Methyl Esters of Tallow Fatty Acids in a Poultry Ration

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In two trials with Indian River Cross chicks 3, 5, and 7 and 7, 11, and 15% of No. 2 tallow methyl esters were substituted for milo in a practical soybean meal chick ration. Control groups were fed 7, 11, and 15% of the tallow from which the esters were prepared. The rations with 7, 11, and 15% lipide also contained 0.3% methionine. One 15% methyl ester group without methionine was added as a control. It was found that 3 to 15% of methyl esters are not toxic to poultry as measured by the rates and efficiencies of gain. During the first 5 weeks, at least, methyl esters and tallow increase the feed efficiency in proportion to the increased caloric value of the rations. Neither influences rate of growth. On high-fat rations added methionine increases the growth rate and feed efficiency of female but not male chicks, at least through 6 weeks of age. Methyl esters mix quickly, easily, and smoothly with a dry ration.

THE PRODUCTION OF INEDIBLE FATS AND OILS has exceeded the demand (*1*, *2*), during the past few years. The price, therefore, has been reduced to the level where these products can compete with corn and other sources of energy, in the manufacture of feeds for livestock.

For the most part, studies on the utilization of fats added to animal feeds have been confined to the better grades of tallow (*3*, *5*, *6*). To take full advantage of the price structure, however, it would be desirable to use the lower grades of tallows and greases (*4*, *7*) or even acidulated soap stock.

The higher grades of tallow have several disadvantages. Because its relatively high melting point causes the tallow to solidify in tanks and pipes in cold weather, and it is often difficult to mix it without lumpiness, special equipment for adding fat to animal feeds is almost essential.

A possible solution to some of these problems is to convert inexpensive fats of high free fatty acid content to their methyl or ethyl esters. The esters, having a lower melting point than either the corresponding fatty acids or glycerides are easier to handle. Because of their lower viscosity and surface tension, they mix very readily, spread thinner, and keep dust down in a feed at a lower level than either fatty acids or glycerides.

Ethyl esters have a lower melting point than methyl esters, and the alcohol is known to be nontoxic. On the other hand, dry ethanol is considerably more expensive than dry methanol, its use requires government supervision, and it cannot be recycled for ester formation after it has been diluted with water, because it forms an azeotrope. Methanol does not form an azeotrope with water and may readily be distilled from water and recycled.

A survey of the literature revealed little information on the level at which methyl esters may be fed to farm animals without toxic symptoms, and no comparisons appear to have been published on the relative effects of esters and glycerides on growth and feed efficiency.

Table I. Basal Ration of Chicks Fed Methyl Esters and Tallow

Constituent	%
Soybean oil meal	35.0
Ground yellow corn	30.0
Ground milo[a]	28.0
Alfalfa leaf meal	3.0
Dicalcium phosphate	2.0
Ground oyster shell	1.5
Salt	0.5
Manganese sulfate, g./100 lb.	8.0
Methionine[b]	0.3
Vitamins and Antibiotics Added per Pound of Feed	
Riboflavin, mg.	2.0
Pantothenic acid, mg.	5.0
Niacin, mg.	12.5
Choline, mg.	400.0
Penicillin, mg.	1.0
Bacitracin, mg.	2.5
Vitamin A, I.U.	2270.0
Vitamin D, I.U.	600.0
Vitamin B_{12}, γ	3.0

[a] Methyl esters and tallow substituted for milo, pound for pound.
[b] Substituted for milo in second series of tests.

It was decided, therefore, to test the toxicity, growth, and feed efficiency factors of methyl esters prepared from No. 2 tallow at 3, 5, 7, 11, and 15% of the diet, and to compare the esters to tallow at the 7, 11, and 15% levels.

Experimental

Rations. The basal ration is given in Table I. Tallow methyl esters and tallow were substituted for milo pound for pound. Because of the increase in caloric value of the rations containing higher levels of fatty material, it was considered possible that the daily intake of methionine might be suboptimum. Therefore, 0.3% methionine was added to the high-fat rations. A group receiving 15% esters without added methionine was used as a test for this factor.

Procedure. Two series of tests were made. In the first series, four groups each of 25 unsexed day-old Indian River Cross chicks received the basal ration and 3, 5, and 7% of methyl esters, respectively. They were vaccinated against New Castle disease and placed in electrically heated batteries with raised wire floors. All birds received the basal ration for the first week. At the end of that period, they were wing banded and placed on the experimental diets for 9 weeks. The birds were weighed weekly and feed consumption was determined weekly except for the fifth and seventh weeks of the test. After the fourth week the weights of the males and females were recorded separately, and the average weights calculated as weighted averages.

In the second series of tests 7, 11, and 15% esters were fed, and as controls 7, 11, and 15% of the tallow from which the esters were prepared. Because of the

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high fat level, 0.3% methionine was added to these rations. As a control, one additional group was fed the 15% ester ration without 0.3% methionine. Eleven males and 11 females were placed on each ration, and feed efficiencies of each sex were recorded separately.

Results

The results of the first series of tests are recorded in Table II. During the first 4 weeks of the test the average weights of the birds in each group were recorded. For the last 4 weeks the two sexes were weighed separately and the weighted average weights calculated.

There was no significant difference in the average weights of the chicks at 10 weeks of age. Although the level of significance of the differences in feed efficiency may not be great the ratios of the weights of feed consumed to gains in weight are consistently lower in the ester-fed groups than in the basal. Furthermore, the higher the ester level, the lower the ratio.

