Carcass Composition of Broilers Fed Diets Based on Total and Digestible Amino Acid Formulation

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ABSTRACT

The objective of this research was to determine the difference in carcass composition between male and female birds and between birds of two different genotypes fed four diets differed in formulation, i.e: 1) based on total amino acids, 2) based on digestible amino acids (published book values), 3) based on digestible amino acids values determined, 4) based on digestible amino acids formulated commercially. This study demonstrated that sex and strain of broilers affect the requirement of amino acids. Male broilers had higher dietary amino acid requirements than females. With regard to genotype, the more rapid the growth of the birds, the higher requirement of amino acids. Birds given diets based on digestible amino acid formulation had a higher proportion of body protein and a low proportion of body fat (P<0.05) than birds fed diets based on total amino acid formulation.

Key words: amino acid, broiler, carcass, diet formulation, digestible

INTRODUCTION

The efficiency of protein utilization depends to a large extent on the amino acid composition of the diet. Within commercial poultry nutrition, there has been an increasing interest in the concept of using digestible amino acids to formulate cost-effective diets which more accurately meet the nutrient requirements of the bird. The concept of digestible amino acids is based on the realization that amino acids in most ingredients are not completely digested and diets based on total amino acid concentrations may not provide an appropriate balance of amino acids to meet the birds' requirements. However, many feed companies still use total amino acids to specify poultry diets and there is a need for a better-feed formulation system than one based on total amino acids.

For reliable application of digestibility in practice, it is necessary to quantify the effect of genotype and sex. Growth rates of male and female broilers were differ and it is suggested that they have different nutritional requirements (Ten Doeschate *et al.*, 1992). In regard to genotype, Leclerq (1983) stated that genetically lean chickens use dietary protein more efficiently than fat birds to make their own body protein. Pym *et al.* (2004), however found that the growth rate of genetically lean chickens was much more severely depressed at low dietary levels of protein than that of genetically fat birds. Strain and sex differences in digestibility of feed need further investigation and have implications for mixed sex versus single sex rearing.

MATERIALS AND METHODS

One hundred and sixty male and female chickens were obtained from two commercial hatcheries. The experiment used a factorial design with 2 genotypes, 2 sexes, and 4 diets. From day 21, the birds were given 4 experimental diets (iso-energetic and iso-nitrogenous). The diets were formulated based on: 1) total amino acids; 2) digestible amino acids refferring to publish book values (Ravindran *et al.*, 1998); 3) digestible amino acids values determined on the same ingredients as used in diet 1; and 4) digestible amino acids formulated commercially.

Birds were wing-banded for identification. Feed and water were given *ad libitum*. Birds were weighed at 21 days of age and again at 42 days of age. Feed intake was recorded weekly and feed conversion ratio was calculated. On day 42, 10 males and 10 females of both genotypes per dietary treatment were randomly selected for carcass analysis. Birds were killed by cervical dislocation to avoid loss of blood following a 12 h fast. They were then placed in individual plastic bags and frozen at -20^{o}C. The whole body of the chickens were minced and dried and then re-ground prior to determination of fat and protein. Carcass composition (fat and protein in the whole body of chicken) was determined and calculated as follow:

Breast meat yield (%) =

$$\frac{\text{Breast meat weight without bone (g)}}{\text{Body weight}} \times 100$$

Abdominal fat content (%) =

$$\frac{\text{Abdominal fat weight}}{\text{Body weight}} \times 100$$

Statistical Methods

The experiment used a factorial design with 2 genotypes, 2 sexes, 4 diets and 10 individual bird replicates per genotype X sex X diet sub group. Main and interaction effects were determined by analysis of variance. The statistical methods for body composition included the effects of strain, sex, diet and all possible interaction. The data was analysed using SAS (SAS/STAT 6.04, 1987; SAS Institute Inc., Cary, North California). Superscripts were used in tables to indicate statistical differences between means. The significant level was set at P<0.05 and if F-ratio indicated significance, the differences between the means were separated using the Least Significance Difference test (Steel and Torrie, 1980).

RESULTS AND DISCUSSION

As shown in Table 1 there was a significant effect of diet on body fat (P=0.004). Body fat content of birds fed diet 1 (based on total amino acid formulation) was significantly higher than in birds fed diet 2 (based on digestible amino acids formulation). However, body fat content in birds given diet 2, 3 and 4 was not significantly different.

