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Full Name of Author — Nom complet de l'auteur

Mario Reinaldo Rebolledo

Date of Birth — Date de naissance	Country of Birth — Lieu de naissance
March 1st 1945	CHILE

Permanent Address — Résidence fixe

25 - 10950 - 83 St Edmonton, Alta T6H - 1M1

Title of Thesis — Titre de la thèse

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1980	Alexander Robblee

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THE UNIVERSITY OF ALBERTA

COMPOSITION AND NUTRITIVE VALUE OF RAPESEED SCREENINGS MEALS IN RATIONS FOR BROILERS AND LAYING CHICKENS

BY

MARIO REBOLLEDO

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE

IN

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THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommended to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Composition and nutritive value of rapeseed screenings meals in rations for broiler and laying chickens" submitted by Mario Rebolledo in partial fulfilment of the requirements for the degree of Master of Science.

....
(Supervisor)

....

....

Dated Dec. 13. 79.

ABSTRACT

The chemical composition of five rapeseed screenings meals and of the original samples of screenings from which the meals were produced was determined. Subsequently three experiments were conducted to evaluate the effect of adding varying levels of the rapeseed screenings meals to rations for broiler chickens and laying hens. In the first experiment male broilers were fed rations containing 0, 2.5, or 10% of a composite sample of rapeseed screenings meal. In the second experiment male and female broilers were fed rations containing 10% of each of the rapeseed screenings meals. The third experiment was conducted with laying hens fed rations containing 0, 2, 4, or 8% of the composite sample of rapeseed screenings meal.

The results of the chemical determinations conducted on the rapeseed screenings meal showed considerable variability among the samples. The following ranges in composition were observed: crude protein 21 to 28%, crude fibre 12 to 19%; fat 19 to 28%; ash 7 to 27% calcium 0.40 to 0.45%; phosphorus 0.74 to 0.98%; silica 1 to 19% and glucosinolates 0.34 to 2.36 mg/g. Amino acid analysis indicated that the levels of lysine, histidine, and cystine in the protein from rapeseed screenings meal were lower than in the protein of Tower rapeseed meal. The amino acid content in the protein of the original samples of screenings was higher than in the rapeseed screenings meals.

The results of the experiments conducted with broiler chicks indicated that as much as 10% of rapeseed screenings meal, could be included in rations, either as separate meals or as a composite mix, without any adverse effect on the rate of growth, efficiency of feed conversion, mortality or incidence of perosis. Visual examination of the livers revealed no significant differences in fat content and no signs of haemorrhages or haematomas on the livers were detected.

The experiments carried out with laying hens indicated no detrimental effect on the rate of egg production, egg size, Haugh units values, egg specific gravity, efficiency of feed conversion or mortality. However inclusion of rapeseed screenings meal or 8% of Tower rapeseed meal in the ration resulted in significantly lower body weight of the hens at the end of the experiment as compared to hens fed the control ration containing soybean meal. Liver-to-body weight ratio of hens fed rations containing 4 or 8% rapeseed screenings meal was significantly smaller than those of the control group, but the fat content of the liver was not affected by the treatments used. Incidence of haemorrhagic liver syndrome was not influenced by the inclusion of rapeseed screenings meal in the rations of laying hens. The thyroid weights of the hens fed 4 or 8% rapeseed screenings meal were significantly increased but productive performance of the birds was not affected.

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INTRODUCTION

Rapeseed is a very important oil seed crop in Canada. Annual production has risen from a few thousand tonnes twenty five years ago to over 3.4 million tonnes in 1978. As a result of increased tonnage, large quantities of rapeseed are available for processing locally or for export to other countries.

Rapeseed as it is marketed from the farms contains varying levels of non-rapeseed components; these may consist of many different weed seeds, stems of plants and other contaminants. When rapeseed is cleaned, most of the non-rapeseed components are removed and in addition varying amounts of very small or broken rapeseeds are included in the screenings. The cleaning process yields varying levels of screenings depending on the cleanness and uniformity of the sample; however, on average when Canadian rapeseed is cleaned to export standards, the process yields 8 to 10% of screenings. Since well over half of the Canadian crop is exporte , a arge quantity of screenings is available either for dire t ivestock feeding or for disposal by further processing. When rapeseed is processed in Canada it may not always be cleaned to expor standar ls. As a result the quantity of screenings obtained may vary and the meals produced may contain varying levels of screenings.

Since it is not known what effect the rapeseed screenings (RSS) may have on the nutritive quality of rapeseed meals (RSM), experiments were conducted to determine the chemical composition of meals produced from different samples of RSS and to evaluate their nutritive quality when added at varying levels to rations for broilers and laying hens.

REVIEW OF LITERATURE

Composition of Rapeseed Screenings

There is a limited amount of information on the composition of RSS. Bell and Linton (1961) described RSS as being composed of varying proportions of hull or seed pod fragments, immature or small seed some weed seeds and other extraneous materials retained with rapeseed during combine harvesting. Giovannetti and Bell (1972) summarized data on the composition of eleven samples of rapeseed processed for use in an experimental program. They reported that the levels of weed seeds present averaged 1.5%, ranging from 0.39 to 4.08% and the levels of inert matter averaged 0.53% with a range from 0.16 to 1.13%. Classification of the weed seeds present indicated that a large number of species were represented. Among the more common species were wild mustard, stinkweed, lamb quarters, green foxtail, smart weed and wild buckwheat. Other seeds found in the rapeseed samples were wheat, flax, alfalfa and sweet clover. Robertson (1973) reported that refuse screenings from a rapeseed processing plant contained 51% wild oats; 34% wheat, oats and barley; and 15% rapeseed, rapeseed hulls, fines, chaff and pods.

The chemical composition of the RSS varies widely from one sample to another. Bell and Linton (1961) reported that several samples of screenings had crude protein contents ranging from 8 to 11% and average crude fat and crude fibre contents of 18 and 25% respectively. A sample that was used in a digestibility trial contained 14.7% protein but no values for crude fat or fibre were given. Bell and Devlin (1972) reported on an experiment conducted at the University of Saskatchewan in which RSS averaging 16% protein, 12% fat and 15% crude fibre were used.

