UTILIZATION OF OIL IN SEED MEALS DETERMINED WITH CHICKENS AT DIFFERENT AGES

S. Askbrant* and D.J. Farrell**

SUMMARY

Fat digestibity and metabolizable energy (ME) of 9 diets were determined with chickens at 6 different ages ranging from 1 to > 16 weeks. To a basal diet (60%) was added 40% (1) full-fat rice bran (2) full-fat sunflower seed (3) full-fat rapeseed (4) full-fat soybean or (5) extruded soybean. The other 3 diets contained the basal diet and each of the seed meals with oil returned to equal the full-fat product.

There was no difference in the ME of birds on the same diet within the age groups 1-3 weeks, 5-7 weeks and > 16 weeks. Apparent digestibility (%) of fat increased at the three different ages; values were 82.7, 85.2 and 88.3; mean values for the rice bran-based diet were 61.0, 73.5 and 85.6 respectively. For the full-fat rapeseed, sunflower and soybean-based diets mean digestibility (%) of the oil was 78.0, 93.0 and 79.0; when the oil was returned to the meals corresponding values were 91.2, 91.2 and 90.5.

Mean ME increased with age of bird from 14.25 to 14.69 MJ/kg DM. Differences between the mature birds and groups of younger birds were different ($P<0.05$). ME of full-fat and extruded soybeans was 14.58 and 15.41 MJ/kg DM; values for full-fat rapeseed were 19.50 and 19.01 with the oil added back. Corresponding values for soybean were 14.58 and 15.98.

INTRODUCTION

There is evidence to suggest that young chickens do not metabolize dietary energy to the same extent as adult birds (Mollah et al. 1983). As the young chick ages it appears to improve its ability to digest oils and fats (Duckworth et al. 1950; Fedde et al. 1960; Annison 1974; Hakansson 1974) particularly the lipid in some vegetable by-products (Warren et al. 1985). Furthermore when oil is extracted from an oil seed meal this oil may be better digested than when in the unextracted meal, but this may also depend, in part, on age of bird.

The aim of the present study was to determine, with birds of different ages, the metabolizable energy (ME) and fat digestibility of full-fat oil seed meals, rice bran and the seed meals when extracted and the oil returned.

MATERIALS AND METHODS

Diets

Four hundred grams of either full-fat rapeseed meal, sunflower meal, soyabean meal, extruded soyabean meal or rice bran were added to 600g of basal diet (940 g milled sorghum, 60g meat and bone meal plus minerals and vitamins).

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* Present address: Department of Animal Nutrition and Management, Swedish University of Agricultural Sciences, Uppsala, Sweden

** Department of Biochemistry, Microbiology and Nutrition, University of New England, Armidale, N.S.W. 2351

Each extracted meal plus the corresponding oil were also added to the basal diet in the same amount as in the unextracted meal. Sunflower seed hulls were also returned with the oil to the meal in the same amount (130 g/kg) as found in the extracted sunflower meal. Ingredients and chemical composition of diets are given in Table 1.

TABLE 1 Ingredient and chemical composition of test diets.

Diets	1	2	3	4	5	6	7	8	9
Basal diet	1000	600	600	600	600	600	600	600	600
Full-fat ricebran		400							
Full-fat rapeseed			400						
Full-fat soybean				400					
Extruded full-fat soybean					400				
Full-fat sunflower seed						400			
Sunflower oil							160		
Sunflower meal							189		
Sunflower hulls							51		
Soybean oil								85	
Soybean meal								315	
Rapeseed oil									158
Rapeseed meal									242
Dry matter (%)	89.0	89.6	91.3	91.1	92.3	91.9	93.0	90.4	90.8
Ether extract (%DM)	3.8	10.5	18.5	11.3	10.8	19.6	21.0	11.7	18.3
Crude protein (%DM)	13.0	13.7	17.4	23.4	23.7	16.0	16.7	22.6	17.2

Animals

Sixty, one-day-old broiler chickens were reared in a battery brooder on a commercial broiler diet. At 7 days of age, 27 chicks of similar bodyweight were randomly assigned to 9 cages in a room at 22 °C and offered one of the 9 diets ad libitum for one week. Birds were then rerandomised to the 9 cages in a room at 25 °C and each assigned to one of the 9 diets. Both experiments were replicated.