There was a significant effect of genotype on body protein (P<0.01), but not on body fat. Strain B had significantly higher body protein content than strain A. There was also a significant effect of sex (P<0.001) on body fat. Females had a significantly higher percentage of body fat than males. This difference is most likely due to the developmental characteristics of these two genotypes. It seems logical that male broiler would require higher levels of amino acids than females, because male chicks contain more protein and less fat.

There also was a significant interaction between genotype and sex for both body protein (P=0.001) and fat (P=0.02). The effect for protein was due to significantly higher levels of protein in the males birds of strain B than in the males of strain A. The effect for fat was due to slightly higher levels in the strain B than strain A males, but the reverse for the females. In strain A, the sex difference in body fat was much greater than in strain B. This study confirmed previous studies (Acar *et al*., 1991) that breast muscle and fat development is affected by sex and strain.

There was a significant effect of diet on both fat (P=0.004). Body fat content in strain B males fed diet 1 was significantly higher than birds fed diets 2 based on digestible amino acids formulation. However, body fat content in birds given diet 2, 3 and 4 was not significantly different.

It is of interest that in the females of both genotypes, the commercially formulated diet produced birds with the highest fat content, whilst in the males highest fat levels were found in birds received diet 1, formulated on total amino acid levels. It may be that amino acids excess ofrequirement for protein metabolism by the females were deaminated, and used for energy. This is included by the higher levels of total lysine and methionine in the diet 4 than in the two diets formulated on digestible amino acids. The fact that it did not happen in the males suggest that they not only have higher overall amino acid requirements, but possibly a different for a specific amino acids in the two sexes.

The greater proportion of both fat and protein in the strain B than in the strain A males, suggest that the latter genotype birds have a significantly greater proportion of water in their bodies. This is reflected in the lower FCR of the strain A than strain B males, and suggests a greater emphasis on selection for improved feed efficiency in strain A. Pym and Solvyns (1979) reported positive phenotypic correlations between FCR and carcass fat in chickens. It is interesting that the relationship between fat, protein and water have been altered by selection in the two lines. Normally, an increase in body fat is accompanied by a reduced in both water and protein. The sexes responded differently suggesting some influence of differential hormonal control on the process.

Table 1. Protein and fat composition (%) of female and male broilers from two strains fed diets formulated on total and digestible amino acids

Parameter	Diet	Strain A		**Mean**	Strain B		**Mean**	**Overall means**
		Females	Males		Females	Males		
Protein	1	17.5±0.63[d]	17.4±0.56	17.45±0.6	18.4±0.67	19.2±0.56[b]	18.8±0.6	18.13
	2	18.2±0.72[bcd]	17.5±0.59	17.85±0.6	18.5±0.67	19.3±0.63[ab]	18.9±0.6	18.38
	3	17.6±0.59[cd]	18.2±0.59	17.90±0.6	19.3±0.63	21.0±0.72[a]	20.15±0.6	19.03
	4	18.2±0.59[bcd]	17.4±0.59	17.80±0.6	18.2±0.67	19.1±0.56[ab]	18.65±0.6	18.23
	Mean	**17.88±0.31**	**17.63±0.35**	**17.75±0.31 [b]**	**18.6±0.31**	**19.65±0.30[a]**	**19.13±0.32 [a]**	
Fat	1	16.1±0.69[a]	12.4±0.62[defg]	14.25±0.74	14.4±0.74[abcd]	14.2±0.62[abc]	14.3±0.6[a]	14.28 [a]
	2	14.2±0.80[bcde]	11.5±0.65[efg]	12.85±0.74	13.2±0.74[cdef]	11.3±0.69[efg]	12.2±0.6[b]	12.55 [b]
	3	13.5±0.62[cdef]	11.3±0.65[fg]	12.40±0.69	14.1±0.69[abc]	12.4±0.80[defg]	13.2±0.6[ab]	12.83 [ab]
	4	16.4±0.65[a]	11.4±0.65[g]	13.90±0.74	15.5±0.74[ab]	12.5±0.62[defg]	14.0±0.6 [ab]	13.95 [ab]
	Mean	**14.70±0.35 [a]**	**11.40±0.30 [b]**	**13.05±0.31**	**14.27±0.35 [a]**	**12.07±0.35 [b]**	**13.17±0.32**	

Note: Values are means and standard deviation of 20 individual birds;
Values with different superscripts are significant difference (P<0.05).

CONCLUSIONS

Birds given diets formulated on digestible amino acid basis had a higher proportion of body protein and a low proportion of body fat than birds fed diets formulated on a total amino acid basis. This study indicated that genotype and sex differences in body composition should be taken into account in implementing formulation diets to maximize performance of broiler chickens.

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