<u>Nutritive Value of Rapeseed Screenings</u>

A few studies have been conducted in which RSS have been fed to lambs and cattle; no report on their use in rations for poultry or swine are available. Bell and Linton (1961) included screenings from combine-harvested rapeseed in rations for feeding lambs. The screenings made up 50% of a pelleted feed in which the balance was composed of 36.5% oat hulls, 4% dehydrated alfalfa meal, 7% cane molasses, 0.5% urea, 1% dicalcium phosphate and 0.5% salt. The level of pelleted feed included in the concentrate mixture given to the lambs along with 1.5 pounds of hay varied from 0 to 100%. Digestibility trials indicated that the pelleted feed contained 51% TDN and 10.6% DCP. When the pelleted feed was included as one third of the concentrate mixture the lambs gained 0.[illegible]7 pounds per day but higher levels of inclusion resulted in decreased rate of gain. It was concluded that the RSS may be used successfully in ruminant rations but should be regarded as a roughage because of the high fibre content and low TDN value. Bell and Devlin (1972) studied the effects of including levels of 0, 10 and 20% of ground RSS in rations for steers. The experiment was started when the animals weighed 370 kg and ended after 91 days of trial. All diets were based on barley and contained 15% oat hay, cobalt-iodized salt, dicalcium phosphate and supplementary vitamins A and D. Each ration was fed with or without addition of molasses and was supplied either as a meal or as a completely pelleted diet. The steers fed the completely pelleted diets grew more slowly than the steers offered non-pelleted rations; however, the performance of all other groups was similar, achieving a rate of gain between 1.31 to 1.51 kg per day. Feed conversion ratios ranged between 7.6 and 8.4 kg of feed per kg of gain. The experiment showed that as much as 20% of RSS may be used with good results in fattening cattle and that the masking effect of molasses was not necessary to obtain good rates of gain and feed conversion. In another experiment conducted with finishing cattle at the University of Alberta (cited by Bell and Devlin 1972) it was shown that diets containing 30% RSS produced the cheapest gains. Bell and Devlin (1972) also reported on a study conducted by Agriculture Canada Research Station, Melfort, Saskatchewan, in which it was concluded that as much as 40% RSS can be included in diets for finishing beef cattle with satisfactory results. Robertson (1973) studied the effect of processing and physical form of the screenings on voluntary intake and digestibility by sheep. He observed that the voluntary intake of wethers was about 23% lower when the screenings were supplied as a meal than when they were offered as pellets. The digestibility of dry matter, energy or cellulose of coarsely ground screenings and pellets was similar but there was a decrease in the digestibility of these components when the screenings were finely ground.

Since RS are produced by cleaning rapeseed they may contain varying proportions of immature or small rapeseed. As a consequence the composition and nutritive value of meals produced from screenings may be related in varying degree to the composition and nutritive value of RSM.

Composition of Rapeseed Meal

The composition of RSM has been extensively studied. As a result, data are available on components such as protein, amino acids, minerals and glucosinolates.

The protein content of RSM may vary widely depending on the variety and location where grown. Renner et al (1955), Klain et al.(1956) and Clandinin and Bayly (1963) reported that RSMs produced from Argentine varieties had higher protein content than meals produced from Polish varieties. Clandinin and Bayly (1963) also found that the meals produced from rapeseed grown in three different locations differed significantly in protein content.

Several reports have shown that the protein content of meals may vary from year to year. Clandinin (1967) published a summary of results obtained during the periods 1956-1967 and 1965-1967. According to this report, during the first period the protein content of RSMs produced by expeller and prepress-solvent processes of oil extraction were 35.9 and 37.4% respectively. During the second period RSMs produced by prepress-solvent process contained 35.6% of protein and meals produced by the solvent process contained 36.5%.

In more recent studies Rao and Clandinin (1972) observed higher levels of protein in meals produced, but the increase was independent of the procedure used to extract the oil. The protein content of meals produced by the expeller, prepress-solvent and solvent process averaged 38.7, 39.2 and 39.3% respectively. Bell and Jeffers (1976) reported that the samples assembled from 5 different crushers throughout Canada had an average protein content of 37.1%.

The levels of protein in meals produced from low glucosinolate rapeseed varieties have been reported by several workers, among them Olomu (1974) reported 39.4% of protein in meals produced from Bronowski rapeseed, Fisher (1977) found that Tower RSM had a protein content of 40% and Salmon (1977) noted that a sample of Candle RSM contained 33.8% protein. Clandinin et al. (1978) observed that high glucosinolate meals produced in Canada in the past have contained about 36% protein but that low glucosinolate RSM from Tower and Regent varieties are expected to contain 38 to 39% protein.

Type of processing, variety and environment under which the cultivar is grown influence the amino acid composition of the protein in RSM. Clandinin et al. (1959) found that the excessive amount of heat employed during the oil extraction from the seed reduced the lysine content of the protein from 5.69 to 4.41%. Clandinin and Tajcnar (1961) showed that in order to avoid the destruction of amino acids during expeller processing the amount of heat applied in cooking and conditioning should only be enough to reduce the oil content of the seed to about 6%. Clandinin (1967) stated that the change from expeller to prepress-solvent processing, that occurred between 1956-1967, resulted in production of meals with levels of available lysine increased from 4.4 to 5.5%. Clandinin and Bayly (1963) reported that the lysine content in rapeseed of an Argentine variety was lower than a Polish variety. It was also observed that environmental conditions under which rapeseed was grown affected the content of lysine, histidine, arginine, phenylalanine and leucine in the seed.

Based on analyses done on a large number of commercial samples of RSM, Clandinin (1967) concluded that the principal limiting amino acid in this supplement is lysine. Rutkowski (1971) observed that RSM has well balanced amino acid composition, characterized by a relatively high content of methionine and cystine, even though it may be slightly deficient in lysine.

Studies on the mineral content of RSM have shown variations depending on the soil where the seed is grown and the source at which the seed is obtained. Wetter (1965) reported variations from 6 to 7% ash for meals produced in western Canada. Finlayson (1977) noted that the ash content of RSM varied between 4.5 and 6%, Rutkowski (1971) observed that in general the mineral content of RSM is relatively high compared to other oil meal products. Clandinin et al.(1978) compared the mineral content of RSM with that of soybean meal. It was noted that RSM is a richer source of minerals than soybean meal. Bragg (1974), Motzok (1974), Seth et al.(1975)

and Finlayson (1977), however, showed that the availability of some of the minerals were low. Clandinin et al.(1978)concluded that in spite of the lower availability, RSM is a better source of available calcium, iron, manganese, phosphorus, selenium and magnesium than soybean meal.

Nutritive Value of Rapeseed Meal for Poultry

The introduction of the low glucosinolate varieties of rapeseed has resulted in improvement in the nutritive value of meals produced as compared to meals from high glucosinolate varieties. The glucosinolate content of the new low glucosinolate varieties has been reported to be much lower than the high glucosinolate varieties grown previously. Stefansson and Kondra (1975) reported that Tower RSM contained approximately one tenth of the level of glucosinolates usually found in Target RSM, a high glucosinolate variety. Smith and Campbell (1976) obtained values of 0.49 and 0.34 mg/g of glucosinolate in Bronowski and Tower RSM respectively. Fisher (1977) reported variations from 0.86 to 1.25 mg/g in samples of RSM obtained at two different sources. Thomas et al.(1978) and Goh and Clandinin (1977) also determined values within the same range for Tower RSM.

The lower glucosinolate content of the new varieties has resulted in production of meals that are less goitrogenic than the high glucosinolate RSM. It has also reduced losses from haemorrhagic liver syndrome which appeared to be related to the glucosinolate content of RSM (Jackson 1969; Hall 1972; Olomu et al. 1975; Slinger et al. 1976 and Clandinin et al.1977)

The results of experiments on the utilization of low glucosinolate RSM in rations for poultry has been summarized recently (Robblee et al. 1978). They concluded that low glucosinolate RSM may be satisfactorily used in rations for broilers, laying and breeding chickens and starting, growing and breeding turkeys. The recommended levels of use of low glucosinolate RSM are generally higher than those recommended previously for high glucosinolate RSM.

