FATS AND PROTEINS RESEARCH FOUNDATION, INC.

Director's Digest

FRED D. BISPLINGHOFF, D.V.M.
Director Technical Services

7150 ESTERO BLVD • APT. 906
FT. MYERS BEACH, FL 33931
AREA CODE 813 — 463-4744
FAX 813 — 463-1315

JUNE 1992 No. 228

# EFFECTS OF POULTRY FAT AND YELLOW GREASE ON BROILER PERFORMANCE AND PROFITABILITY

M. D. Ouart, B. L. Damron, F. G. Martin,
R. B. Christmas, and D. R. Sloan
Institute of Food and Agricultural Sciences
Poultry Science Department
University of Florida

## INTRODUCTION

Poultry fat (PF) is the feed fat of choice for broiler producers because of its relatively high ME and superior effect on feed conversion (Fuller and Rendon, 1977). A relative cost advantage is often obtained with PF because it is frequently rendered from processing plant offal (as part of vertically integrated broiler firm operations) and recycled in their feeds. Poultry fat is tentatively defined for trading purposes as an animal fat primarily obtained from the tissue of poultry in commercial processes of rendering or extraction. It should contain not less than 90% total fatty acids and not more than 3% unsaponifiables and impurities and have a minimum titer of 33 C (Association of American Feed Control Officials, 1990).

Yellow grease (YG), a recycled restaurant grease, is defined for trading purposes as an inedible tallow or grease with a minimum titer of 36 C, maximum free fatty acid content of 15% and minimum Fat Analysis Committee (FAC) color value of 37 (National Provisioner Daily Market Service, 1988). Yellow grease is further tentatively classified as a Fat Product, Feed Grade (Association of American Feed Control Officials, 1990). Burton

(1989) explained that although low-titer composite oils, dark color, and relatively high free fatty acid content had kept YG out of market channels for high-quality tallows, it has been long used as a feed fat. Additionally, both quality and quantities of YG have increased as a result of the development of the United States fast and convenience food industries. However, concern exists in some regions regarding the use and quality of YG. Much of that concern is associated with its lack of resistance to oxidation as measured by methods commonly used in the feed industry.

Halloran (1986a,b) reviewed the topic of feed fats for poultry diets. He reported that: 1) potential exists for wide variations in commercial laboratory values for fat oxidation levels (expressed as initial peroxide value or IPV) and levels of stability against oxidation (expressed as 20-h active oxidation method, or AOM value); 2) AOM tests are not applicable in determining oxidation potential of free fatty acids; 3) study of the effect of oxidation on feed value of fats has concentrated on fats rapidly oxidized using very high temperatures that are not common to normal fat storage conditions; and 4) little practical information was available to correlate commonly used fat quality standards with bird performance results.

The use of blends of fats such as those from animal and plant sources has resulted in improved performance due to certain fat synergisms (Garrett and Young, 1975; Sibbald and Kramer, 1977; Hulan et al., 1984). Also, logistics problems in some geographic locations may require blending of PF with other feed grade fats during times of peak chick placements. Additional chick placements create conditions where the demand for feed fats outstrips the supply of PF. Prices of alternative fats as well as return over feed cost when different fats are fed are important in finding solutions to such logistics problems.

Few economic analyses utilizing various input and output values are available. Adams and Craig (1985) summarized the results of a number of laying hen studies and showed that statistical analysis of economic information over a variety of feed and egg prices could yield potentially meaningful management decision information. Hulan et al. (1984) analyzed returns over feed and chick costs in a study of various fats. No significant differences were found due to source of fat. However, feed costs remained constant regardless of fat source used.

