A comparison of pelleting and expander treatment on nutritional value of a broiler diet containing two different fat sources

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Abstract

A study was conducted to assess the interaction between different source of fat application through the process of pelleting and expander treatment followed by pelleting, and its influences on nutritional value of the feed and performances of broiler chicken. Soy oil and a fat containing a high level of palmitic acid (Akofeed) were added in a feed mixture at two different inclusion levels (2.5 and 5%) before being processed. Pellet durability decreased as fat addition increased, but the reduction in pellet quality was much higher for soy oil than for Akofeed. Expander treatment improved pellet durability compared to pelleting only. Expander treatment tended to give poorer weight gain, and feed/gain was significantly poorer with expansion compared with pelleting only. Expander treatment increased starch gelatinisation, but this did not have an effect on faecal starch digestibility. However, both expansion and fat source had an effect on jejunal starch content, indicating that degradation rate may be affected by both processing and fat source used.

Introduction

Pelleting is the dominating process used for broiler feed production. However, a recent development is the use of the expander for a more severe thermal treatment of the feed prior to pelleting. The advantage of this process is a better sterilization of the feed and an improved pellet quality. However, the high temperature may induce other changes in the feed that may be disadvantageous for the nutritional value of the feed. One such negative effect may be the formation of complexes between fat and starch in the feed. Other negative effects include reduced protein digestibility and loss of heat labile components such as vitamins and enzymes. The purpose of the current experiment was to compare the effect of pelleting and expander treatment, and to study the interaction between processing method and fat type used.

Materials and Methods

Diets

A broiler diet containing 34 % ground wheat, 34 % ground barley and 22 % soybean meal was composed in accordance with requirements. The diet contained titanium oxide added as a marker, and also contained fibre-degrading enzymes. The experiment was organized as a three factorial design with two fat sources, two inclusion levels of fat and two processing method. Soy oil and akofeed were included at levels of 2.5 and 5% and all mixtures were either pelleted or expanded and pelleted. Akofeed consists of 94 % free fatty acids, of which palmitic acid dominates with 65 % of the fat. Feed production was performed at the Centre for Feed Technology, Ås, Norway. Soy oil was sprayed on the feed mixture during mixing, while akofeed was added in a solid form. Pelleted feeds were conditioned at 75°C and pressed through 3mm pellet die, while expanded feeds were processed on 110°C with cone pressure of 20 bars before pelleting.

Chicken experiment

Eleven day-old male broiler chickens (Ross 208) were selected at random and moved to single-bird cages (50 cm x 35 cm x 20 cm) in a room with constant temperature (21oC) and with 16 hours light. Each of the 8 diets was given ad libitum to 14 birds. In the morning of the 25th day of age, the food was removed and weighed. After 6 hours starvation, each bird was weighed and clean trays were placed under the cages, followed by access to feed. Excreta were quantitatively collected twice during the next 48 hours. At 28 days of age the food was removed from the birds and weighed, and the birds were weighed and excreta were collected after 6 hours starvation. At 32nd day of age, all birds and feed were weighed, before the birds were killed by CO2-asphyxiation followed by dissection. The contents from the distal 2/3 length of the ileum and from all jejunum were collected and frozen at –18 oC. Pellet durability (PDI) was measured using the Holmen Pellet Tester (Holmen Chemical Ltd., Borregaard Group, Norsolk, UK). Amylose-lipid complex was measured on a Mettler DSC 30 S (Mettler Toledo AG, Schwerzenbach, Switzerland). Starch content was analysed using an enzymetric method. A Three-way ANOVA was performed using the GLM procedure of SAS.

Results and Discussion

The technical analysis (Table 1) supports previous studies concerning the negative effect of fats with regard to PDI (Van Vliet, 1981; Thomas et al., 1998). Fats will act as lubricants and will thus reduce pressure in the pellet press. This can also be read out from the energy consumption data. However, diets containing Akofeed showed remarkable results, with PDI above 93% even at fat inclusion levels of 5%. This is probably due to the high melting point of 55 °C for Akofeed. In addition, the high PDI could be attributed to the amphiphilic nature of Akofeed, which provides better emulsifying properties.