EXPERIMENTS AT THE UNIVERSITY OF ALBERTA

Experiments were conducted to study:

Section I : Composition of rapeseed screenings meals

Section II : Nutritive value of rapeseed screenings meals for broilers and laying chickens.

SECTION I

Composition of Rapeseed Screenings Meals

Status of the Problem

Large quantities of RSS are available in Canada for possible use in rations for livestock and poultry. Since screenings consist of weed seeds, small rapeseeds and stems of plants and other contaminants, there is some variability in the composition of RSS available for use.

There is limited information on the chemical composition of different samples of RSS. Consequently, studies were conducted to determine the composition of five samples of rapeseed screenings meals (RSSM). The meals were produced by processing screenings obtained from five separate locations in Canada and thus presumably represented a wide range in the proportions of various components. In addition, the protein, amino acid and fatty acid composition of the screenings from which the meals were made were determined.

Experimental

Five RSSMs produced in a pilot plant (1) were provided for the studies. In addition, small samples of the screenings from which the meals were produced were also provided.

For identification purposes the five meals were designated as sample A, B, C, D, and E.

---

1) POS Pilot Plant Corporation
Saskatoon, Saskatchewan.

Analyses conducted on the meals were as follows: dry matter, protein, fat, crude fibre, ash, silica, calcium, phosphorus, glucosinolates and amino acid composition. In addition, the protein, amino acid levels, fat content and fatty acid distribution in the seed samples were determined. All the samples to be analyzed were ground to pass a 20-mesh screen.

The dry matter content of the meals was determined by drying in an oven at 110°C until constant weight was attained. Protein (N x 6.25) was determined by the Kjeldahl method (AOAC, 1975). The fat content of the meals and seeds was also determined by AOAC methods (1975). Crude fibre was analyzed using a slight modification of the standard AOAC methods (AOAC, 1975). Silica levels were assessed by the method outlined by McCarthy et al. (1974). Calcium content was determined by atomic absorption (AOAC, 1975) and phosphorus was analyzed by a photometric procedure (AOAC, 1975). Glucosinolates were determined by the method outlined by Appelqvist and Josefsson(1967). Samples of the meals and seeds were analyzed for amino acid content using a JLC-5AH Amino Acid Analyzer (Jeol Co. Japan). In the determination of fatty acid distribution, the lipids were extracted with chloroform-methanol (2: I v) and methylated using methanolic boron trifluoride (35% solution) in pentane. The esters were purified by thin-layer chromatography and eluted with chloroform-methanol. The pattern of the fatty acids were obtained using a Bendix Gas Chromatograph provided with a flame ionization detector and a 3 m by 6 mm glass column packed with 10% 5CP on 80-100 mesh chromosorb W.

Results and Discussion

The results of the analyses conducted on the samples of RSSM and on the RSS are summarized in Tables 1-3.

The moisture content of the five RSSMs (Table 1) was quite uniform. Dry matter content ranged from 89 to 91%.

The protein content of the meals (Table 1) ranged from 21.3 to 28.2% and the protein content of the unprocessed screenings ranged from 17.7 to 23.1% (Table 3).

The meals contained low levels of fat. The fat content ranged from 0.4 to 1.7% (Table 1).

Considerable variability in the fibre content was observed (Table 1) levels ranged from 12.2 to 19%. Most of the samples (B, C, D and E) had fibre levels much lower than the average value reported by Bell and Linton (1961). The fibre levels reported by Bell and Devlin (1972) were similar to that determined for Meal A. In general the fibre content of the RSSMs tended to be higher than the average values reported for RSM (Clandinin et al. 1978). The higher values may be attributed to the smaller seed size and higher fibre content of non-rapeseed components in the samples.

The ash content of all of the meals (Table 1), was well above average values reported for RSM (Clandinin et al. 1978). Ash content varied from 7.6 in Meal D to 27.3% in Meal A. The extremely high content in sample A suggested

Table 1. Chemical composition of rapeseed screenings meal and Tower RSM

Rapeseed Screenings Meal	Dry Matter %	Protein %	Fat %	Crude Fiber %	Ash %	Silica %	Calcium %	Phosphorus %	Glucosinolates mg/g
A	91.0	21.3	0.6	19.0	27.3	19.0	0.4	0.90	0.34
B	90.2	23.2	1.7	16.3	12.9	6.37	0.41	0.74	0.55
C	89.5	27.4	1.4	15.3	9.9	3.34	0.45	0.89	2.36
D	88.7	28.2	0.7	12.2	7.6	1.11	0.44	0.98	0.85
E	90.2	26.8	0.4	14.3	8.7	2.96	0.40	0.76	1.96
Tower RSM	88.2	38.6	2.0	11.7	6.4	0.14	0.39	1.09	1.22

that the screenings from which the meal was produced may have been contaminated with soil or sand.

Because of the high content of ash observed in Meal A, levels of silica present in the meals were determined. Meal A was found to contain 19% silica, while the content of the other meals ranged from 1.1 to 6.4%. The levels of silica found in the meals indicate that the ash contents determined were affected by the levels of silica in the samples.

A narrow range of calcium content (0.40 - 0.45%) in the RSSMs was observed (Table 1). The values are somewhat lower than those commonly found in RSM which average 0.66% (Clandinin et al. 1978).

Levels of phosphorus also varied within a fairly narrow range (0.74 - 0.98%). These values are also somewhat lower than average values reported for RSM (Clandinin et al. 1978).

Considerable variation in the total glucosinolate content of the meals was observed (Table 1). Values ranged from 0.34 to 2.36 mg/g. This compares to average values of 1.04 and 0.62 mg/g for the low glucosinolate varieties Tower and Candle respectively and 7 mg/g for higher glucosinolate varieties (Clandinin et al. 1978). This suggests that the screenings were probably derived, in large part, from rapeseed samples of low glucosinolate content.

The amino acid composition of the five RSSMs as well as Tower RSM is presented in Table 2. In addition, the amino acid distribution in the RSS and Tower rapeseed from which the meals were produced are given in Table 3. In general,

Table 2. Amino acid[1] composition of rapeseed screenings meals and Tower RSM

	Meals					
	A	B	C	D	E	Tower
Protein content %	21.3	23.2	27.4	28.2	26.8	38.6
<u>Amino acids</u>						
Lysine	4.99	4.66	4.79	5.28	4.86	5.69
Histidine	2.34	2.25	2.39	2.46	2.47	2.84
Ammonia	2.17	2.12	2.17	2.27	2.74	2.22
Arginine	5.66	5.35	5.96	5.92	5.64	6.00
Aspartic acid	7.70	7.63	7.44	7.79	7.09	7.52
Threonine	4.27	4.10	4.16	4.20	4.09	4.49
Serine	4.22	4.21	4.18	4.20	4.13	4.34
Glutamic acid	14.79	14.11	15.38	15.15	15.60	17.72
Proline	5.49	5.30	5.72	5.43	5.67	6.75
Glycine	4.97	4.81	5.00	4.84	4.70	4.99
Alanine	4.50	4.32	4.37	4.45	4.48	4.53
Cystine	0.58	0.66	0.65	0.82	0.82	1.06
Valine	4.99	4.80	4.82	5.02	4.80	5.20
Methionine	1.63	1.54	1.65	1.64	1.63	1.87
Isoleucine	3.89	3.66	3.80	3.93	3.74	4.11
Leucine	6.69	6.24	6.68	6.76	6.90	7.16
Tyrosine	2.44	2.30	2.25	2.39	2.22	2.43
Phenylalanine	3.97	3.80	3.89	3.95	3.85	3.98
Total	85.29	81.86	85.30	86.50	85.43	92.90