Several studies have evaluated PF as a feed ingredient (Edwards et al., 1973; Fuller and Rendon, 1977; Griffiths et al., 1977; Hulan et al., 1984). Seidler et al. (1955), Young (1961), and Cullen et al. (1962) all reported the effects of YG on broiler performance. Among these, only Cullen et al. (1962) specifically compared PF and YG and found similar bird performance. Little information is available comparing these two fats and their blends in association with laboratory analyses for fat quality when stabilized and held under normal feed mill conditions. Therefore, three experiments were conducted to evaluate the use of PF, YG, or a blend of both to compare their suitability for broiler feeding.


Abstract

Three experiments were conducted to evaluate the use of poultry fat (PF) or yellow grease (YG) when fed to broilers. Experiments 1 and 2 were duplicate, 21-day studies, and experiment 3 compared the fats over a 42-day period. Treatments for Experiments 1 and 2 consisted of six replicates of eight battery-housed chicks that were fed 5% added fat as all PF, all YG or PF: YG blends of 90:10, 80:20, 70:30, 60:40, or 50:50. In Experiment 3, five replicate pens of 70 day-old broiler chicks were floor-reared and fed either all PF, all YG, or a 50:50 blend in diets containing 3.0 and 3.5% added fat in starter and finisher diets, respectively. Factored across fat source were two different fat stabilization times: 1) fresh from the rendering plant; and 2) held under feed mill conditions for 7 days.

All fat combinations performed comparably in terms of body weight, feed intake, feed conversion, and mortality rate. Fatty acid content and fat quality factors, including 20-h active oxygen method (AOM) determinations, were similar among fat sources. In Experiment 3, no differences were found due to stabilization time. Return over feed cost was not affected by any of the fat and stabilization time treatment combinations. No association was found between bird performance and AOM, suggesting that a better analytical procedure of fat quality was warranted. At levels tested, YG and PF-YG blends were found to be as suitable a feed fat source as PF.



(**Key words:** broilers, poultry fat, yellow grease, economic analysis, fat stabilization times)


Results and Discussion

Table 2 shows laboratory analysis values for samples of pure forms of fats used in experimental diets. Variation was found between fat sources and for the same fat compared across experiments. Nonetheless, values for moisture content, insoluble impurities, free fatty acid content, and IPV were all within suggested quality specifications for feed fats recommended by Ostby (1986). Similar levels of ethoxyquin were detected in all samples.

Stability against oxidation expressed as AOM values (Table 2) were all higher than the 20 meq peroxides/kg level suggested by Ostby (1986). The AOM values for both fats were 2.9 to 3.8 times higher in Experiment 3 as compared with average AOM values from Experiments 1 and 2. These results agree with Halloran (1986a), who reported considerable variations in both IPV and AOM measurements in checking the results from various commercial laboratories. He found AOM values to be the most variable, citing inadequate test equipment, cleanliness, inefficient temperature control, and improper procedures regarding test length as some of the reasons for variability.

Table 3 shows Experiment 3 IPV and AOM values from fats sampled at three different times: upon arrival from supplier and 10 and 21 days thereafter. The IPV values were not consistent over time within fat source. However, with the exception of the initial sample of PF stabilized after 7 days (5.2 meq peroxide/kg), the values all fell within the acceptable range of less than 5.0 meq peroxide/kg as reported by Ostby (1986). On the other hand, AOM values exceeded, by 4.4 to 8.4 times, the limits of 20 meq peroxides/kg (Ostby, 1986). Additionally, AOM values of fats over time showed higher values suggesting that the fats' potential for oxidation increased with time regardless of fat source and degree or time of stabilization.

The fatty acid profiles of samples are shown in Table 4. Overall, average composition values indicated that both PF and YG contained predominantly the same fatty acids. Fatty acids $C_{18:1}$, $C_{16:0}$, $C_{18:2}$, $C_{18:0}$, $C_{16:1}$, $C_{14:0}$, and $C_{18:3}$ made up over 94% of each fat source. Additionally, rank order of fatty acids was similar for poultry fat and yellow grease except that $C_{16:0}$ and $C_{18:2}$ were reversed as the second and third most prevalent. Minor differences were found for rank order and presence or absence of minor fatty acids (those present in one or both fats at less than .5%).