Eighteen broilers aged 49 days were allocated at random to individual cages in a room at 22 °C and offered one of the 9 test diets for one week. They were then rerandomised and the experiment repeated.

Eighteen mature crossbred cockerels (>16 weeks) were placed in individual cages in a room at 22 °C and offered one of the 9 diets for one week. They were then rerandomised and allocated to dietary treatments for one week. Thus the experimental design was 9 diets x 6 ages x 2 replicates.

Experimental Procedure

For the first three days birds were allowed to adjust to the experimental conditions. On day 4 feed was removed for 3 h and plastic sheets were placed under the cages designed for excreta collection. During the last 4 days feed intake and feed spillage were measured and excreta collected daily. At the end of day 7 feeders were removed and 3 h later excreta collected.

Chemical and statistical analysis

Excreta were dried at 70°C to constant weight, then finely milled. Dry matter, ether extract and gross energy were measured on representative samples of feed and excreta according to standard procedures (AOAC 1980). Nitrogen was measured on the feed samples (Ivan et al. 1974).

Data were analysed using an analysis of variance and differences between means were tested using the Studentized Range. Missing data were estimated according to Steel and Torrie (1960).

RESULTS

The chemical composition of the 9 diets is given in Table 1. The oil content (%) of the raw ingredients on a DM basis was: rapeseed 43.0, rapeseed meal 2.1; sunflower seed 43.9; sunflower meal 0.9; soybean seed 23.0; soybean meal 1.0; extruded soybean 21.2 and rice bran 23.4.

One adult cockerel (>16 weeks) did not consume sufficient feed and excreta from a bird aged 7 weeks, on diet 3, were not collected completely. These data were not used. Analysis of variance showed that there was no difference (P<0.05) between measurements of birds on the same diets within each of the three age groups (1-3 weeks, 5-7 weeks, >16 weeks). The data were therefore analysed according to these three age groups with four replicates per diet.

The apparent digestibility of oil in the 9 diets at three ages is shown in Table 2. As birds aged there was a significant (P<0.01) increase in the apparent digestibility of dietary oil. Respective values (%) were 82.7, 85.2 and 88.3.

TABLE 2: The apparent digestibility of oil (%) and the metabolizable energy (MJ/kg) of experimental diets at three different ages.

Diet	Age (weeks) (1-3)		(5-7)		(>16)	
	Digestibility*	Metabolizable energy*	Digestibility	Metabolizable energy	Digestibility	Metabolizable energy
1	80.0	13.72	85.5	13.84	82.3	13.80
2	61.0	11.87	73.5	11.91	85.6	12.90
3	72.4	15.34	75.5	15.23	86.1	16.24
4	81.1	13.99	76.2	13.46	79.6	13.91
5	88.8	14.16	89.4	14.15	90.2	14.45
6	91.8	15.12	93.8	15.49	93.5	15.32
7	88.0	14.82	89.5	15.25	93.9	15.59
8	90.1	14.15	92.4	14.22	89.9	14.16
9	89.4	15.09	91.6	15.10	92.6	15.83

* LSD(ME)=0.18, LSD(Dig.)=1.67, (n=27).
(0.05) (0.05)

The lowest mean digestibility (%) was for diet 2 (73.5) containing rice bran, and the highest diet 6 (93.0) containing full-fat sunflower seed meal. A comparison of diets with the full-fat meal and the corresponding meal plus returned oil was: for rapeseed (78.0 vs. 91.2); sunflower (93.0 vs. 91 .2) ; soybean (79.0 vs. 90.5) and extruded soybean (89.5).