(1) Expressed as % of N x 6.25

Table 3. Amino acid[1] composition of rapeseed screenings and Tower rapeseed

	Meals					
	A	B	C	D	E	Tower
Protein content %	17.7	20.3	21.0	23.1	19.7	22.2
Amino acids						
Lysine	5.78	5.62	5.96	5.91	5.15	6.27
Histidine	2.43	2.32	2.63	2.53	2.52	2.92
Ammonia	2.12	1.81	2.16	2.17	2.05	2.03
Arginine	5.96	5.96	6.19	5.94	5.62	6.02
Aspartic acid	7.64	7.54	7.46	7.64	7.08	7.44
Threonine	4.40	4.12	4.31	4.25	4.16	4.48
Serine	4.34	4.22	4.24	4.34	4.27	4.44
Glutamic Acid	15.35	14.46	16.23	15.72	16.68	18.43
Proline	5.64	5.42	6.50	5.85	6.47	6.99
Glycine	5.13	4.86	5.22	4.72	4.65	4.98
Alanine	4.57	4.33	4.52	4.57	4.73	4.52
Cystine	0.63	0.69	0.76	0.86	0.83	1.08
Valine	5.25	4.94	5.08	5.15	5.04	5.21
Methionine	1.75	1.72	1.73	1.84	1.76	1.86
Isoleucine	3.80	3.63	3.86	3.86	3.71	3.96
Leucine	6.61	6.21	6.74	6.79	6.94	6.97
Tyrosine	2.42	2.27	2.30	2.35	2.20	2.50
Phenylalanine	3.96	3.77	4.01	3.92	3.98	3.98
Total	87.78	83.89	89.90	88.41	87.84	94.08

(1) Expressed as % of N x 6.25

the distribution of the amino acids in the RSSMs is similar to that in Tower RSM, however, the levels of lysine, histidine and cystine in the protein of RSSM are considerably lower than in Tower RSM.

The levels of amino acid in the protein of the RSS and of Tower rapeseed is given in Table 3. Comparison of the values with those of RSSMs and Tower RSM (Table 2) indicated that the unprocessed screenings had higher lev s of amino acids in the protein than the meals that were produced from them. This suggests that some damage to the meals occurred in processing. The lower level of lysine in the RSSMs may have been a result of overheating during some phase of the production process.

The fat content and fatty acid composition of the RSS and of Tower rapeseed are shown in Table 4. The oil content of the screenings varied from 19.6 in sample B to 28% in sample E, while the sample of Tower rapeseed had a content of 43.5%. The large variation in oil content among the different samples of screenings may be related to leve of stems, weed seeds and other impurities in the samples. The variable composition of the screenings as well as the smaller seed size may explain the lower oil content of the screenings as compared to rapeseed.

The fatty acid composition of the oil from RSS and Tower rapeseed showed some differences. The level of oleic acid in the oil of RSS was considerably lower than in Tower

Table 4. Fat content and fatty acid composition of the rapeseed screenings and Tower rapeseed

Sample	A	B	C	D	E	Tower
Fat Content (%)[1]	23.48	19.58	27.22	26.88	28.07	43.50
Fatty Acids (%)						
14:0 Myristic acid	0.19	0.24	0.52	0.33	0.28	1.13
15:0 Pentadecylic	0.26	0.04	0.05	0.05	0.13	0.12
16:0 Palmitic acid	5.94	7.41	5.98	6.79	5.54	5.09
16:1 Palmitoleic acid	0.42	0.48	0.32	0.48	0.50	0.31
17:0 Heptadecanoic acid	0.04	0.07	0.07	0.21	0.32	0.13
18:0 Stearic acid	1.95	2.54	1.86	1.87	2.11	1.62
18:1 Oleic acid	45.58	47.41	48.51	44.27	45.22	57.17
18:2 Linoleic acid	21.43	24.72	22.20	27.99	22.14	21.20
18:3 Linolenic acid	8.57	8.75	8.76	10.32	11.80	9.65
20:0 Arachidic acid	0.65	0.88	0.45	0.67	0.85	0.43
20:1 Gadoleic acid	4.16	2.28	2.96	2.03	3.14	1.33
20:2 Certoleic	0.43	0.22	0.23	0.38	0.21	0.21
22:0 Behenic acid	0.33	0.42	0.37	0.45	0.37	1.00
22:1 Erucic acid	8.67	3.01	6.30	2.70	6.26	0.15
Other	1.38	1.53	1.42	1.46	1.13	0.46
TOTAL	100.00	100.00	100.00	100.00	100.00	100.00

(1) Air dry basis

rapeseed oil. All of the rapeseed screenings oils had higher levels of erucic acid (2.7 to 8.7%) as compared to that found in Tower rapeseed oil (0.15%).

Summary

Five RSSMs and Tower RSM and samples of the screenings and Tower rapeseed from which the meals were produced were used in the study. The meals were analyzed for dry matter, protein, fat, crude fibre, ash, silica, calcium, phosphorus, glucosinolates and amino acid composition. The RSS and Tower rapeseed were analyzed for protein, amino acid levels, fat content and fatty acid distribution.

The results of the analyses of the meals showed the following:

1. The dry matter was very uniform and ranged from 89 to 91%.
2. The protein content of the meals and of the screenings ranged from 21.3 to 28.2 and from 17.7 to 23.1% respectively.
3. Levels of fibre varied from 12.2 to 19%. These values are higher than average values reported for RSM.
4. The ash content of the RSSMs ranged from 7.6 to 27.3% and were much higher than those commonly found in RSM, suggesting possible contamination with soil or sand.
5. Silica content of the samples ranged from 1.1 to 19%.
6. Levels of calcium and phosphorus were somewhat lower than average values found for RSM.
7. The low levels of glucosinolates present in the meals

varieties.

8. The distribution of amino acids in RSSMs was similar to that in Tower RSM; however, the levels of lysine, histidine and cystine were considerably lower in the protein of RSSMs than in the protein of Tower RSM. Higher levels of amino acids were found in the protein of unprocessed screenings than in the protein of meals produced by POS Pilot Plant Corporation suggesting possible heat damage during processing.

9. The oil content of the screenings varied from 19.6 to 28.0%. The low values found may be related to the small size of the seed and to the presence of non-rapeseed components in the screenings. The level of oleic acid was lower in the oil of RSS than in the oil of Tower rapeseed but the levels of erucic acid noted (2.7 to 8.7%) were higher than that noted in Tower rapeseed oil (0.15%).