Pooled values for 21-day feed consumption, feed conversion, and body weight from Experiments 1 and 2 indicated no significant differences due to dietary fat treatment (Table 5). Similarly, no significant differences were found among these response variables for either fat source or stabilization time at 21 or 42 days of age for broilers in Experiment 3 (Table 6). In all three experiments mortality was very low (less than 3%) and not related to treatment. Therefore, data have not been presented.

Comparison of pooled 21-day data from Experiment 1 and 2 versus Experiment 3 (Tables 5 and 6) indicated similar growth responses. Feed conversions were slightly higher and body weights slightly lower, however, for the floor-reared birds in experiment 3 as compared with those from battery-reared birds in Experiments 1 and 2. Feed conversion rates were somewhat higher in Experiment 3 due to cool evening growing conditions and the fact that diets were not pelleted.

These results agree with those of Seidler et al. (1955), Young (1961), and Cullen et al. (1962), who reported similar performance for broilers fed YG when compared with other feed fats. The agreement of the current results with previous studies is particularly important in the context of reported quality improvements in YG over recent years (Burton, 1989).

Results due to stabilization time (Experiment 3) suggest that holding fats under feed mill conditions did not alter them in a way that resulted in significantly poorer bird performance (Table 6). This supports the report of Halloran (1986b), indicating that fat quality concerns regarding oxidation should not be based on results where fats had been subjected to very high (60 to 230 C) temperatures.

Laboratory values for AOM agreed with Halloran (1986a,b) in that exceptionally high values were found. These results coupled with growth responses consistently demonstrated the lack of a relationship of AOM values with broiler growth or feed efficiency.

Table 6 shows the return over feed cost results generated from performance response variables in Experiment 3. Neither fat source nor stabilization time resulted in significant differences in returns. These results agree with Hulan et al. (1984).

The present data show that the fat sources (PF, YG, or blends of the two) were equally effective. Also, results of Experiment 3 indicated that a 7-day delay in final stabilization did not significantly affect performance. The absence of a positive relationship between AOM and performance results supports Halloran's (1986b) suggestion that a better analytical procedure needs to be developed to evaluate feed fat quality.

Economic analysis results supported the growth data and indicated that all fat sources were equally suitable for use in broiler diets. Furthermore, results show that a blend of PF and YG could be used effectively to supply regional poultry fat shortages associated with high chick placements.

References

Adams, A. W., and J. V. Craig, 1985. Effect of crowding and cage shape on productivity and profitability of caged layers: a survey. Poultry Sci. 64:238-242.

Association of American Feed Control Officials, 1990. Feed ingredient definitions. Pages 144-145 in: Official Publication 1990. Association of American Feed Control Officials, Inc., Atlanta, GA.

Burton, F., 1989. Restaurant grease: how much is out there? Render (June, 1989):10-11, 16.

Cullen, M. P., O. G. Rasmussen, and O. H. M. Wilder, 1962. Metabolizable energy values and utilization of different types and grades of fat by the chick. Poultry Sci. 41:360-367.

Edwards, H. M., F. Denman, A. Abou-Ashour, and D. Nugara, 1973. Carcass composition studies: 1. Influences of age, sex and type of dietary fat supplementation on total carcass and fatty acid composition. Poultry Sci. 52:934-948.

Fuller, H. L., and M. Rendon, 1977. Energetic efficiency of different dietary fats for growth of young chicks. Poultry Sci. 56:549-557.

Garrett, R. L., and R. J. Young, 1975. Effect of micelle formation on the absorption of neutral fat and fatty acids by chickens. J. Nutr. 105:827-838.

Griffiths, L., S. Leeson, and J. D. Summers, 1977. Influence of energy system and level of various fat sources on performance and carcass composition of broilers. Poultry Sci. 56:1018-1026.

