ISSN 1682-8356
ansinet.org/ijps

INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

International Journal of Poultry Science 5 (5): 449-452, 2006
ISSN 1682-8356

Alpha-Linolenic and Linoleic Acid Status of Broilers Kept on Small Holdings in Cameroon

R. Hovenier[1], A. Teguia[2] and A.C. Beynen[1]
[1]Department of Nutrition, Faculty of Veterinary Medicine, Utrecht University,
P.O. Box 80.152, 3508 TD Utrecht, The Netherlands
[2]Department of Animal Science, Faculty of Agronomy and Agricultural Sciences,
University of Dschang, P.O. Box 222, Dschang, Cameroon

Abstract: The idea tested was that a limiting provision of alpha-linolenic acid (ALA) contributes to the poor growth performance of broilers kept on small holdings in Cameroon. The study had a cross-sectional design and involved 14 small-holder farms. The ALA and linoleic acid (LA) concentrations in the broilers' diets were determined and so were the contents of ALA and LA in adipose tissue collected from selected birds. When expressed as percentage in the whole diet, the LA content in the diets fed on the 14 farms varied between 1.64 and 3.81 % and that of ALA between 0.04 and 0.41%. There was a significant relationship between the relative percentage of ALA in the diet and that in the abdominal adipose tissue of the broilers. It was concluded that the LA supply was not limiting growth in the broilers. The ALA requirement of broilers is not known, but it might be in the order of 0.05 to 0.1 % of the dietary dry matter. If and when the ALA requirement is 0.05% of the diet, then the supply of ALA on at least one farm could have limited growth of the broilers. However, caution is warranted because the design of this study does not allow drawing conclusions as to cause-and-effect relations. Furthermore, on all farms growth rates were sub-optimal so that factors other than the ALA supply had limited growth. Absolute proof for a role of the ALA supply can only be obtained by controlled studies on the farms in which supplemental ALA is the only variable.

Key words: Alpha-linolenic acid, fatty acid, energy source

Introduction

Linoleic acid (LA, C18:2 n-6) and alpha-linolenic acid (ALA, C18:3 n-3) are essential polyunsaturated fatty acids for poultry because they cannot be synthesized in the body. Apart from their roles as membrane constituent and energy source, LA and ALA are the parent compounds of the n-6 and n-3 families of polyunsaturated fatty acids. They can be desaturated and elongated in the body to yield the precursors of the numerous eicosanoids which have various hormone-like actions.

A deficiency of LA in poultry is unlikely to be encountered in practice because many feed ingredients contain significant amounts of LA in their fat component. Under experimental conditions, LA deficiency can be induced resulting in a reduced growth rate followed by increased water consumption, development of fatty liver and decreased resistance to disease (Balnave, 1970). The LA requirement of growing chickens is met by a dietary concentration of 1 % in the dry matter fraction (National Research Council, 1994). The ALA requirement of growing chickens has not yet been determined, but it is reasonable to suggest that it will be in the order of 0.05 to 0.1 % of the dietary dry matter.

In Cameroon, growth performance of broilers kept on small holdings is poor (Teguia and Beynen, 2004). One possible cause of the poor performance might be a limiting provision of ALA as this essential fatty acid is not taken into account in the feed formulation procedures. The ALA content of adipose tissue of broilers is a valid index of the intake of this fatty acid (Bavelaar and Beynen, 2003). This study was carried out to obtain information on the ALA status of broilers kept on small holdings in Cameroon. To meet the objective, the contents of ALA in the diet and adipose tissue of broilers were measured. For comparison, the contents of LA were determined as well.