SECTION II

Nutritive Value of Rapeseed Screenings Meals for Broilers and Laying Chickens

Status of the Problem

Cleaning of rapeseed for domestic processing may leave varying amounts of non-rapeseed components in the cleaned seed. As a consequence meals produced may contain fairly high levels of material that would be removed as screenings if the samples were thoroughly cleaned. Since it is not known what effect these components may have on the nutritive quality of RSM it seemed desirable to evaluate the quality of meals produced from rapeseed screenings in rations for broilers and laying hens.

A preliminary trial was conducted to assess the effects of including 0, 2.5 or 10% RSSM in a broiler ration. The rations were kept isonitrogenous and isocaloric by adjusting the levels of Tower RSM, wheat and stabilized animal fat. The RSSM used was a mix of equal quantities of each of the five RSSM that had been supplied. The results of the trial indicated that the different levels of RSSM used had no effect on growth rate or feed efficiency of broilers at 4 or 8 weeks of age. Consequently experiments were planned to assess the utilization of the RSSMs more fully.

Experiment 1

Object

To study the effect of adding different levels of a composite sample of RSSMs to rations for broilers.

Experimental

Six hundred male broiler chicks (White Mountain ♂ x Hubbard ♀) kept in floor pens (1.4 x 4.3 m) were divided into 12 comparable groups of 50 birds each. Two groups were placed on each of the rations shown in Table 5. The rations were formulated to be isocaloric and isonitrogenous by making appropriate adjustments in levels of wheat, stabilized animal fat, soybean meal, Tower RSM and dicalcium phosphate. As in the preliminary trial, the RSSM used was a mixture of equal quantities of each of the five RSSMs. Ration 1, consisting mainly of wheat and soybean meal, served as one control ration. Ration 2, was similar to Ration 1 except that it contained 10% Tower RSM. Rations 3-5 contained 2.5, 5 or 10% RSSM replacing Tower RSM and Ration 6 contained 10% RSSM replacing soybean meal.

Feed and water were supplied ad libitum. The chicks were given 24 hours of light per day during the first 3 days and 16 hours of light per day for the remainder of the experiment.

The birds were individually weighed at 4 and 8 weeks of age. Records were kept on mortality, feed consumption and incidence of perosis. Chicks designated as perotic included those in which some deformation and swelling of the tibio-tarsal joint was evident, as well as birds in which the Achilles tendon had slipped from the condyles and crippling had occurred.

The data obtained was subjected to analyses of

Table 5. Composition of broiler rations (1) (Experiment 1)

	Ration number					
Ingredients	1	2	3	4	5	6
Ground wheat	66.19	61.39	59.24	57.09	52.79	55.39
Stabilized animal fat	1.00	2.80	3.40	4.00	5.20	4.20
Dehydrated alfalfa	1.00	1.00	1.00	1.00	1.00	1.00
Meat meal (50%)	3.00	3.00	3.00	3.00	3.00	3.00
Soybean meal (47.5%)	25.00	18.20	18.20	18.20	18.20	22.60
Tower rapeseed meal (38.6% protein)	-	10.00	9.05	8.10	6.20	-
Rapeseed screenings meal (25.5% protein) (3)	-	-	2.50	5.00	10.00	10.00
Ground limestone	1.00	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate (18.8% Ca-21% P)	1.40	1.20	1.20	1.20	1.20	1.40
Iodized salt	0.25	0.25	0.25	0.25	0.25	0.25
Manganese oxide	0.02	0.02	0.02	0.02	0.02	0.02
Zinc oxide	0.01	0.01	0.01	0.01	0.01	0.01
Micronutrients (2)	1.13	1.13	1.13	1.13	1.13	1.13

(1) Calculated composition of the rations were as follows: ME, 2800 kcal/kg; protein, 22.2%; calcium, 1% phosphorus, 0.85%

(2) Supplied the following levels per kg of ration: vitamin A, 6000 IU; vitamin D3, 1200 ICU; vitamin E, 10 IU; menadione sodium bisulfate 1 mg; riboflavin, 4 mg; calcium pantothenate, 5 mg; niacin, 20 mg; choline chloride, 60 mg; folic acid, 1 mg; DL-methionine, 500 mg; biotin, 200 mcg; vitamin B12, 10 mcg; selenium, 0.1 mg; amprol (25% amprolium), 500 mg.

(3) Estimated ME value 1600 Kcal/kg

variance. Significance of differences was assessed by applying an "F" test at the 0.05% level of probability.

Results and Discussion

The performance of the birds on the different treatments of Experiment 1 is presented in Table 6. The average body weight of the birds fed 2.5, 5 or 10% RSSM replacing Tower RSM or 10% RSSM replacing soybean meal were not significantly different from the control group at 4 or 8 weeks of age. The low standard error of the means observed at 4 and 8 weeks of age indicated that the rate of gain in the groups was very uniform.

Efficiency of feed conversion (feed/gain) at 8 weeks of age was not affected by the treatments used. Even the highest level of inclusion did not influence efficiency of feed conversion.

No significant differences in level of mortality in the different groups were observed. There was, however, considerable variability in the rate of mortality in different replicates. The high level of mortality observed in the groups fed Ration 5 resulted from a very high level of mortality in one replicate and none in the other replicate. Thus the high-level noted could not be attributed to the treatment used.

The levels of perosis observed in this experiment could not be attributed to the treatment used. Levels observed fell well within the incidence generally noted in broilers when birds with some deformation of the hock joint are included along with those that are crippled.

Table 6. Effect of rapeseed screenings meal on the performance of broilers

	Ration number						
	1	2	3	4	5	6	SEM[1]
Treatment	SBM control	Tower RSM 10%	RSSM 2.5%	RSSM 5%	RSSM 10%	RSSM 10%	
Body wt (4wk)gm	689	637	675	701	680	662	± 23.60
Body wt (8wk)	2106	2040	2044	2084	2056	2048	± 18.46
Efficiency (feed/gain)	2.30	2.26	2.34	2.31	2.34	2.26	± 0.08
Mortality %	2.00	1.00	2.00	2.00	3.00	6.00	± 5.1[2]
Perosis %	2.00	4.00	2.00	1.00	3.00	1.00	

(1) Standard error of the mean

(2) Percentages of mortality were transformed to arc sin $\sqrt{\%}$ prior to the analysis

The application of an "F" test at 0.05% level showed no significant differences

Summary

Duplicate groups of 50 male broiler chicks (White Mountain ♂ x Hubbard ♀) were fed isocaloric and isonitrogenous rations containing 2.5 to 10% RSSM replacing Tower RSM or 10% RSSM replacing soybean meal.

The results obtained indicated that:

1. Additions of as much as 10% RSSM replacing either Tower RSM or soybean meal in broiler rations had no effect on body weight or efficiency of feed conversion.
2. Level of mortality observed was quite variable between replicates but showed no effect of ration treatment.
3. Incidence of perosis was low and could not be attributed to the treatment used.

Experiment 2.

Object

The addition of 10% of a composite sample of five RSSMs to broiler rations (Experiment 1) had no effect on productive performance of broilers; however, the possibility remained that a high level of one or more of the individual RSSM might have some effect. Consequently an experiment was conducted to determine the effect of adding the individual RSSMs to broiler rations.

