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RAPESEED OIL IN POULTRY DIETS

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The value of fat in poultry diets is well recognized by nutritionists. Although fat was formerly thought to be poorly tolerated by poultry, birds can utilize high levels of fat in balanced diets. When fat is priced competitively with grain as a source of energy, feed manufacturers can justifiably use large quantities of fat in poultry feeds.

The fat most commonly used by feed manufacturers is animal tallow, but other fats, especially vegetable oils, have advantages over tallow of greater digestibility and metabolizable energy, and at times are economical sources of energy for feed use.

This paper will review briefly some previous studies relating to the use of rapeseed oil (RSO) in poultry diets, and will conclude by considering a study that is underway at the present time at the Swift Current Research Station.

Early experiments indicated a problem in feeding high levels of RSO. A depression of growth and feed consumption of rats was attributed to the erucic acid content of the oil. Subsequently, Beare et al.(1963) were able to overcome the growth depressing effect of RSO on rats by increasing the saturated fatty acid content of the diet.

Early reports conflicted on the value of RSO in poultry diets. RSO at 4 and 8% of a chick starter diet and oil from rapeseed screenings in a broiler diet were found to be as satisfactory as other fats from the point of view of growth and feed conversion (Sell and Hodgson, 1962; Tsang et al., 1962). In turkey diets, in contrast, 5 or 10% RSO depressed growth and feed consumption of poults to 6 weeks of age (Joshi and Sell, 1964), although no such growth depression was seen in older turkeys (Blakely et al., 1964; Salmon, unpublished data).

In a series of experiments at Swift Current, RSO at a level of 9 or 10% of the diet was found to depress the early growth of both chickens and turkeys (Salmon, 1969a, 1969b). Supplementation of RSO with a low level of beef tallow was found to be more effective than the same level of soybean oil in overcoming the growth depressing effect of RSO, in agreement with the findings of Beare's group with rats. It appeared that an increase in

saturated fatty acids overcame the growth depression and that a blend of RSO with about 25% tallow should be a satisfactory source of energy in turkey diets.

At about the same time, Slinger (1969) reported that a mixture of 50% RSO with tallow had an ME value equal to or higher than that of RSO alone and substantially higher than that of tallow, indicating a synergistic effect on the utilization of the combination. No growth depression of chicks was observed when degummed RSO was fed, but non-degummed RSO was reported to depress their feed consumption and growth. The performance of poults was impaired by either form of RSO, with non-degummed oil causing the greatest depression. It was suggested that RSO gum might contain a factor which depressed feed consumption.

Subsequently, to that report I fed crude rapeseed gum to both chicks and poults at levels of up to 3% of the diet. There was no impairment of performance at even these very high levels of gum in the diet (Salmon, 1970). However, it could be argued that a factor in non-degummed oil may be altered during the refining process and that we may not be dealing with the same material. The effect of the properties of RSO on the finished carcass has been considered in work conducted at Swift Current. The carcass fat that is deposited in the tissues by growing turkeys has been found to be very similar in fatty acid composition to the fat supplied in the diet.

Table I illustrates that the depot fat of poults fed 9% soybean or rapeseed oil to 6 weeks of age was almost unchanged in fatty acid composition as compared with the dietary fat.

It seemed possible, in view of the sensitivity of the turkey's carcass lipids to changes in dietary fatty acids, that the composition of the depot fat might affect the physical characteristics of the carcass and its desirability as food. A fat that is soft at the temperature of the carcass, for example, might give the skin a less attractive appearance than a harder, more saturated fat, and might reduce the carcass grade and therefore the income to the producer.

It was found, as a result of our studies, that the type of fat in the diet strongly influenced the carcass grades for finish (that is, for subcutaneous fat), (Table II). Turkeys fed diets containing no added fat from day-old to market age (24 weeks) achieved grades of only 73% grade A for finish, when graded warm on the processing line. Diets containing palm oil, a hard, highly saturated fat, added at a low level of 2% of the diet or a high level of 11.4%, yielded 100% grade A carcasses. The same levels of RSO gave a mean of only 83% grade A birds. Chilling the carcasses improved the grades of the RSO carcasses from 83 to 95% grade A, but the numerical scores of the PO

TABLE I

FATTY ACID COMPOSITION OF DIETARY AND DEPOT FAT OF TURKEYS FED SOYBEAN OR RAPESEED OIL TO 6 WEEKS OF AGE

Dietary Treatment	Fat Source	FATTY ACID (PERCENT OF TOTAL FATTY ACID METHYL ESTERS)							
		16:0	16:1	18:0	18:1	18:2	18:3	20:1	22:1
Soybean Oil	Diets	11.0	0.1	3.9	24.0	51.8	8.8	0.3	0
Soybean Oil	Turkeys(1)	12.1±0.7	0.5±0.1	5.4±0.7	25.7±0.4	49.4±1.1	5.8±0.5	0.3±0.2	0
Rapeseed Oil	Diets	5.2	0.3	1.6	26.9	24.4	9.3	9.5	22.8
Rapeseed Oil	Turkeys	5.6±0.8	0.7±0.2	2.2±0.2	30.3±1.5	23.3±0.8	6.2±0.8	12.5±1.1	19.0±2.7

(1) Mean ± standard deviation, subcutaneous and abdominal fat combined; 8 poults per treatment.

