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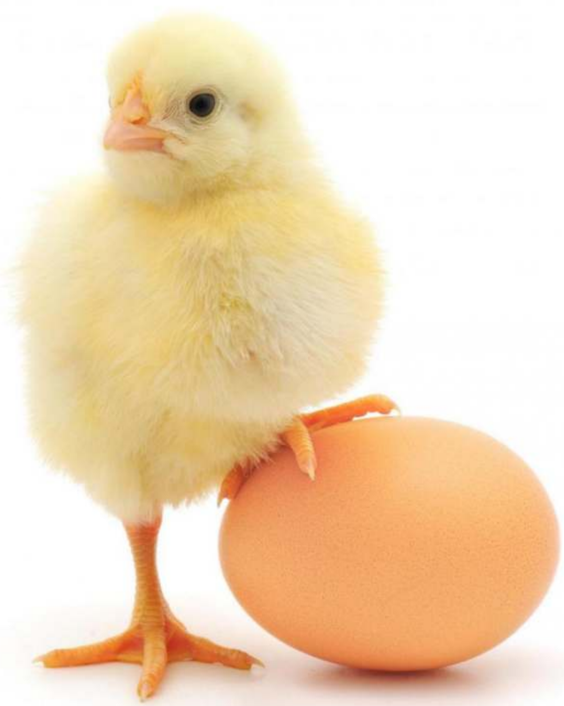

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# Comparison of Fat Sources in Rations of Broilers from Hatch to Market

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**Abstract:** Seven fats were fed on a percent basis to Cobb-Cobb broilers over a seven week period to determine if there were any differences in broiler performance between fat sources. All of the birds were fed a diet that consisted primarily of corn, soybean meal and animal by-product meal. Each of the seven fats was fed to 35 birds per pen with seven replicate pens per treatment. Birds and feed were weighed on 21, 35 and 49 days with processing yield and cut-up on 50 days. There were few differences found when broiler performance was compared between fat sources. No differences were seen in processing yields as well. Data from this study would indicate that any of the fats used in this study will provide similar performance regardless of their differences in measured energy levels.

**Key words:** Fat sources, animal feed, corn, soybean meal, animal by product meal

## INTRODUCTION

Use of fats for animal feed has many advantages. It is a concentrated source of energy and the main method of increasing the energy content of diets. Other benefits of fat addition include: increased growth rates, increased feed efficiency, decreased feed intake, a source of linoleic acid, decreased dustiness of feeds and reduced dust losses, lubricant for equipment in feed mills, increased palatability of feeds, increased rate of gain can decrease age at market and increased throughput of housing systems, lower heat increment during heat stress keeps caloric intake up, may slow gut transit of other feeds, resulting in increased digestibility, may show an "extra caloric" effect and finally, concentrated feeds can decrease transportation costs for feed delivery.

Some concerns that should be noted with fat utilization include: use of higher levels of fat may negate the effects of pelleting, measurement of Metabolizable Energy (ME) content can be difficult, there is the potential for rancidity, equipment needs relative to fat additions must be adequate and potentially poor digestibility of saturated fats by the young bird.

A number of different fat sources are available for poultry from the vegetable sources and the rendering industry. The primary sources are poultry fat, tallow, yellow grease, lard, blends and vegetable fats such as sunflower oil, soybean oil, or palm oil. Generally, the fats that are also used for human consumption are relatively expensive when compared to rendered products, resulting in lower fat utilization and thus lower ME diets when rendered fats are not available. One of the major concerns relative to fat usage is the actual ME value that should be assigned to each fat source. This number is often difficult to determine in a practical sense and may have little practical value in diet formulation. When analyzing energy content of fat, it is generally done indirectly, by substitution of a portion of the ration fed in the ME determination. Additionally, fat may have an extra caloric effect (Jensen *et al.*, 1970; Horani and Sell, 1977), whereby it affects the nutrient availability of other ingredients. This was noted in the lab where it was found that fat additions resulted in digestibility of MBM being increased (Firman and Remus, 1994). This would explain why some ME values reported are greater than the gross energy values possible for fat as well.