Halloran, H. R., 1986a. Feed fats: Important ingredients in poultry diets (Part 1). Feedstuffs 58(35): 14, 17-18.

Halloran, H. R., 1986b. Feed fats: Important ingredients in poultry diets (Part 2). Feedstuffs 58(39): 13-15, 41.

Hulan, H. W., F. G. Proudfoot, and D. M. Nash, 1984. The effects of different dietary fat sources on general performance and carcass fatty acid composition of broiler chickens. Poultry Sci. 63:324-332.

National Provisioner Daily Market Service, 1988. Daily Market and News Service Yellow Sheet. Series OM Number 24. Daily Market and News Service, Chicago, IL.

National Research Council, 1984. Nutrient Requirements of Poultry. 8th rev. ed. National Academic Press, Washington, DC.

Ostby, P., 1986. Guidelines for fats used in feeds. Pages 45-47 in: Proceedings of 1986 Meetings of the American Feed Industry Association Nutrition Council. American Feed Industry Association, Arlington, VA.

SAS Institute, 1985. SAS® Procedures Guide for Personal Computers. Version 6 Edition. SAS Institute Inc., Cary, NC.

Seidler, A. J., H. E. Scheid, and B. S. Schweigert, 1955. Effects of different grades of animal fats on the performance of chicks. Poultry Sci. 34:411-414.

Sibbald, I. R., and J.K.G. Kramer, 1977. The true metabolizable energy values of fats and fat mixtures. Poultry Sci. 56:2079-2086.

Young, R.J., 1961. The energy value of fats and fatty acids for chicks. Poultry Sci. 40:1225-1233.

TABLE 1. Composition of experimental diets (Experiments 1, 2, and 3)[1]

| Ingredients | Experiments 1 and 2 | Experiment 3 | |
|---|---|---|---|
| | Starter diet[2] | Starter diet[3] | Finisher diet[3] |
| | (%) | | |
| Yellow corn | 53.59 | 55.24 | 62.40 |
| Soybean meal (48.5% CP) | 37.45 | 37.43 | 30.20 |
| Fat source[4] | 5.00 | 3.00 | 3.50 |
| Limestone | 1.08 | 1.18 | 1.10 |
| Dicalcium phosphate (22% Ca:18.5% P) | 1.75 | 2.04 | 1.82 |
| DL-methionine | .18 | .18 | .05 |
| Iodized salt | .35 | .33 | .33 |
| Microingredients[5] | .50 | .50 | .50 |
| Monensin | .10 | .10 | .10 |

[1]All diets calculated to contain amino acids to meet National Research Council (1984) specifications for broiler starter and finisher diets.

[2]Calculated to contain 3,170 kcal ME/kg.

[3]Calculated to contain 3,027 and 3,135 kcal ME/kg for starter and finisher diets, respectively.

[4]Fat sources: all poultry fat (PF), all yellow grease (YG), or various PF:YG blends; all fats calculated to contain 8,184 kcal ME/kg.

[5]Supplied the following activities per kilogram of diet: vitamin A, 6,600 IU; cholecalciferol, 2,200 ICU; menadione dimethylpyrimdinol bisulfite, 2.2 mg; riboflavin, 4.4 mg; pantothenic acid, 13.2 mg; niacin, 39.6 mg; choline chloride, 499 mg; vitamin $B_{12}$, .022 mg; ethoxyquin, 125 mg; manganese, 60 mg; iron, 50 mg; copper, 6 mg; iodine, 1.1 mg; zinc, 35 mg; selenium, .1 mg.

