			
days 0-20	1.37[a]	1.61[b]	0.002

[a,b] Means with different superscripts within a row are significantly different at $p<0.05$.

Table 3. Effects of genotype and feeding regimen on body weight (day 56) and feed conversion ratios (feed/gain) (days 21-55)

Feeding regimen	Body weight		Feed conversion ratio	
	Broilers	Jungle fowl	Broilers	Jungle fowl
Single feeding	2,977[ax]	264[ay]	2.08[ax]	4.51[ay]
Choice feeding	2,630[bx]	283[ay]	2.37[bx]	4.04[ay]
ANOVA				
Genotype (G)	*		*	
Feeding regimen (F)	NS		NS	
G × F	*		*	
Pooled SEM	13.49		0.05	

* $p<0.05$; NS = not significant ($p>0.05$).

a,b Means within a column with no common superscripts differ significantly.

x,y Means within a row with no common superscripts differ significantly.

choice-fed JF (2.5%) had lower mortality rate than their control counterparts (10%).

Results of total feed, protein and energy intakes from days 21 to 55 are depicted in table 4. Although feed intake from days 21 to 55 was not affected by feeding regimen, interaction of genotype × feeding regimen was significant for total protein intake. The interaction resulted from similar values between feeding regimens for JF, and higher total protein consumption for CB fed single complete diet than those under choice feeding. The total energy intake of CB from days 21 to 55 was higher than the JF chicks. Irrespective of genotype, birds provided a single complete diet consumed more energy than their choice-fed counterparts. In the choice-fed CB and JF chicks, the total consumption from days 21 to 55 of the complete diet was the highest followed by corn and soybean (table 5).

DISCUSSION

As expected, highly significant differences due to genotype were observed for body weight, feed intake and FCR at all ages. Intense selection for rapid growth has resulted in a large disparity in growth rate between CB and JF. The body weights of the JF chicks on days 0, 21, and 56 were about 44%, 13%, and 9%, respectively, of their CB counterparts. The high feed intake of CB is also attributed to long term selection for rapid growth which alters brain and peripheral mechanisms influencing feed intake (Lacy et al., 1985; Denbow, 1989). Heavy breed birds consumed feed at a volume close to the total capacity of their gastrointestinal tract, while light breed chickens ate more to satisfy metabolic need and normally filled only a relatively small percentage of their gastrointestinal tract (Nir et al., 1978). The close relationship between growth rate and FCR has long been recognised (Emmerson, 1997). Smith et al. (1990) indicated that selection for rapid growth altered the size and surface area of villi, and thus, improved nutrient absorption and concomitant feed efficiency.

Literature concerning the effects of choice feeding on growth performance of broiler chickens is conflicting. Studies by Summers and Leeson (1978), Shariatmadari and Forbes (1993), and Yo et al. (1998) suggested that broiler chickens fed a single complete diet grew faster with better feed efficiency than those under self-selection feeding regimen. On the contrary, Cumming (1983) reported that broiler chickens given a choice of cereal and high protein concentrate performed just as well as controls. Similarly, Ramlah and Halim (1994) noted no significant differences in body weight and FCR between choice-fed (a choice of a complete diet and ground corn) and those provided a single complete diets. In the present study, the dietary self-selection regimen of a complete diet, ground corn and soybean, retarded the growth rate and FCR of CB. According to Mastika and Cumming (1981), and Sinurat

Table 4. Effects of genotype and feeding regimen on total feed (g), protein (g) and energy (ME kcal) consumption from days 21 to 55

Feeding regimen	Total feed		Total protein		Total energy		
	Broilers	Jungle fowl	Broilers	Jungle fowl	Broilers		Jungle fowl
Single feeding	4,819	661	975[ax]	134[ay]	15,186	(8,635[a])	2,083
Choice feeding	4,800	742	796[bx]	139[ay]	14,105	(8,215[b])	2,150
	(4,810[x])	(702[y])			(14,646[x])		(2,117[y])
ANOVA							
Genotype (G)	*		*		*		
Feeding regimen (F)	NS		*		*		
G × F	NS		*		NS		
Pooled SEM	32		6		98		

* $p<0.05$; NS=not significant ($p>0.05$).

a,b Means within a column with no common superscripts differ significantly.

x,y Means within a row with no common superscripts differ significantly.