Early work on use of fat in poultry rations generally indicated a higher ME value for unsaturated vegetable oils when compared to animal products or products with high free fatty acid content (Seidler *et al.*, 1955; Young, 1961; Waldroup *et al.*, 1995). However, when fed as a portion of a complete ration, most experiments indicated no difference in performance parameters when different fat sources were fed (Seidler *et al.*, 1955; Young, 1961; Fuller and Rendon, 1979; Fuller and Rendon, 1977; Pesti *et al.*, 2002; Quart *et al.*, 1992). In a study by Pesti *et al.* (2002), a variety of fat sources were fed and differences of >4,000 kcal/kg were seen. However, when these same fats were fed to birds in a floor pen trial, no differences in gain or feed-to-gain ratio were observed, indicating that the net energy available to the bird was similar (Leeson and Atteh, 1995).

It was the objective of this study to determine the differences between seven different fats in broiler rations.

## MATERIALS AND METHODS

Initially, metabolizable energy levels were determined using cecectomized leghorn roosters (Sibbald, 1976). A total of seven fats were obtained through commercial sources. Roosters were not allowed feed for 24 h to insure adequate clearing of the gastrointestinal tract.

They were then tube fed 30 g of a corn/fat mixture (25 g of corn and 5 g of fat) and placed in metabolism cages. Each fat source was replicated 6 times as were birds used for endogenous collection. Six replicates of 30 g corn samples were also tube fed in order to calculate the energy from corn and allow calculation of the metabolizable energy from the fat source that was mixed with the corn. Excreta was collected for 48 h. Excreta was dried at 60°C in a forced air oven until dry and quantitated. Samples were then ground in a hammer mill and pelleted. Gross energy of the feed and the excreta content were determined via oxygen bomb calorimetry. Nitrogen content of feed and excreta were also determined by LECO analysis (AOAC Method 990.03) for nitrogen correction. Excreta were nitrogen corrected to maintain a zero nitrogen balance offset from fasting and yield a $TME_n$ value.

All fats were fed at 3% of the diet from hatch to 7 weeks of age. Seven replicate pens of birds, with 35 birds per pen, were utilized in a randomized block design with location within the facility as the blocking factor. Each block then had the fats randomized within the block. Cobb × Cobb straight run chicks were housed and raised under industry standard conditions in a curtain-sided building. The birds received a lighting schedule of 23 h of light and one hour of darkness. Birds were allowed feed and water *ad libitum*. Birds were weighed and feed intake was quantitated at 21, 35 and 49 days of age with cut-up and yield at 50 days of age. Diets consisted primarily of corn, soybean meal and animal by-product meal (Table 6) and were formulated to industry standards or above. All procedures were conducted in accordance with our standard operating procedures and the University of Missouri Animal Care and Use Committee under an approved protocol.

There were seven treatments that consisted of the Soybean Oil (positive control), Yellow Grease, Poultry Fat, Tallow (choice white grease), VA (Vegetable/Animal blend), Lard and Palm Oil. All the fats were obtained from rendering facilities in Missouri except palm oil which was obtained from Bogotá, Colombia.

Data collection occurred on 21, 35 and 49 day. Mortality was collected daily for adjusted feed conversion. A feed to gain ratio was determined for each pen. Four birds, two males and two females were selected from each pen on day 49 to be cut up on day 50. After processing, weights were collected for the whole bird hot and cold, the leg, wing, thigh, fat pad, pectorals major and pectorals minor.

All data was analyzed by Analysis of Variance (ANOVA) with a one-way design using the general linear model. Block effects were not significant and this portion of the variance was added into the error mean square. Following ANOVA, means were separated where appropriate using Tukey-Kramer HSD. All data was analyzed using JMP (SAS). The level of significance was set at 5%.

## RESULTS AND DISCUSSION

The ME's of the fats (Table 1) were similar to those found in the poultry National Research Council (1994). Six of the seven were similar, the exception being tallow. When calculated, tallow had a value >9,000 Kcal/kg. Wiseman *et al*. (1986) found that the ME for tallow could vary from 6,633-9,353 Kcal/kg. Muztar *et al*. (1981) also found tallow to range from 8,460-10,640 Kcal/kg, indicating that a high ME value for tallow is not uncommon.