TABLE II

EFFECT OF DIETARY FAT ON CARCASS FAT GRADE AND FAT SCORE

Dietary Fat Source	Fat Grade (% Grade A)		Fat Score(1) (chilled)		
	Warm	Chilled	Breast	Back	Mean
Control (No Fat Added)	75.6	86.0	3.43	2.60	3.02
Rapeseed Oil	83.1	95.0	3.75	3.43	3.59
Palm Oil	100	100	4.17	3.87	4.02

(1) Carcasses scored visually from 1 to 5.

carcasses were still significantly higher than those of the birds fed RSO. While the birds fed a saturated type of fat tended to yield slightly more skin than those fed RSO, the differences in skin fat content were very small and the differences in grade were undoubtedly due to the differences in fatty acid composition and physical characteristics of the subcutaneous fat.

The degree of saturation of the carcass fat also influenced the storage characteristics of the carcass. TBA assays for rancidity of abdominal depot fat, thigh and breast meat, were carried out on carcasses of birds fed RSO or palm oil. Under storage at -22°C (-10°F), there was no difference in rancidity of the two types of carcass after 10 months. Under poor storage conditions, at - 12°C (+10°F), however, the unsaturated fat of the RSO-fed carcasses became measurably rancid in 10 months.

I want to look now at a study that is currently under way. The purpose of the study was to investigate the effect of mixtures of RSO with animal fat on their utilization and metabolizable energy value and on the utilization of specific fatty acids. At the same time, this experiment offered an opportunity to look at the physiological effects of RSO on growing turkeys. While the data are not yet complete on either phase of this study, I want to indicate some of the findings to date.

Poults were fed degummed RSO or beef fat or a series of blends of the two fats at a level of 10% of the diet. The RSO was a conventional type with an erucic acid content of about 30%.

The growth response to the fat treatments (Table III) was unlike that obtained in previous experiments, in that there

TABLE III

FINAL WEIGHT, FEED CONVERSION AND METABOLIZABLE ENERGY OF TURKEYS FED COMBINATIONS OF RAPESEED OIL AND BEEF FAT TO 42 DAYS OF AGE

Dietary Treatment		Final Weight	Feed Conversion	Metabolizable Energy kcal/g (Dry Wt.) 40-42 Days
RSO	BF	(grams)	(feed/gain)	
10.0	0	1,657	1.52	3.44
7.5	2.5	1,767	1.44	3.49
5.0	5.0	1,802	1.44	3.40
2.5	7.5	1,850	1.46	3.37
0	10.0	1,917	1.44	3.36

was a highly significant linear growth depression as the proportion of RSO in the diet increased. In previous trials with turkeys a growth depression was evident only at the highest levels of RSO. It is clear that in this experiment the addition of a low level of saturated fat fid not overcome the growth depressing effect of RSO.

In feed conversion the birds fed the highest level of RSO were significantly poorer than those fed any other treatment. Feed conversion was improved by the addition of beef fat.

The two highest levels of RSO were significantly higher in ME at 6 weeks of age than the two lowest levels of RSO. The highest ME value was obtained when the added fat contained 25% beef fat, indicating that the absorption of the mixed fats was superior to that of either fat alone. Metabolizable energy at 2 weeks was considerably lower than at 6 weeks. The values are not shown in the Table. We are repeating the determinations after experiencing difficulty in drying the excreta samples which contained very high levels of unabsorbed fat.

The feed conversion data may seem at first glance to be inconsistent with the ME measurements; however, the slower-growing birds on the higher levels of RSO used a greater proportion of their energy intake for maintenance as opposed to growth, and could have also been depositing more carcass fat than the more rapidly growing group. Total carcass fat was not measured. If growth had been uniform, one would expect the ME level to be reflected in feed conversion.

The apparent digestibility of the dietary fatty acids was determined (Table IV). The total fatty acids of the diet containing 10% RSO were 88% absorbed, while those of the diet containing 10% beef fat were only 73.5% utilized. The absorption of RSO alone or mixed with 25 or 50% beef fat was significantly greater than that of beef fat alone or combined with 25% RSO. The mixtures were better utilized than would be predicted from the digestibility of the unmixed fats.