There is no indication of toxicity in methyl esters.

The average gain in weight, total weight, and feed efficiency of the chicks in the second series of tests are given in Table III. After 5 weeks of test, at 6 weeks of age, with the exception of the chicks on 15% tallow, the gain in weight increases with increases of fatty material in the diet. Without exception, the feed efficiency improves with increase in fatty material in the diet. Roughly, the percentage of improvement in feed efficiency is the same as the increase in caloric value of the rations. Neither esters nor tallow have any influence on rate of growth.

Table II. Weights and Feed Efficiencies of Indian River Cross Chicks on Methyl Ester Rations

(Test Series I)

				Weeks of Age						
				2	3	4	5	7	9	10
				Weeks of Test						
Ration	Males	Females	Measured	1	2	3	4	6	8	9
Basal	17	13	Av. wt.[a]	170	261	343	513	823	1099	1288
			Feed efficiency	1.87	2.00	2.36	2.31	2.53	2.71	2.78
3% esters	12	18	Av. wt.	164	255	336	498	808	1109	1278
			Feed efficiency	1.69	1.80	2.17	2.74	2.43	2.55	2.68
5% esters	14	16	Av. wt.	161	253	348	501	834	1105	1285
			Feed efficiency	1.89	1.99	2.28	2.28	2.38	2.58	2.66
7% esters	18	12	Av. wt.	171	274	353	539	858	1118	1278
			Feed efficiency	1.88	1.92	2.29	2.17	2.32	2.52	2.63

[a] For first 4 weeks on test only average weights are given. For the last three weighings (fifth through ninth weeks) males and females were weighed separately and weight average weights for two sexes calculated.

Table III. Weight and Feed Efficiency

Diet	Av. Wt. Gain, Grams			Av. Total Wt., Grams			Feed Efficiency[b]		
	Male	Female	Av.	Male	Female	Av.	Male	Female	Av.
	Fifth Week on Test[a]								
Basal	589	469	504	649	560	605	2.39	2.53	2.46
Methyl esters									
7%	572	446	509	684	534	609	2.24	2.39	2.32
11%	595	451	523	704	533	619	2.19	2.25	2.22
15%	554	497	526	654	584	619	2.12	2.14	2.13
15%, no added methionine	554	415	485	663	498	581	2.16	2.54	2.35
Tallow									
7%	527	471	499	635	560	598	2.28	2.37	2.33
11%	620	478	549	726	568	647	2.14	2.32	2.23
15%	585	457	521	696	545	622	2.16	2 24	2 20
	Ninth Week on Test[c]								
Basal	1218	1115	1167	1108	1024	1066	2.73	2.68	2.69
Methyl esters									
7%	1368	1156	1262	1256	1068	1162	2.49	2.68	2.59
11%	1390	1027	1209	1281	945	1113	2.57	2.80	2.69
15%	1247	1094	1171	1147	1007	1077	2.64	2.54	2.59
15%, no added methionine	1279	1010	1145	1170	927	1049	2.57	2.64	2.61
Tallow									
7%	1232	1065	1149	1124	976	1050	2.68	2.63	2.66
11%	1401	1112	1257	1295	1022	1159	2.60	2.45	2.53
15%	1283	1104	1194	1172	1016	1094	2.65	2.41	2.53

[a] Birds 6 weeks old.
[b] Feed consumed/gain in weight.
[c] Birds 10 weeks old.

The addition of methionine appears to have given some advantage to the females receiving it, but to have no influence on males. Methyl esters show no toxicity, since at the 15% level the chicks receiving the esters did better than those on tallow.

Unfortunately, during the last 4 weeks of the 9-week test the birds were disturbed by unusual activity in the animal quarters. The average weight was less than 1100 grams, while in the first series it approached 1300 grams.

Although small percentage differences have been lost, the results show that tallow has no advantage over methyl esters, and that the latter are not toxic at 15% of the ration for 10 weeks.

Subjectively it was found that methyl esters mix quickly and evenly into a dry ration and require no special equipment. Although the minimum amount of esters which would be required to prevent dustiness, as compared to tallow was not determined, the dust was laid with smaller amounts and more quickly by the esters.

Conclusions

Methyl esters are not toxic to poultry when included from 3 to 15% in their rations, as determined by their effect on rate and efficiency of gain.

During the first 5 weeks, at least, methyl esters and tallow increase the feed efficiency proportionally to the increased caloric value of the rations.

Neither esters nor tallow have any influence on rate of growth.

On high-fat rations added methionine may increase the growth rate and feed efficiency of female but not male chicks, at least through 6 weeks of age.

Methyl esters mix quickly, easily, and smoothly with a dry ration.

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Literature Cited

(1) Ewell, R. H., J. Agr. Food Chem. **1,** 552 (1953).
(2) Krieg, A. A., *J. Am. Oil Chemists' Soc.* **31,** 489 (1954).
(3) Runnels, T. D., *Poultry Sci.* **34,** 140 (1955).
(4) Seidler, A. J., Scheid, H. E., Schweigert, B. S., *Ibid.*, **34,** 411 (1955).
(5) Seidler, A. J., Schweigert, B. S., *Ibid.*, **32,** 449 (1953).
(6) Sunde, M. L., *J. Am. Oil Chemists' Soc.* **31,** 49 (1954).
(7) Yacowitz, H., *Poultry Sci.* **32,** 930 (1953).

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