Table 1: Calculated ME of the seven rendered fat sources

| Fat source | ME (Kcal/kg) |
|---|---|
| Yellow Grease | 8268 |
| VA (vegetable-animal blend) | 8124 |
| Soybean Oil | 8196 |
| Poultry Fat | 8220 |
| Lard | 8386 |
| Palm Oil | 8561 |
| Tallow | 9144 |

[1]ME of each fat source was calculated using the method described by Sibbald (1976)

The results for performance are shown in Table 2-4 and show that between the seven fats, there were few statistical differences in performance. Growth of the birds was good at almost 3 kg at 7 weeks. Feed: gain ratio during each phase or over the course of the study showed few differences with the lard having a slightly lower feed: gain. Previous research by our lab has not shown any benefits to lard relative to other fats, so we do not see this as an important response. Yield data (Table 5) also showed no significant differences or trends.

Table 2: Means for the adjusted feed:gain ratios per bird for the 3, 5 and 7 week growth period

| Fat source | 0-3 week (kg/kg) | 0-5 week (kg/kg) | 0-7 week (kg/kg) |
|---|---|---|---|
| Soybean Oil | 1.38 | 1.60 | 1.87b |
| Yellow Grease | 1.38 | 1.56 | 1.85b |
| Poultry Fat | 1.38 | 1.58 | 1.85b |
| Tallow | 1.40 | 1.61 | 1.83ab |
| HAPVA | 1.42 | 1.63 | 1.86b |
| Lard | 1.40 | 1.52 | 1.77a |
| Palm Oil | 1.42 | 1.56 | 1.88b |

[1]Level of significance ($p<0.05$)

A number of different fat sources are available for poultry from the vegetable sources and the rendering industry. A variety of the fats available were tested in this study and few differences were noted. One of the major concerns relative to fat usage is the actual ME value that should be assigned to each fat source. This number is often difficult to determine in a practical sense and based on these data appear to have little practical value in diet formulation. Differences in determined ME values relative to the actual feeding value may be due to an extra caloric effect (Jensen *et al*., 1970; Horani and Sell, 1977), whereby it affects the nutrient availability of other

Table 3: Means for the adjusted broiler feed intake for the 3, 5 and 7 week growth period

| Fat source | 0-3 week (kg/bird/phase) | 0-5 week (kg/bird/phase) | 0-7 week (kg/bird/phase) |
|---|---|---|---|
| Soybean Oil | 1.05 | 3.07 | 5.32 |
| Yellow Grease | 1.05 | 3.06 | 5.44 |
| Poultry Fat | 1.05 | 3.06 | 5.39 |
| Tallow | 1.05 | 3.07 | 5.47 |
| HAPVA | 1.06 | 3.08 | 5.49 |
| Lard | 1.05 | 2.87 | 5.24 |
| Palm Oil | 1.06 | 3.03 | 5.51 |

[1]Level of significance ($p<0.05$)

Table 4: Means for broiler gain for the 3, 5 and 7 week growth period

| Fat source | 0-3 week (kg/bird/phase) | 0-5 week (kg/bird/phase) | 0-7 week (kg/bird/phase) |
|---|---|---|---|
| Soybean Oil | 0.77 | 1.92 | 2.85 |
| Yellow Grease | 0.76 | 1.96 | 2.95 |
| Poultry Fat | 0.76 | 1.93 | 2.92 |
| Tallow | 0.75 | 1.92 | 2.99 |
| HAPVA | 0.74 | 1.89 | 2.96 |
| Lard | 0.75 | 1.88 | 2.97 |
| Palm Oi | 0.75 | 1.95 | 2.94 |

[1]Level of significance ($p<0.05$)

Table 5: Day 50 processing and yield data

| Fat source (g) | Live Wt. (kg) | Fat pad (g) | Cold carcass (g) | Leg (g) | Thigh (g) | Wing (g) | Maj. Breast (g) | Min. Breast |
|---|---|---|---|---|---|---|---|---|
| Soybean Oil | 2.89 | 48 | 2147 | 149 | 177 | 123 | 256 | 50 |
| Yellow Grease | 2.92 | 53 | 2174 | 150 | 180 | 125 | 258 | 51 |
| Poultry Fat | 2.99 | 60 | 2215 | 156 | 186 | 126 | 262 | 53 |
| Tallow | 2.89 | 52 | 2136 | 148 | 182 | 124 | 247 | 51 |
| VA* | 2.90 | 52 | 2172 | 150 | 180 | 124 | 251 | 48 |
| Lard | 2.91 | 50 | 2188 | 150 | 173 | 128 | 246 | 50 |
| Palm Oil | 2.93 | 51 | 2166 | 149 | 180 | 125 | 248 | 51 |