Experimental

Five hundred and sixty sexed day-old broiler chicks (White Mountain x Hubbard) were used in this trial. The chicks were randomly alloted into 14 groups, each containing 20 males and 20 females. From one-day old until the end of the experiment (8 weeks of age) each group was kept in a floor heated pen (1.5 x 4.2 m). Two groups of chicks were fed each of the rations shown in Table 7. The control rations were the same as those used in Experiment 1. Rations 3 to 7 contained 10% of each of the RSSMs A, B, C, D and F respectively replacing soybean meal. All of the rations were designed to be isocaloric and isonitrogenous.

The management of the broilers and the records kept were the same as in Experiment 1.

At the end of the experiment, four males and four females from each group were sacrificed by cervical dislocation, weighed and their livers and thyroid glands were removed. The livers were weighed and the ratios liver weight-to-body weight were calculated. Each liver was visually scored for fat content according to the procedure outlined by Serrano (1976) in which grades ranging from 1 to 5 were assigned. Grade 1 was given to livers of normal dark red appearence and the grade number was increased progressively as the fatness of the livers increased. A grade of 5 was given to livers that were pale in color and friable.

The thyroid glands of the birds were removed, cleaned of adhering fat and tissues and weighed. The ratio between thyroid weights and body weight was then calculated.

The data obtained were subjected to analysis of variance and the significance was established by applying Duncan's Multiple Range Test (Steel and Torrie, 1960) at the 0.05% level of probability.

Table 7. Composition of broiler rations[1] (Experiment 2)

	Ration number						
	1	2	3	4	5	6	7
Ingredients							
Ground wheat	66.19	61.39	54.69	55.09	56.59	56.79	56.19
Stabilized animal fat	1.00	2.80	4.10	4.10	3.90	3.90	4.00
Dehydrated alfalfa meal	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Meat meal (50%)	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Soybean meal (47.5%)	25.00	18.20	23.60	23.10	21.90	21.70	22.10
Rapeseed screenings meals	-	-	10.00	10.00	10.00	10.00	10.00
Tower rapeseed meal(38.6% protein)	-	10.00	-	-	-	-	-
Ground limestone	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Dicalcium phosphate(18% Ca-21% P)	1.40	1.20	1.20	1.30	1.20	1.20	1.30
Iodized salt	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Manganese oxide	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Zinc oxide	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Micronutrients[2]	1.13	1.13	1.13	1.13	1.13	1.13	1.13

(1) Calculated composition of the rations were as follows: ME, 2800 kcal/kg; protein, 22.2%; calcium, 1%, phosphorus, .85%.

(2) Supplied the following levels per kg of ration: vitamin A, 6000 IU; vitamin D3, 1200 ICU; vitamin E, 10 IU; menadione sodium bisulfate, 1mg; riboflavin, 4 mg; calcium pantothenate, 5 mg; niacin , 20 mg; choline chloride, 60 mg; folic acid, 1 mg; DL-methionine, 500 mg; biotin 200 mcg; vitamin B12, 10 mcg; selenium, 0.1 mg; amprol (25% amprolium) 500 mg.

Results and Discussion

The results obtained are summarized in Table 8.

Average body weights of the birds fed the rations containing 10% of each RSSM (Ration 3 to 7) were not significantly different from those fed the control rations (Rations 1 and 2) at 4 or 8 weeks of age. As in Experiment 1, the standard error of the means was low which indicated that the rate of gain within each treatment was relatively uniform.

Inclusion of the different samples of RSSMs in the rations had no effect on efficiency of feed conversion (feed/gain). Values observed were similar for all the treatments at 4 or 8 weeks of age.

Although additions of 10% of RSSMs to broiler rations had no effect on the rate of gain or feed efficiency, significant differences in the ratios of liver-to-body weight were observed. The liver-to-body weight ratio of the birds on Ration 3 containing RSSM A was significantly higher than those of the control groups (Rations 1 and 2). Birds fed rations 3 and 5 containing RSSM A and C respectively had liver-to-body weight ratios significantly greater than birds on Rations 2, 4, 6, and 7, containing Tower RSM and RSSM B, D and E respectively.

It was also observed that the ratios of liver-to-body weight of females were greater than those of males in the groups fed RSSM or Tower RSM but were less in the control group. No explanation for the difference is apparent.

There were no significant differences between treatments in visual fat scores. There was however, consider-

Table 8. Effect of individual rapeseed screenings meals on the performance of broilers.

	Ration number							
	1	2	3	4	5	6	7	SEM (1)
Treatment	SBM Control	Tower RSM 10%	RSSM A 10%	RSSM B 10%	RSSM C 10%	RSSM D 10%	RSSM E 10%	
4 weeks								
Body wt(g)	735	708	713	715	708	699	691	± 23.60
Feed conversion (g feed/g gain)	1.78	1.80	1.75	1.76	1.81	1.78	1.83	± 0.04
8 weeks								
Body wt(g)	1999	1989	1994	2033	2020	2033	1975	± 22.20
Feed conversion (g feed/g gain)	2.48	2.44	2.40	2.37	2.46	2.36	2.39	± 0.03
Liver wt(g/100 g body wt)								
Females	2.82	3.06	3.40	3.09	3.15	2.65	2.88	
Males	2.97	2.66	2.81	2.45	2.85	2.61	2.84	
Average	2.89[bc]	2.86[c]	3.11[a]	2.77[c]	3.00[ab]	2.63[c]	2.86[c]	± 0.39
Average liver scores								
Females	2.75	2.88	3.38	2.88	2.88	3.88	3.12	
Males	2.88	3.38	3.75	3.75	3.75	3.62	3.50	
Average	2.81	3.12	3.56	3.31	3.19	3.75	3.31	± 0.30
Thyroids wt (mg/100g body wt)	11.10[c]	16.42[a]	10.18[c]	12.46[bc]	15.31[ab]	12.92[bc]	17.43[a]	± 0.98
Mortality %	2.50	1.25	1.25	1.25	8 75	2.50	1.25	± 3.48
Perosis %	0.0	2.50	3.75	0.0	1.25	1.25	2.50	

•Row values with the same letters or no letter are not significantly different ($p \geq 0.05$)
1) Standard error of the mean 2) Percentage values were transformed to arc sin V% prior to analysis

able variability in fatness of the livers within treatments. Despite variation noted there was no evidence of haematomas that might have indicated an effect of the treatment on incidence of liver haemorrhages.

The inclusion of RSSMs in broiler rations significantly affected thyroid-to-body weight ratios. Differences noted were closely related to the levels of glucosinolate in the meals. The thyroid-to-body weight ratios of the chicken fed RSSM A, B and D were similar to that of the control group; however, the ratios observed in the groups fed Tower RSM or RSSM C and E were significantly higher than that of the control group.

In spite of the increase in thyroid size observed in some treatments there was no evidence of any detrimental effect on the rate of growth or feed efficiency. The lack of effect on these parameters may be related to the adjustment process that occurs in the gland and that has been described by Clandinin (1966). It has been observed previously (Clandinin 1973a; Clandinin et al. 1976; Slinger et al. 1976 and Robblee et al. 1978) that the degree of enlargement of the thyroid gland as a result of feeding low glucosinolate RSM in broiler diets apparently had no effect on productive performance.

