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Title: **Utilization of rendered fats in comparison with soybean oil in rations of broilers from hatch to market.**

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B. Industry Summary/abstract

Fat utilization in broiler rations in the US has been established for many years. In many other countries however, use of fats have been sporadic and at much lower levels and with an emphasis on vegetable fats. This project attempted to address both of these issues relative to fat use. In international markets, soybean oil is the preferred fat source as it is perceived as the highest quality fat available. It often sells at a multiple of greater than 2x that of imported US yellow grease and thus makes no economic sense unless it has a substantially greater benefit in terms of the performance of the bird. Relatively speaking little work on use of fats has been performed in the past 20 years. While there has been a good bit of work relative to the energy contents of a variety of fat sources (please see NRC, 1994 table 9.9), there has been less work relating how these numbers relate to real world performance. The objectives of this work were : a)To compare various fat sources fed at similar levels to demonstrate that the differences in energy content seen in a digestibility assay have little practical significance at typically fed fat levels; and b) To show the benefits of fat additions through a titration of energy in broiler rations using the fats tested above. Two broiler floor pen trials were conducted. In the first trial, seven different fat sources were utilized at industry standard levels (based on Agri-Stats or communication with industry nutritionists) from hatch to 7 weeks of age. Seven replicate pens of birds will be utilized in a randomized block design with location within the facility as the blocking factor. Birds were weighed and feed intake 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. The second trial will utilize a 2 x 4 factorial treatment arrangement (6 replicate pens) to test soybean oil versus a rendered product versus an animal vegetable blend at 4 different levels of energy. Diets will be formulated to the industry standard levels used in the initial trial as well as 3 additional diets with energy increasing at 100 kcal/kg increments. Thus if the starter diet is 3075 kcal, the additional diets will contain 3175, 3275 and 3375 based on energy content of the rendered product. Soybean oil will replace the rendered fat on a 1:1 basis rather than being adjusted for differential energy content. Similar procedures will be utilized as in the first trial with weights obtained at diet changes of 21, 35 and 49 days of age. Results for the first study found no differences in any of the parameters measured, suggesting that the choice of fat source should be based on economics rather than perceived differences. Results for the second study found no differences in body weight at the conclusion of the trial, but increased energy content resulted in improved feed efficiency at the conclusion of the trial.

Keywords: Poultry , broiler, energy, fat

C. Objectives:

a) To compare various fat sources fed at similar levels to demonstrate that the differences in energy content seen in a digestibility assay have little practical significance at typically fed fat levels.
b) To show the economic benefits of fat additions through a titration of energy in broiler rations using the fats tested above.

D. Experimental design

Two broiler floor pen trials were conducted. In the first trial, seven different fat sources were utilized at industry standard levels (based on Agri-Stats or communication with industry nutritionists) from hatch to 7 weeks of age. Seven replicate pens of birds were utilized in a randomized block design with location within the facility as the blocking factor. Each block will then have the different fat sources randomized within the block. Chicks will be industry sourced from a common cross such as Cobb-Cobb and housed and raised under standard conditions in a curtain-sided building. All procedures will conducted in accordance with our standard operating procedures which are similar to GLP procedures (available upon request) and the University of Missouri Animal Care and Use Committee under an approved protocol. Birds will be weighed and feed intake quantitated at 21, 35 and 49 days of age with cut-up and yield at 50 days of age. Diets will consist primarily of corn, soybean meal and animal by-product meal. All diets will meet or exceed NRC specifications.

The second trial utilized a 2 x 4 factorial treatment arrangement (6 replicate pens) to test soybean oil versus an animal vegetable blend at 4 different levels of energy. Diets will be formulated to the industry standard levels used in the initial trial as well as 3 additional diets with energy increasing at 100 kcal/kg increments. Thus if the starter diet is 3075 kcal, the additional diets will contain 3175, 3275 and 3375 based on energy content of the rendered product. Soybean oil will replace the rendered fat on a 1:1 basis rather than being adjusted for differential energy content. Similar procedures will be utilized as in the first trial with weights obtained at diet changes of 21, 35 and 49 days of age.

Samples of the following fats sufficient to run the experiments were obtained: yellow grease, poultry fat, tallow, soybean oil, animal/vegetable blend, palm oil and lard. Each of these fats were screened for MIU and free fatty acid profile as well as metabolizable energy content.

All treatments were analyzed by ANOVA based on the experimental designs noted. Means will be separated with LSD where appropriate.

E. Results and Discussion

Results for the first study are found in tables 1 and 2. Birds on all treatments performed very well with final body weights approaching 3 kg. No differences in any of the parameters measured were noted, suggesting that the choice of fat source should be based on economics rather than perceived differences. While numerous analyses suggest that there are differences in ME of different fat sources, there is no indication that these differences are of consequence in a practical formulation. Although not of statistical significance, the highest numerical growth rates were found in the more saturated animal fats (lard and tallow).