TABLE 2. Fat analysis values for Experiments 1, 2, and 3[1]

| Measurement | Average for Experiments 1 and 2[2] | | Experiment 3 | |
|---|---|---|---|---|
| | Poultry fat | Yellow grease | Poultry fat | Yellow grease |
| Moisture content, % | .10 | .40 | .41 | .44 |
| Insoluble impurities, % | .40 | .02 | .05 | .04 |
| Free fatty acid content, % | 10.79 | 19.40 | 7.85 | 7.93 |
| Initial peroxide number oxidation value, meq/kg | 1.40 | 4.30 | 1.60 | 3.40 |
| 20-h Active oxygen method oxidation value, meq/kg | 34.00 | 32.00 | 98.00 | 120.00 |
| Ethoxyquin content, mg/kg | 108.00 | 109.00 | 108.00 | 109.00 |

[1]All analysis values were determined from duplicate, coded samples of each fat upon delivery from the fat rendering firm.

[2]Consistent values were found for fats of Experiments 1 and 2 and are expressed as average values.

**TABLE 3. Fat analysis values for initial peroxide value (IPV) and 20-h active oxygen method (AOM) determinations over time (Experiment 3)**

| Treatment combination | Initial[1] IPV | Initial[1] AOM | Initial plus 10 days[2] IPV | Initial plus 10 days[2] AOM | Initial plus 21 days[3] IPV | Initial plus 21 days[3] AOM |
|---|---|---|---|---|---|---|
| | (meq peroxide/kg) | | | | | |
| Poultry fat | | | | | | |
| Stabilized fresh | 1.6 | 98 | 1.8 | 102 | 1.0 | 130 |
| Stabilized after 7 days | 5.2 | 88 | 1.6 | 132 | 4.2 | 146 |
| Yellow grease | | | | | | |
| Stabilized fresh | 3.4 | 120 | 2.6 | 112 | 4.0 | 156 |
| Stabilized after 7 days | 3.1 | 9.2 | 4.0 | 104 | 2.6 | 168 |

[1]Samples taken prior to final stabilization with 300 ppm ethoxyquin at two different times; for "stabilized fresh", sampled when delivered from fat rendering firm; for "stabilized after 7 days", sampled after being held 7 days under feed mill conditions.

[2]Samples taken after final stabilization with 300 ppm ethoxyquin; all samples taken after 10 days storage at 4 C when starter diets were mixed.

[3]Samples taken after final stabilization with 300 ppm ethoxyquin; all samples taken after 21 days storage at 4 C when finisher diets were mixed.

**TABLE 4. Fatty acid content of poultry fat and yellow grease (Experiments 1, 2, and 3)[1]**

| Fatty acid | Poultry fat: Average for Experiments 1 and 2[2] | Poultry fat: Experiment 3 | Poultry fat: Overall average | Yellow grease: Average for Experiments 1 and 2[2] | Yellow grease: Experiment 3 | Yellow grease: Overall average |
|---|---|---|---|---|---|---|
| | (%) | | | | | |
| Oleic ($C_{18:1}$) | 43.30 | 43.61 | 43.46 | 47.70 | 45.83 | 46.62 |
| Palmitic ($C_{16:0}$) | 21.10 | 19.64 | 20.37 | 17.60 | 16.74 | 17.17 |
| Linoleic ($C_{18:2}$) | 18.20 | 18.62 | 18.41 | 17.70 | 18.78 | 18.24 |
| Stearic ($C_{18:0}$) | 7.90 | 8.49 | 8.20 | 11.00 | 10.50 | 10.75 |
| Palmitoleic ($C_{16:1}$) | 5.80 | 4.92 | 5.36 | 2.30 | 2.04 | 2.17 |
| Myristic ($C_{14:0}$) | 1.00 | .96 | .98 | 1.20 | 1.06 | 1.13 |
| Arachidic ($C_{20:0}$) | 1.00 | 0 | .50 | 1.10 | 0 | .55 |
| Linolenic ($C_{18:3}$) | .60 | 1.14 | .87 | .70 | 1.50 | 1.10 |
| Behenic ($C_{22:0}$) | 0 | .54 | .27 | .40 | .58 | .49 |
| Gadoleic ($C_{20:1}$) | 0 | .47 | .24 | 0 | .70 | .35 |
| Myristoleic ($C_{14:1}$) | .30 | .18 | .24 | .20 | .24 | .22 |
| Hexadecanoic ($C_{16:2}$) | 0 | .38 | .19 | 0 | .59 | .30 |
| Lignoceric ($C_{24:0}$) | 0 | .38 | .19 | 0 | .32 | .16 |
| Heptadecanoic ($C_{17:0}$) | .30 | 0 | .15 | .40 | 0 | .20 |
| Margaraleic ($C_{17:1}$) | 0 | .23 | .12 | 0 | .32 | .16 |
| Arachadonic ($C_{20:4}$) | .20 | 0 | .10 | 0 | 0 | 0 |
| Lauric ($C_{12:0}$) | .10 | .10 | .10 | 0 | .10 | .05 |
| Pentadecanoic ($C_{15:0}$) | .10 | .10 | .10 | .10 | .18 | .14 |