Mortality levels were low in all the treatments except the one fed Ration 5 containing RSSM sample C. Statistical analysis of mortality levels, however, indicated that even this treatment was not significantly different from the others.

Incidence of perosis was well within the levels that are frequently observed in broiler chickens. There was no indication that any of the RSSMs affected the occurrence of this disorder.

Summary

Duplicate groups of 20 males and 20 females broiler chicks (White Mountain x Hubbard) were fed isocaloric and isonitrogenous rations containing 10% of each of the RSSMs or Tower RSM. The meals were introduced by replacing soybean meal and wheat in the control ration.

The results obtained indicated that:

1. Rate of growth and efficiency of feed conversion were not significantly affected by the inclusion of 10% of any of the RSSMs in the rations.
2. The inclusion of 10% RSSM A (Ration 3) resulted in an increase in liver-to-body weight ratio but no effect on the productive performance of the birds was observed. Visual scores for fat content of the livers were not statistically different and there was no evidence of increased incidence of liver haemorrhages.
3. Thyroid-to-body weight ratios were closely related to the content of glucosinolate in the meals, but despite the differences that occurred, no effect on the performance of the birds were observed.
4. Mortality and incidence of perosis were low throughout the experiment and were not affected by the treatment used.

Experiment 3.

Object

To study the effect of adding several levels of a composite sample of RSSM to rations for laying hens.

Experimental

Seven hundred and sixty Shaver Starcross 288 laying hens, 22 weeks of age, were randomly assigned to six treatment groups. Each treatment group consisted of 4 replicates of 32 hens each, housed in cages (2 birds per 30 x 40 cm cage).

The rations fed (Table 9) contained four levels of RSSM (0, 2, 4, or 8%) and two levels of Tower RSM (4 or 8%) replacing soybean meal.

All rations were formulated to contain 2660 kcal of metabolizable energy per kg, 15.7% protein, 3.4% calcium and 0.7% phosphorus. As in Experiment 1 the RSSM used was a composite sample prepared by mixing equal amounts of each of the five RSSMs supplied by POS Pilot Plant Corporation.

Feed and water were supplied ad libitum. Artificial light was provided to give the birds 14 hours of light per day. The experiment was terminated after 280 days on test.

Records were kept on egg production, feed consumption, egg weight, Haugh unit values and egg specific gravity. Egg production was recorded daily and feed consumption was determined at the end of each 28 days period. Egg weight was determined once a week based on a one-day collection of eggs from each replicate. Haugh units and specific gravity were measured once a month on all the eggs produced

Table 9. Composition of laying rations[1] (Experiment 3)

	Ration number					
Ingredients	1	2	3	4	5	6
Ground wheat	74.12	72.17	70.22	72.045	69.97	65.82
Stabilized animal fat	1.00	1.70	2.40	1.60	2.20	3.40
Dehydrated alfalfa meal	2.00	2.00	2.00	2.00	2.00	2.00
Soybean meal (47.5%)	12.00	9.30	6.60	11.50	11.00	10.00
Tower rapeseed meal (38.6% protein)	-	4.00	8.00	-	-	-
Rapeseed screenings meal (25.5% protein)	-	-	-	2.00	4.00	8.00
Ground limestone	8.00	8.00	8.00	8.00	8.00	8.00
Dicalcium phosphate (18% Ca-21% P)	1.50	1.45	1.40	1.475	1.45	1.40
Iodized salt	0.35	0.35	0.35	0.35	0.35	0.35
Manganese oxide	0.02	0.02	0.02	0.02	0.02	0.20
Zinc oxide	0.01	0.01	0.01	0.01	0.01	0.01
Micronutrients[2]	1.00	1.00	1.00	1.00	1.00	1.00

[1] Calculated composition of the rations were as follows: ME, 2660 kcal/kg;protein, 15.7%; calcium, 3.4%; phosphorus, 0.68%.

[2] Supplied the following levels per kg of ration: Vitamin A, 8000 IU; vitamin D3, 1200 ICU; vitamin E, 5 IU; riboflavin, 3 mg; calcium pantothenate. 6 mg; niacin, 15 mg; choline chloride, 100 mg; vitamin B12, 7.5 mcg; biotin, 50 mcg; DL-methionine, 500 mg.

in one day. The birds were individually weighed at the beginning and end of the experiment and the change in body weight was noted. Daily records on mortality were kept and all the birds that died were sent to the Provincial Veterinary Laboratory, Edmonton, in order to ascertain the cause of death.

At the end of the experiment five hens per replicate were sacrificed by cervical dislocation. The livers were examined in the same manner as described in Experiment 2 and were rated for fat content according to the procedure outlined by Serrano (1976). The livers were removed, examined for signs of haematomas and weighed. The thyroid glands were also removed, cleaned of adhering fat and weighed. Thyroid-to-body weight ratios were then calculated.

The data were subjected to analysis of variance and significance of the differences were evaluated by applying Duncan's Multiple Range Test (Steel and Torrie, 1960).

Results and Discussion

The effects of feeding rations containing RSSM to laying hens are presented Table 10. The results obtained indicated that additions of 2, 4 or 8% RSSM or 4 or 8% Tower RSM did not affect egg production (expressed as hen-housed or hen-day production), egg weight, Haugh unit values, egg specific gravity, or efficiency of feed conversion. However, body weight gain, liver weight (g of liver/100g body weight), thyroid weight (mg/100g body weight) and mortality were significantly affected by the treatments used. Weight gain of the hens fed the rations containing 2,4, and 8% RSSM or

Table 10. Effect of rapeseed screenings meal on the performance of laying hens.

	Ration number						
	1	2	3	4	5	6	SEM(1)
Trait	SBM control	Tower RSM 4%	Tower RSM 8%	RSSM 2%	RSSM 4%	RSSM 8%	
Hen-housed production	74.[illegible]	75.2	76.3	75.[illegible]	74.1	74.7	± 1.28
Hen-day production	78.2	77.3	77.9	[illegible]	76.3	79.5	± 1.06
Egg weight	59.4	58.5	58.3	58.[illegible]	58.7	58.8	± 0.29
Egg Haugh units	84.0	83.5	81.9	81.9	82.8	82.8	± 0.73
Egg specific gravity	1.082	1.082	1.082	1.083	1.082	1.083	± 0.0004
Feed/doz egg, kg	1.80	1.77	1.75	1.75	1.77	1.72	± 0.02
Initial body wt, kg	1.49	1.49	1.50	1.51	1.50	1.50	
Final body wt, kg	2.00	1.92	1.86	1.84	1.84	1.78	
Body weight gain, kg	0.51[a]	0.43[ab]	0.36[bc]	0.33[bc]	0.34[bc]	0.28[c]	± 0.04
Liver wt(g/100 g body wt)	3.50[a]	3.54[a]	3.47[a]	3.26[ab]	2.90[b]	2.85[b]	± 0.18
Liver scores	3.50	3.25	3.45	3.30	3.00	2.70	± 0.26
Thyroid weight (mg/100 g body wt)	8.98[c]	13.69[a]	14.64[a]	11.13[bc]	12.34[ab]	13.29[ab]	± 0.79
Mortality %	7.8[ab]	8.6 [ab]	5.5 [b]	4.7 [b]	7.8 [b]	13.3 [a]	± 1.78

Row values with the same letters or no letter are not significantly different ($p \geq 0.05$)
1) Standard error of the mean 2) Percentage values were transformed to arc sin $\sqrt{\%}$ prior to analysis

8% Tower RSM was significantly lower than that of hens fed the control ration (Ration 1). Hens fed 4% Tower RSM had body weight gain similar to the controls There were no significant differences in body weight gain of hens fed the different levels of RSSM and of those fed 8% Tower RSM. The results of body weight gain of birds fed 8% Tower RSM, in this experiment, differ from those reported by Thomas (1978), who noted that even 15% Tower RSM added to rations for laying hens had no effect on the final weight of the birds.