[1]Level of significance ($p<0.05$). *VA = Vegetable-animal blend

Table 6: Percent composition of diets for broilers

| Ingredients (%) | 0-3 week starter diet (%) | 3-5 week grower diet (%) | 5-7 week finisher diet |
|---|---|---|---|
| ME (Kcal/kg) | 3075 | 3150 | 3200 |
| Ground Corn | 56.914 | 64.542 | 69.660 |
| Soybean Meal | 31.802 | 25.183 | 20.568 |
| Porkmeal | 6.579 | 5.884 | 5.562 |
| Avatec | 0.050 | 0.050 | 0.050 |
| Baciferm | 0.050 | 0.050 | 0.050 |
| Trace Mineral Premix[1] | 0.100 | 1.000 | 0.100 |
| Choline Chloride | 0.067 | 0.000 | 0.018 |
| Copper Sulfate | 0.013 | 0.013 | 0.013 |
| Dicalcium Phosphate | 0.377 | 0.040 | 0.000 |
| DL-Methionine | 0.125 | 0.040 | 0.004 |
| Fat | 3.000 | 3.000 | 3.000 |
| Salt | 0.250 | 0.250 | 0.250 |
| Sodium Bicarbonate | 0.200 | 0.200 | 0.200 |
| Vitamin Premix[2] | 0.075 | 0.075 | 0.075 |
| Selenium Premix[3] | 0.030 | 0.030 | 0.030 |
| Lime Stone | 0.368 | 0.544 | 0.421 |

[1]Trace mineral premix analysis: Ca 2.50%, Fe 6.0%, Mg 2.68%, Mn 11.0%, Zn 11.0%, I 2,000 ppm. K 2 mg, Thiamin 1.8 mg, Riboflavin 4.5 mg, Pyridoxine 3.5 mg, Folic acid 0.55 mg, Miacin 35, mg, Pantothenic acid 14 mg, Choline 1,300 mg. [2]Vitamin premix provided per kilogram of diet: vitamin A 1,500 IU, D 200 IU, E 10 IU. [3]Selenium premix analysis: Ca 36.08%, Se 0.06%. [4]All values are a percentage of the diet except ME which is calculated in (Kcal/kg)

ingredients. This was noted in our lab where it was found that fat additions resulted in digestibility of MBM being increased (Firman and Remus, 1994). Early work on use of fat in poultry rations generally indicated a higher ME value for unsaturated vegetable oils when compared to animal products or products with high free fatty acid content (Seidler *et al.*, 1955; Young, 1961; Waldroup *et al.*,1995), but that was not the case in this experiment. Most experiments indicated no difference in performance parameters when different fat sources were fed (Seidler *et al.*, 1955; Young, 1961; Fuller and Rendon, 1979; Fuller and Rendon, 1977; Pesti *et al.*, 2002; Quart *et al*., 1992), similar to the results presented here. Several reasons may be postulated why the differences seen in energy value in an ME analysis do not translate into differences in actual performance when added to complete diets. One of these is that the improvement in utilization of other dietary components is equally enhanced by different sources regardless of ME content. A more obvious answer may be the relatively small difference in ME content of a total ration at typical fat inclusion levels. In other words, if 2 fats of 7,000 and 8,000 kcal/kg ME are fed at 3% of the diet, the difference in ME content of the complete ration is only 30 kcal/kg, or <1%, of the total dietary energy. This type of difference is very small and would be very difficult to pick up experimentally. Similar results have been seen in a battery study (Pesti *et al*., 2002) and previously in a floor pen trial (Leeson and Atteh, 1995).

Based on these data, it appears that any differences found in ME values do not translate into differences in performance or yield of broilers. It is suggested that fat source used should be selected based on price.

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