Materials and Methods

Farms, feed and broilers: Fourteen small-holder farms in the West Province of Cameroon were included in the survey. There were 50 to 1000 broilers on each farm. Diets were prepared on the farms using locally available feedstuffs and commercial concentrates or premixes or complete commercial diets were used. One-day old chicks had been obtained from local hatcheries. The strains were Arbor Acre, Hybro and Starbro. Chickens were either kept in a room in the owner's house or in separate constructions with walls made of wood, concrete or clay blocks. There was ventilation by an open window or door or through the open walls. Floors consisted either completely or partially of concrete, soil

Table 1: Broiler live weights, growth rates and mortality on the 14 small-holder farms

Farm	Age (days)	Body weight of chicks sampled (g)	Body weight of 10% of flock (g)	Growth rate (g/day)	Mortality (% of initial flock)
1	36	828	888	23.69	23.5
2	32	738	728	21.66	2.2
3	32	557	760	22.66	1.7
4	34	907	977	27.71	7.8
5	33	741	830	24.09	2.0
6	34	710	840	23.68	2.4
7	33	867	755	21.82	5.0
8	32	735	710	21.09	3.5
9	32	743	927	27.88	1.7
10	31	482	576	17.45	1.2
11	32	816	890	26.72	3.3
12	31	743	646	19.71	4.0
13	31	819	920	28.55	2.0
14	31	404	630	19.19	2.6
Mean	32.4	720.7	791.2	23.28	4.49
SD	1.5	144.8	123.7	3.45	5.74

or bamboo. The floors were generally covered with wood shavings or canvas.

Sample collection: Starter diets were fed until 21 to 38 days of age and these diets were sampled on each farm for subsequent analysis. Body weights of 10% of the animals on each farm were measured when the broilers were aged 30-35 days and six randomly chosen broilers (three males and three females) were bought from the owner. On farm 13 only 3% of the total flock was weighed. After 12 hours without access to food, but with free access to water, the purchased animals were weighed individually, killed and abdominal adipose tissue samples were collected.

Fat and fatty acid analyses: Fat was extracted from the feed samples with chloroform:methanol (2:1, v/v) as described by Folch *et al.* (1957). The extracted fat and the adipose tissue samples were saponified using methanolic sodium hydroxide. The constituent fatty acids were converted into their methyl esters using borontrifluoride in methanol. Fatty acid analyses were performed by gas liquid chromatography using a flame ionisation detector, a Chrompack column (Fused silica, no.7485, CP.FFAPCB 25m * 0.32 mm, Chrompack, Middelburg, The Netherlands) and H_2 as carrier gas (Metcalfe *et al.*, 1966). The individual fatty acids were expressed as weight percentage of total methyl esters (total fatty acids, TFA).

Statistical analysis: Linear regression analysis on data for LA and ALA in feed and adipose tissue was done for farm mean data. The linear regression equations were calculated with the following statistical model: y = a + b*x, where y = adipose tissue fatty acid (weight % TFA) and x = dietary fatty acid (weight % TFA). The level of statistical significance was pre-set at $P<0.05$.

Results

The farm average body weights ranged from 576 to 977 g (Table 1). Growth rates were very low on farms 10, 12 and 14. Mortality was recorded and found to vary between farms from 1.2 to 23.5 %.

Table 2 shows that the total fat contents of the diets on the 14 farms varied between 4.3 and 8.9%. The LA concentration in the diets, expressed as percentage of total fatty acids, ranged between 36.0 and 49.2% and that of ALA between 0.8 and 5.3%. The adipose tissue fatty acids consisted for 15.0 to 28.2% of LA and for 0.3 to 1.2% of ALA.

Fig. 1 illustrates that there was a linear relationship between the relative percentage of ALA in adipose tissue fatty acids and that in dietary fatty acids. The linear correlation coefficient and regression formula for LA was $R^2 = 0.12$, $y = 0.32x + 3.91$ (n=14, p= 0.22). For ALA the outcome was $R^2 = 0.55$ and $y = 0.17x + 0.22$ (n=14, p= 0.002).