[1]Total fatty acid contents that do not add to 100% are due to rounding of individual fatty acid values.

[2]Consistent values were found for fats of Experiments 1 and 2 and are expressed as average values.

**TABLE 5. Means for 21-day feed consumption, feed conversion, and body weight (Experiments 1 and 2)[1]**

| Treatments | Feed consumption | Feed conversion (feed:body weight) | Body weight |
|---|---|---|---|
| (Poultry fat:yellow grease) | (g per bird per day) | (g:g) | (g) |
| 100:0 | 41 | 1.43 | 618 |
| 90:10 | 40 | 1.40 | 612 |
| 80:20 | 40 | 1.44 | 601 |
| 70:30 | 41 | 1.44 | 608 |
| 60:40 | 40 | 1.38 | 611 |
| 50:50 | 42 | 1.45 | 616 |
| 0:100 | 40 | 1.46 | 605 |

[1]Data pooled over two, 21-day experiments.

**TABLE 6. Means for 21-day and 42-day feed consumption, feed conversion, body weight, and 42-day return over feed cost (Experiment 3)**

| Treatments | Feed consumption | | Feed conversion (feed:body weight) | | Body weight | | Return over feed cost (42-day)[1] |
|---|---|---|---|---|---|---|---|
| | 21-day | 42-day | 21-day | 42-day | 21-day | 42-day | |
| | (g per bird per day) | | (g:g) | | (g) | | ($ per 1,000 birds)[2] |
| Fat source | | | | | | | |
| All poultry fat | 39 | 76 | 1.46 | 1.96 | 558 | 1,640 | 423.80 |
| All yellow grease | 39 | 76 | 1.46 | 1.96 | 558 | 1,646 | 425.20 |
| Blend[3] | 40 | 76 | 1.47 | 1.96 | 562 | 1,640 | 425.40 |
| Stabilization time[4] | | | | | | | |
| Stabilized fresh | 39 | 77 | 1.46 | 1.96 | 564 | 1,650 | 428.30 |
| Stabilized after 7 days | 39 | 76 | 1.46 | 1.97 | 555 | 1,635 | 421.20 |
| Sex | | | | | | | |
| Male | | | | | 568[a] | 1,721[a] | |
| Female | | | | | 550[b] | 1,563[b] | |

[a,b]Means within a column and treatment with no common superscripts are different (P<.05).

[1]Feed price assumptions calculated (without price of added fat) were $176.20/metric ton and $162.40/metric ton for starter and finisher diets, respectively (based on reported prices of feed ingredients). Added fat prices (based on average reported prices) were assumed to be 22.5 and 23.8¢/kg for poultry fat and yellow grease, respectively. Feed cost per treatment combination was based on pen 42-day feed consumption values without adjustment due to mortality.

[2]Returns were calculated based on bird income values derived from 42-day pen body weight values assuming the live bird price of 63.9¢/kg.

[3]Treatment consisted of a 50:50 blend of poultry fat and yellow grease.

[4]Treatments varied by time of addition of 300 ppm ethoxyquin.