Metabolizable energy of the 9 diets is also shown in Table 2. As birds* aged mean ME increased with age from 14.25 to 14.69 MJ/kg. Differences between the mature birds and the two younger groups were significant ($P<0.01$), but not between the two former groups. The lowest ME was 12.23 MJ/kg for the rice bran based diet (2), and highest on diet 3 containing full-fat rapeseed meal (15.61 MJ/kg). This was followed by diets 6, 7 and 8 which had similar values,

Table 3 Mean metabolizable energy (DM basis) of full-fat ingredient and the oil-extracted ingredient with oil returned.

Ingredient	MJ/kg
Full-fat rice bran	10.88
Full-fat rape seed	19.50
Rapeseed M + oil	19.01
Full-fat soybean	14.58
Extruded soybean M	15.41
Soybean M + oil	15.98
Full-fat sunflower	17.92
Sunflower M + oil	17.62

Contribution of the basal diet ME(MJ/kg) was 8.23, 8.30 and 8.28 at the three-different ages. The mean ME of the ingredients are given in Table 3. Extruded and full-fat soybean values were 14.58 and 15.41 MJ/kg respectively, despite the fact that the former had almost 2% less oil. There was a major difference between the ME of full-fat soybean and of soybean meal plus oil. The latter was 1.4 MJ/kg DM higher than the former.

DISCUSSION

The digestibility of fats and oils in poultry was reviewed by Annison (1974) and in general animal nutrition by Wiseman (1984a). There is substantial evidence to suggest that as birds increase in age their ability to digest lipid improves (Hartel 1986), particularly of animal fats (Fedde et al. 1960; Hakansson 1974; Wiseman 1984b). This was confirmed in the present study although the amount of oil in the diets was generally high (Table 1). As would be expected there was a corresponding increase in ME with level of dietary lipid, and generally within a diet ME increased with increasing lipid digestibility. There was however substantial variation between replicates particularly in fat digestibility indicating within bird variation. There is very little information on the digestibility of oil in full-fat oil seed meals with the exception of soybean meal. Such seed meals may increase this variation among birds in oil digestibility.

Diet 2, containing 40% rice bran, gave the lowest ME and fat digestibility in the young birds. These values increased in the adult cockerels. Warren et al. (1985) made similar observations and reported apparent digestibility values for rice bran oil of 37% for chicks (10-14d) and 93% for adult cockerels. Corresponding ME values (MJ kg DM) were 10.2 and 14.84; these may be compared with 10.07 and 12.85 found here. The lower ME value found here for cockerels is supported by a lower lipid digestibility of 90.5% but this may also indicate an interaction between rice bran and the basal diet. Warren et al. (1985) diluted a complete broiler diet with rice bran, while here the basal diet was 94% milled sorghum plus meat and bone meal.

Rapeseed and soybean contain growth inhibitors. Some of these are destroyed on heating and may account for the higher digestibility of the oils when returned to the meals which are heated during oil extraction. Furthermore this depression in digestibility was not found for extruded soybean which is not oil-extracted but is subjected to high temperature in this process. Finally lipid release during chemical extraction may be more difficult in the full-fat meals compared to when the return of free oil to the meals is undertaken.

The amounts of oil in the diets (Table 1) are generally higher than those used in practice. It is known that at increasing levels, particularly of added fat, the ME value of the fat declines (Wiseman 1984b). It may not be meaningful therefore to calculate the ME of the individual oils for comparative purposes (Table 3) although values are within the expected range.

These results are preliminary in nature but they do highlight the complexity of the evaluation of oils and fats in poultry nutrition; in particular, source of oil, its form and the age of birds are important. The future of the oil seed meal industry is uncertain but there is clearly the need to evaluate further those meals which may be available to the animal industry in the future and contain considerable amounts of residual oil depending on economic circumstances.

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