TABLE IV

APPARENT DIGESTIBILITY OF TOTAL FATTY ACIDS AND PALMITIC, STEARIC AND OLEIC ACIDS BY TURKEYS FED COMBINATIONS OF RAPESEED OIL AND BEEF FAT TO 42 DAYS OF AGE

Dietary Treatment		APPARENT DIGESTIBILITY (PERCENT)			
RSO	BF	Total Fatty Acids	16:0	18:0	18:1
10.0	0	88.0	76.2	73.6	91.3
7.5	2.5	88.6	84.2	82.2	92.1
5.0	5.0	84.7	79.6	65.8	93.6
2.5	7.5	78.2	72.7	53.1	92.9
0	10.0	73.5	66.4	44.8	92.7

Looking at three specific fatty acids, the absorption of the saturated fatty acids was significantly greater when the fat mixture contained 75% RSO than when either fat was fed alone. Saturated fatty acid absorption was also greater in the case of the other mixtures than would be expected if the digestibility of fatty acids from the two sources were simply additive. Oleic acid was efficiently utilized in all diets. It seems clear that the mixture of an unsaturated fat with the highly saturated beef fat enhanced the absorption of the saturated fatty acids of beef fat. This effect is similar to that observed by Sibbald *et al.* (1961, 1963) and by others. Although not shown in Table IV, erucic acid was absorbed to the extent of about 90%.

Measurement of the weights of certain organs at six weeks revealed enlargement of the heart and liver of turkeys fed the two highest levels of RSO (Table V). The differences were highly significant when expressed as percent of body weight. There was no difference in the weight of the aorta, but the spleen was reduced in size in the case of the birds

fed the highest level of RSO. As neither erucic acid nor saturated fatty acids were held constant, neither constituent can be assigned the blame on the basis of this experiment for the physiological changes observed. Certainly there is evidence from others which might incriminate both constituents.

TABLE V

ORGAN WEIGHTS OF POULTS FED COMBINATIONS OF RAPESEED OIL AND BEEF FAT TO 6 WEEKS OF AGE

Dietary Treatment		Heart		Liver		Aorta		Spleen	
RSO	BF	Wt. g	%	Wt. g	%	Wt. g	%	Wt. g	%
10.0	0	10.6	0.561	47.3	2.47	1.26	0.066	1.87	0.095
7.5	2.5	10.7	0.499	48.6	2.17	1.41	0.066	2.58	0.119
5.0	5.0	10.3	0.469	44.7	2.03	1.52	0.069	2.67	0.122
2.5	7.5	9.9	0.454	43.1	1.99	1.44	0.066	2.62	0.121
0	10.0	9.7	0.447	38.5	1.79	1.44	0.068	2.35	0.109

Dr. Craig Riddell of the Western College of Veterinary Medicine, Saskatoon, is collaborating in a histological study of various organs; however, I can give no report of his findings yet.

The appearance of myocardial lesions associated with long-chain fatty acids in other species has occurred somewhat later than six weeks of age. However, because of the possible significance of long-term consumption of erucic acid, turkeys from this experiment are being maintained on the same oils for further study later.

In conclusion, the repeated reports of growth depression of turkeys fed RSO, at least of the type that is high in erucic acid, as well as at least one report of growth depression in chickens, are reason for caution in the use of high performance feeds for poultry. If the depressing effects of RSO can be overcome through correction of a fatty acid imbalance or by the reduction of erucic acid, the use of RSO in feeds is capable of improving the utilization of the highly saturated animal fats. The sensitivity of turkey carcass lipids to dietary fatty acids and the enlargement of the organs of turkeys fed RSO suggests that the turkey may be a tool for study of such effects which may have broader implications in nutrition.

REFERENCES

1. Beare, Joyce L., J.A. Campbell, C.G. Youngs and B.M. Craig. 1963. Effects of saturated fat in rats fed rapeseed oil. Can. J. Biochem. Physiol. 41: 605-612.

2. Blakely, R.M., H.I. MacGregor, and Hanel, Donna. 1965. Performance of turkeys on finishing diets containing different fats. Can. J. Anim. Sci. 45: 59-61.

3. Joshi, S.K., and J.L. Sell. 1964. Comparative dietary value of soybean oil, sunflower oil, rapeseed oil, and animal tallow for turkey poults. Can. J. Anim. Sci. 44: 34-38.

4. Salmon, R.E. 1969a. Soybean versus rapeseed oil in turkey starter diets. Poultry Sci. 48: 88-93.

5. Salmon, R.E. 1969b. The relative value of rapeseed and soybean oils in chick starter diets. Poultry Sci. 48: 1046-1050.

6. Salmon, R.E. 1970. Rapeseed gum in poultry diets. Can. J. Anim. Sci. 50: 211-212.

7. Sell, J.L., and G.C. Hodgson. 1962. Comparative value of dietary rapeseed oil, sunflower oil, and animal tallow for chickens. J. Nutrition 76: 113-118.

8. Slinger, S.J. 1969. Reported in Can. Poultry Rev., p. 18 (April, 1969).

9. Tsang, S.T.L., E.L. McKee, G.P. Andrews, and H.A. Windsor. 1962. The value of rapeseed screening oil in broiler rations. World's Poultry J. 18: 142-146.