Table 1. Technical results1

Fat type	Fat level (%)	Pro-cess	Holmen durability, after 24 hours	Holmen durability, after 2 months	Energy Consumption, kW/t/h
Soy oil	2.5	P	96.28A	95.36A	21.93D
Soy oil	2.5	E	93.76B	92.92BA	29.03A
Soy oil	5	P	90.67C	86.90C	17.42F
Soy oil	5	E	86.06D	84.09D	26.45C
Akofeed	2.5	P	96.33A	95.62A	20.00E
Akofeed	2.5	E	96.10A	95.17A	29.03A
Akofeed	5	P	93.48B	92.04B	17.42F
Akofeed	5	E	94.06B	93.17BA	27.09B

1Means within column with different letter indicate significant (p<0.05) differences. P and E letters denote pelleted and expanded feeds, respectively.

Amount of amylose-lipid complex formed during feed processing was significantly higher (P<0.05) when diets contained Akofeed (data not shown) compared to soy oil. This is caused by the high level of palmitic acid in Akofeed, which has a high potential for amylose-lipid complex formation (Eliasson and Larsson, 1993). Despite the fact that amylose-lipid complex formation is facilitated by heat, we were not able to detect a higher level of amylose-lipid complexes in expanded diets.

Birds given expanded diets tended to have a lower weight gain. In addition, there was a significant negative effect of expansion on feed/gain (data not shown). These data thus indicate that expander treatment is not a recommendable processing method for broiler diets. Neither AME/GE ratio nor faecal starch digestibility was significantly affected. However, the amount of starch in jejunum was reduced for expanded diets. This indicates that starch is more rapidly degraded after expansion than after pelleting. This also corresponds to an increase in extent of gelatinisation after expansion compared to pelleting (data not shown). A strong tendency (P=0.077, data not shown) for an increase in jejunal starch content was observed for diets containing Akofeed compared to soy oil. This indicates that the amylose lipid complexes formed resulted in reduced starch availability, in accordance with established mechanisms (Eliasson & Krog, 1985; Seneviratne & Biliaderis, 1991). The current data also showed that the difference between soy oil and Akofeed addition for jejunal starch content was higher after expansion than after pelleting. This is probably due to a more effective amylose-lipid complex formation due to the higher temperature and higher water level. This indicates that amylose-lipid complexes formed during processing may reduce starch degradation rate for broilers, although the current data does not provide evidence that this affects total starch digestibility.

Table 2. Results from chicken experiment[1]

Fat type	Fat level (%)	Pro-cess	Feed consumption (g)	Weight gain (g)	Feed/gain (g/g)	Pancreas weight, (g)	AME/GE ratio	Faecal starch digestibility (%)	Jejunum starch content (%)
Soy oil	2.5	P	2572A	1687A	1.52BC	4.70A	0.68A	97.68ABC	12.49BCD
Soy oil	2.5	E	2592A	1653A	1.57BC	4.80A	0.69A	98.44A	9.77D
Soy oil	5	P	2525A	1699A	1.49C	4.19A	0.68A	97.79ABC	15.13AB
Soy oil	5	E	2504A	1639A	1.53BC	4.37A	0.68AB	96.78C	10.96CD
Akofeed	2.5	P	2588A	1612A	1.61AB	4.71A	0.68A	98.38AB	13.31ABC
Akofeed	2.5	E	2689A	1671A	1.61AB	4.86A	0.66AB	97.59ABC	11.39CD
Akofeed	5	P	2702A	1694A	1.59AB	4.89A	0.64AB	97.77ABC	15.86A
Akofeed	5	E	2635A	1583A	1.66A	5.02A	0.62B	97.17BC	13.15ABC

[1]Means within column without common letter indicate significant ($p<0.05$) differences. P and E letters denote pelleted and expanded diets, respectively.

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