The effects of treatment on liver size were variable. Additions of 4 and 8% RSSM resulted in decreased liver-to-body weight ratios but inclusion of 4 or 8% RSM had no significant effect. Olomu et al. (1975) and Thomas (1978 also observed that addition of RSM to laying rations did not affect liver size but Marangos and Hill (1976) reported increased liver weights when rations containing high levels of high glucosinolate RSM were supplied.

Visual rating of the livers indicated that the treatments used had no significant effect on the fatness of the livers. Within each treatment there were wide variations in the scores assigned. Examination of the livers indicated some incidence of haemorrhagic liver syndrome (HLS). Approximately 23% of the livers examined showed lesions related to this disorder, approximately 9% had pin-point lesions, 7% had haematomas and 7% showed evidence of coagulated blood surrounding the liver. There was, however, no indication that the disorder was in any way related to the use of RSSM or Tower RSM. Clandinin et al. (1977) reported that the incidence of HLS was higher in some susceptible breeds or strains of chickens and that it was increased by the addition of high glucosinolate RSM to the diets.

The size of the thyroid (mg/100g body weight) was increased by the addition of RSSM in the rations. Inclusion of 4 or 8% Tower RSM or 4 or 8% RSSM in the rations resulted in thyroid-to-body weight ratios significantly higher than those from birds fed the control rations. The addition of 2% RSSM to the ration resulted in thyroid weights similar to those of the control ration but significantly smaller than those of birds fed 4 or 8% RSSM.

As in the experiments with broilers the enlargement of the thyroid glands was proportional to the content of glucosinolate in the meals included in the ration. In spite of the differences observed in thyroid size the productivity of the laying hens was not affected by the use of RSSM or Tower RSM. This is in agreement with results reported by Clandinin (1973b) Smith and Campbell (1[illegible]); Slinger et al. (1976); Clandinin et al. (1976) and Thomas et al. (1978).

The level of mortality observed in the experiment was somewhat higher than has been experienced in other recent trials and considerable variability between replicates was observed. There were no significant differences in mortality between the treatments and the control ration, but the hens fed 8% RSSM did show a higher rate of mortality than those fed 2 or 4% RSSM and 8% Tower RSM.

Summary

Quadruplicate groups of 32 Shaver Starcross 288 laying hens were fed isocaloric and isonitrogenous rations containing varying levels of RSSM (0, 2, 4, or 8%) or Tower RSM (4 or 8%) for an experimental period of 280 days commencing when the pullets were 22 weeks of age. The results observed indicated the following:

1. Additions of as much as 8% RSSM to laying rations had no significant effects on egg production, egg size, Haugh unit values, egg specific gravity or efficiency of feed conversion.

2. Rate of gain during the laying period was reduced by inclusion of 2, 4, or 8% RSSM or 8% Tower RSM in the ration.

3. Liver size in relation to body weight was reduced when 4 or 8% RSSM was included in the ration. Assessment of liver fat content by visual grading indicated that there was no significant difference in the fat content of the livers of birds from the different treatments. Approximately 20% of the livers examined had signs of HLS, but incidence of the disorder did not appear to be related to the treatments used.

4. Increases noted in the size of the thyroid glands appeared to be directly related to the level of glucosinolates present in the diets fed. Thyroids from birds fed diets containing 4 or 8% Tower RSM (Ration 2 and 3) or 4 or 8% RSSM (Ration 5 and 6) were significantly larger than those from the control group

(Ration 1).

5. Mortality was relatively high in all treatments but did not appear to be related to the rations fed. The rate of mortality in groups fed 8% RSSM was significantly higher than in treatments in which 8% Tower RSM and 2 or 4% RSS was fed.

GENERAL DISCUSSION

As was indicated in the Introduction, approximately 3.4 million tonnes of rapeseed were produced in Canada in each of 1978 and 1979, more than half of which will be sold to other countries. Considering that the cleaning process to bring the rapeseed up to export standards yields 8 to 10% of screenings and cleaning for domestic processing may yield varying levels, as much as 150 thousand tonnes of screenings might be available for feeding purposes. If the screenings were processed to remove the oil present there would probably be a potential production of approximately 100 thousand tonnes of RSSM.

Because of the nature of screenings there are wide variations in their chemical composition. Analysis of the individual RSS that were used in this study showed such variation. The protein content varied from 17.7 to 23.1 and the fat content varied from 19.6 to 28.1 per cent. This suggests that the proportion of stems and pods in some samples were much higher than in others. For this reason, samples of screenings or screenings meals should be analyzed before being included in a feeding program.

It was obvious that the composition of the RSS used in the experiments reported here were vastly different than those used by Bell and Linton (1961), Bell and Devlin (1972) and Robertson (1973). RSS used in the present study contained an average of 20.4 per cent crude protein and 25 per cent crude fat. In contrast Bell and Linton (1961) reported that several RSS samples had crude protein contents ranging from 8 to 11 per cent and a crude fat content of 18 per cent, and Bell and

Devlin (1972) reported that a sample of RSS contained 16 per cent protein and 12 per cent fat. Since these levels are well below the lowest values observed in the five RSS in this experiment, it suggests that the RSS used previously had a high level of contamination with materials such as stems and pods which are low in protein and fat content.

No information on the way in which the RSS were obtained is available. The high levels of silica in one of the samples of meal suggested that the screenings were scraped up from a field and contained a fairly high level of sand. A similar observation was made by Robertson (1973) who in examining samples of RSS found evidences that some soil was included in the samples.

It was apparent from this study that the RSSMs contained a lower level of protein than Tower RSM; however, the amino acid distribution in the protein of the RSSMs and Tower RSM was similar. This is probably the reason why inclusion of RSSM in broiler and laying rations had no effect on their performance. The results obtained suggest that inclusion of some of the screenings in rapeseed at time of processing would not have a very great effect on the biological value of the meal provided the rations fed were kept isocaloric and isonitrogenous.

Despite the relatively good results obtained with RSSMs, the variability in composition of the different samples is of concern. If RSSMs were to receive widespread acceptance as a feedstuff for inclusion in poultry feeds, it would be necessary to produce meals with relatively uniform composition. It might be necessary to ean the screenings to remove materials of high fibre content such as stems and pods before oil processing. If meals of as high a protein and as low a fibre content possible were produced it would appear that they could be utilized satisfactorily in rations for broilers and laying chickens.

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