Table 5. Effect of genotype on feed and nutrient intakes under choice feeding regimen (days 21 to 55)

	Complete diet		Corn		Soy bean	
	Broiler	Jungle fowl	Broiler	Jungle fowl	Broiler	Jungle fowl
Total feed intake (g/bird)	2,805	490	1,884	202	111	50
% of feed intakes	59	66	39	27	2	7
Total energy intake (kcal/bird)	8,738	1,544	5,037	633	330	148
% of energy intakes	62	67	36	27	2	6
Total protein intake (g/bird)	567	99	183	19	46	21
% of protein intakes	71	71	23	14	6	15

and Balnave (1986), the poor performance of choice-fed broilers was primarily due to insufficient intake of amino acids. Our results are congruent with the earlier findings. Although the total feed intake of choice-fed and control CB was similar, the former consumed less protein and energy. Thus, it appears that the CB chicks failed to obtain sufficient protein and energy to support maximum growth. With the choice-fed CB chicks consuming only 59% of their total feed intake as a complete diet, vitamin and mineral deficiencies may occur resulting lower body weight and poorer FCR. The poor performance of choice-fed birds has also been attributed to greater exercise in obtaining the variety of feeds available (Munt et al., 1995).

The approximately 1.5:1 and 2.4:1 ratios of complete diet:corn intake in CB and JF, respectively, suggest a 'preference' for complete diet but not to the exclusion of ground corn. It is interesting to note that although the complete diet is nutritionally adequate, the CB and JF chicks consumed corn at a proportion of 39% and 27%, respectively. These findings can be interpreted in two ways: (i) the chicks are avoiding excessive nutrient intake or (ii) the chicks preferred corn but in order to maintain optimum growth they have to consume a higher proportion of the complete diet. According to Forbes (1995), although an animal has learned that a particular feed is nutritionally balanced, it still samples other feeds to ensure that a change in the quality of an extreme feed does not go undetected and allow for novel feeds to be sampled with relative safety.

The proportions of soybean eaten by CB and JF were only 2% and 7%, respectively. There is a possibility that high-protein diets are unpalatable (Hughes, 1984), so the chicks eat progressively less as protein content rises. In his review, Hughes (1984) indicated that palatability, metabolic and nutritional requirements played a profound role in dietary self-selection.

Wide variations in the performance of chickens in response to dietary self-selection has been associated with genetics. Choice feeding has given inconsistent results in broilers though it has proved to be successful in layers because the former have so little time to learn how to make the appropriate choices (Summers and Leeson, 1979; Mastika and Cumming, 1987). White Plymouth Rocks from line selected divergently for juvenile body weight showed differences in preference for diets varying in protein and energy content (Huey et al., 1982). In the present study, the observed significant genotype × feeding regimen interactions for several traits measured suggested that CB and JF responded differently to choice feeding situation. Although the dietary self-selection was detrimental to the growth performance of CB, the choice-fed JF performed just as well as those provided a single complete diet. Ability to consume sufficient protein, the common limiting nutrient under dietary self selection regimen, may have accounted for the lack of difference in growth performance between the JF provided a complete diet and choice feeding. Thus, it appears that JF are better able to respond to choice feeding setting to support maximum growth. These findings may appear expected in view of the many generations of selection for rapid growth on a complete diet in CB. In his review, Hughes (1984) indicated that domesticated birds were less responsive to the nutritional consequences of their feed intake as compared to their jungle fowl counterparts. Nevertheless, in the present study, the energy consumption of the choice-fed JF was lower than the controls. There is a possibility that the JF are not as sensitive as broilers in terms of nutritional inadequacies because of the slow growth nature of the chicks.

There is the question of whether the choice-fed CB chicks are incapable to select nutrients necessary for maximum growth or innately refuse to do so. Siegel et al. (1997) compared the responses of chickens from three genetic stocks differed in growth potential and concluded that the rapid growing meat-type chickens may innately choose a diet that has long-term survival benefits rather than one with economic benefits to market age. It is well documented that rapid growth and heavy body weight, particularly associated with small skeletal frame, have been implicated in musculoskeletal and cardiovascular disorders in meat-type chickens (Julian, 1993; Lilburn, 1994). Hence, it appears that maintenance of well-being is a priority in modulating dietary self-selection in meat-type chickens.

In view of the preceding discussion, it is expected that single-fed broilers, which had greater body weight at 56 days of age, were more 'distressed' than their choice-fed counterparts. Gross and Siegel (1993) indicated that the physiological demand for rapid growth could be stressful. In the present study, however, the mortality rate between the single-fed and choice-fed CB was not significantly different. Pathological state is an extreme aftermath of biological stress response and occurs when prolonged and intense physiological reactions are involved (Sapolsky, 1992). According to Moberg (2000), most stressful encounters in animals can be coped sufficiently without detrimental effect on well-being.

In conclusion, choice-fed JF are capable to select nutrients necessary to support optimum growth under intensive management systems. There was no difference in body weight and FCR between choice-fed and single fed JF. On the contrary, choice feeding was detrimental to the growth performance of CB. Our data suggest that although the total feed intake of choice-fed and control CB was similar, the former consumed less protein and energy.

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