Discussion

Male and female broilers aged 30 to 35 days and kept under favorable conditions may be expected to have an average live weight of 1000 to 1400 g. The broilers on farms 4, 9 and 13 approached the reference value, but those kept on the other farms had performed less. We have concluded earlier that one reason for the poor productivity of broilers in Cameroon is the low quality of feed ingredients (Teguia and Beynen, 2004).

Diarrhoea was a general health problem on almost all farms. Nevertheless, mortality rates may be considered normal, except for that on farm 1. On that farm high

Table 2: Amount of crude fat in the diets and the percentages of LA and ALA in total dietary and adipose tissue fatty acids

	Feed			Adipose	Tissue
Farm	Fat (%)	LA (% TFA)	ALA (% TFA)	LA (% TFA)	ALA (% TFA)
1	8.2	49.2	5.3	28.2	1.2
2	5.7	45.9	1.0	15.8	0.4
3	8.9	42.6	3.4	13.9	0.4
4	5.0	47.7	1.5	16.7	0.5
5	6.6	47.9	4.0	22.7	1.0
6	6.9	40.5	0.8	16.3	0.3
7	5.3	47.4	1.5	15.3	0.4
8	6.6	41.9	0.9	22.0	0.8
9	5.2	42.4	1.5	17.9	0.4
10	6.7	36.0	1.0	16.6	0.4
11	4.6	46.2	1.7	17.3	0.4
12	4.6	37.6	0.9	15.0	0.3
13	4.3	47.4	1.7	15.7	0.5
14	6.9	39.9	2.4	18.8	1.0

Table 3: Calculated percentages of LA and ALA in the whole diet

	Feed	
Farm	LA (%)	ALA (%)
1	3.81	0.41
2	2.50	0.05
3	3.60	0.29
4	2.28	0.07
5	3.00	0.25
6	2.67	0.05
7	2.37	0.07
8	2.63	0.06
9	2.10	0.08
10	2.30	0.06
11	2.02	0.07
12	1.64	0.04
13	1.93	0.07
14	2.62	0.16

incidences of diarrhoea, cough and torticollis were observed. On the small-holder farms in Cameroon, the broilers are generally vaccinated against infectious bursal disease, Newcastle disease and infectious bronchitis. Coccidiostatics are used for coccidiosis prevention (Teguia and Beynen, 2004).

The dietary total fat content varied between 4.3 and 8.9%. We have found earlier in the Western Highlands of Cameroon that farm-made diets are generally lower in fat than are commercial feeds (Teguia and Beynen, 2004). In the Western Highlands the commercial diets typically contained 5 to 6% of fat, whereas the farm-made diets contained around 3%. Thus, in this survey carried out in the West Province, the dietary fat concentrations are relatively high.

The supply of LA and ALA is determined by the total fat content of the diet and the concentrations of these fatty acids in the crude fat fraction. About 95 % of the crude fat consists of fatty acids. The concentrations of LA and ALA in the total diet can be calculated (Table 3).

When expressed as percentage in the whole diet, the LA content in the diets fed on the 14 farms varied between 1.64 and 3.81 % and that of ALA between 0.04 and 0.41% (Table 3). The requirement of LA has been set at 1 % of the total diet (National Research Council, 1994). Thus, it can be concluded that the LA supply was not limiting growth in the broilers. The situation as to the provision of ALA is less clear. The ALA requirement of broilers is not known, but it might be in the order of 0.05 to 0.1 % of the dietary dry matter. If and when the ALA requirement is indeed as low as 0.05% of the diet, then the supply of ALA on at least one farm could have limited growth of the broilers.

The design of this study does not allow drawing conclusions as to cause-and-effect relations. Furthermore, on all farms growth rates were sub-optimal, implying that factors other than ALA supply had limited growth of the broilers. On farms 10, 12 and 14 the poorest growth was seen while the dietary ALA concentrations were 0.06, 0.04 and 0.16 %, respectively. Clearly, the low growth rate seen on farm 14 cannot be ascribed to a deficiency of ALA. Other dietary constituents or possibly management and/or health factors must have been involved. At present, a marginal supply of ALA on farms 10 and 12 cannot be excluded as a factor contributing to the low growth rates. For farms 4, 9, 11 and 13, the farms with the highest growth rates, the dietary ALA concentrations were between 0.05 and 0.10%.