Results for the second study are found in tables 3 and 4. Again performance of broilers was quite good with body weight gain over 3 kg at 7 weeks. No differences were observed in body weight at the conclusion of the trial, but increased energy content resulted in improved feed efficiency at the conclusion of the trial as expected although the differences seen were perhaps less dramatic than some research in the past. Recent data has shown a reduced caloric intake per pound of body weight gain in modern

broilers which may mean that birds will have less response to added energy than in the past.

Conclusions

1- Utilization of any of the commonly available fats will result in similar performance.
2- Fat additions should probably be made based on economic considerations rather than criteria such as fatty acid profiles.
3- Increasing energy in the diet through fat addition improves feed efficiency.

Table 1. 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	1.87
Yellow Grease	1.38	1.56	1.85
Poultry Fat	1.38	1.58	1.85
Tallow	1.40	1.61	1.83
HAPVA	1.42	1.63	1.86
Lard	1.40	1.52	1.77
Palm Oil	1.42	1.56	1.88

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

Table 2. Means for the Average 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 Oil	0.75	1.95	2.94

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

Table 3. Metabolizable Energy of Fat Sources

Fat Source	ME (Kcal/kg)
Yellow Grease	7268
HAPVA	8124
Soybean Oil	8197
Poultry Fat	8220
Lard	8386
Palm Oil	8561
Tallow	9144

Table 4. Means for the Adjusted Feed:Gain Ratios per Bird for the 3, 5 and 7 Week Growth Period

Energy Source	Treatment	0-3 Week (kg:kg)	0-5 Week (kg:kg)	0-7 Week (kg:kg)
Soybean Oil				
	1	1.51	1.64	1.87^{AB}
	2	1.44	1.62	1.84^{BC}
	3	1.42	1.63	1.83^{BC}
	4	1.51	1.63	1.82^{BC}
HAPVA				
	5	1.50	1.67	1.91^{A}
	6	1.48	1.65	1.86^{ABC}
	7	1.51	1.65	1.84^{BC}
	8	1.60	1.67	1.81^{C}

[1]Means in the same column bearing different subscripts are significantly different ($P<0.05$).

Table 5. Means for the Average Broiler Gain for the 3, 5, and 7 Week Growth Period

Energy Source	Treatment	0-3 Week (kg/bird/phase)	0-5 Week (kg/bird/phase)	0-7 Week (kg/bird/phase)
Soybean Oil				
	1	0.72	1.91[A]	3.28
	2	0.74	1.88[AB]	3.28
	3	0.73	1.78[BC]	3.08
	4	0.70	1.74[C]	3.07
HAPVA				
	5	0.73	1.90[A]	3.24
	6	0.74	1.90[AB]	3.24
	7	0.71	1.88[AB]	3.31
	8	0.72	1.89[AB]	3.28

[1]Means in the same column bearing different subscripts are significantly different ($P<0.05$).

F. Fat Analyses

ESCL # Units Dept #	10304 W/W % Soy Oil	10305 W/W % Yellow grease	10306 W/W % Poultry Fat	10307 W/W % Palm Oil	10308 WW% Ani-Veg Blend	10309 WW% Tallow	10310 WW% Lard
Moisture	0.10	0.17	0.50	0.23	0.63	0.34	0.05
Insolubles	0.0093	0.0052	0.0107	0.0078	0.0050	0.0500	0.0331
Unsaponifuables	0.45	0.41	0.49	0.27	1.10	0.46	0.25
Fat	>99.25%	>99.25%	>99.25%	>99.25%	>99.25%	>99.25%	>99.25%
Myristic (14:0)	0	0	0.62	0.95	0.53	2.41	1.53
Myristoleic (14:1)	0	0	0	0	0	0.40	0
(C15:0)	0	0	0	0	0	0.51	0
Palmitic (16:0)	9.97	9.86	12.74	37.55	13.11	23.68	27.86
Palmitoleic (16:1)	0	0	0.81	0	0.75	3.05	2.15
(17:0)	0	0	0.25	0	0.30	1.33	0.51
(17:1)	0	0	0	0	0.27	0.67	0.35
Stearic (18:0)	4.53	4.59	7.01	4.60	7.32	20.63	17.11
Elaidic (18:1*t9*)	0.46	0	5.42	0	5.87	3.06	1.04
Oleic (18:1*n9*)	22.22	21.67	31.20	44.99	30.25	33.14	39.28
Vaccenic (18:*1n7*)	1.36	1.18	1.79	0	1.74	0	2.53
Linoleic (18:2)	52.47	51.93	29.48	10.64	30.84	1.37	3.48
Linolenic (ω 18:3)	7.72	7.87	0.45	0.50	3.30	0.70	0
(ω18:4)	0	0.36	0.57	0	0.38	0.64	0.54
Arachidic (20:0)	0.36	0.50	0.58	0.44	0.47	0.45	0.43
(20:1n9)	0	0.26	3.27	0	0	0.26	1.18
Arachidonic(20:4*n6*)	0	0	0	0	0.32	0.22	0
Docosanoic (22:0)	0	0.75	0.60	0	0.73	0.28	0
Erucic (22:1*n9*)	0	0	0.26	0	0	0	0
Lignoceric (24:0)	0	0.35	0	0	0.35	0	0

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