There was no significant relationship between the relative percentage of LA in the diet and that in the abdominal fat tissue. As would be anticipated on the

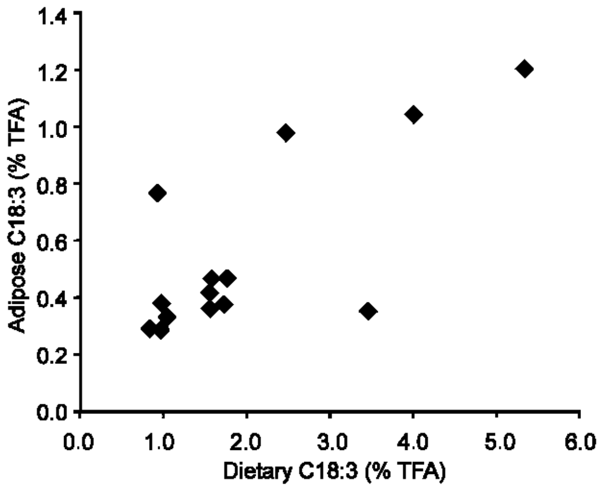

Fig. 1: The relationship between the relative percentages of dietary and adipose tissue ALA in broilers kept on 14 small-holder farms in Cameroon.

basis of the data in Table 2, visual inspection of the scattergram revealed that the data points formed one packed cluster which degrades the correlation coefficient and renders the regression formula inaccurate. Based on literature data, we have shown that the contents of LA in the diet and adipose tissue are strongly correlated in broilers (Bavelaar and Beynen, 2003). In that study we also computed the regression formula for LA and found it to be $y = 0.65x + 1.99$ ($n=116$, $p< 0.001$; $R^2 = 0.47$).

The regression formula for ALA as based on literature data was $y = 0.46x + 0.46$ ($R^2 = 0.94$, $n = 112$, $p < 0.001$) (Bavelaar and Beynen, 2003). It would appear that the formula computed in the present study differs from the one published earlier. However, it should be noted that both the values for the slope and intercept have a considerable coefficient of variation. The lower slope in this study, if indeed lower, could relate to the low weight gain of the birds and the consequent less efficient incorporation of dietary ALA into adipose tissue.

In conclusion, this study confirms that growth rates of broilers kept on small holdings in Cameroon are sub-optimal. The survey indicates that on many farms the ALA supply to broilers is marginal and it could even be argued that this contributes to the poor growth. The nature of the survey makes it impossible to draw conclusions as to cause-and-effect relationships. Absolute proof for a role of ALA can only be obtained by controlled studies on the farms in which supplemental ALA is the only variable.

References

Balnave, D. 1970. Essential fatty acids in poultry nutrition. World Poult. Sci., 75: 881-890.

Bavelaar, F.J. and A.C. Beynen, 2003. Relationships between dietary fatty acid composition and either melting point or fatty acid profile of adipose tissue in broilers, Meat Sci., 64: 133-140.

Folch, J., M. Lees and G.H. Sloane Stanley, 1957. A simple method for the isolation and purification of total lipids from animal tissues, J. Biol. Chem., 226: 497-509, 1957.

Metcalfe, L.D., A.A. Schmitz and J.R. Pelka, 1966. Rapid preparation of fatty acid esters from lipids for gas chromatographic analysis, Anal. Chem., 318: 514-515.

National Research Council, 1994. Nutrient requirements for poultry. National Academy Press, Washington DC, 1994.

Teguia, A. and A.C. Beynen, 2004. Nutritional aspects of broiler production in small-holder farms in Cameroon. Livest. Res. Rural Dev., 16: 1-5.