Journal of Animal and Feed Sciences, 6, 1997, 109 – 121

Chemical composition, energy value for chickens, and protein utilization in rats of rapeseed expeller cakes produced by different pressing technologies

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(Received 4 September 1996; accepted 6 February 1997)

ABSTRACT

The chemical composition, glucosinolate, total and available lysine contents were determined in seven rapeseed „00" expeller cakes and one solvent meal. Five cakes were produced using a 02 ZVO press from seeds heated to 40-50°C (REM), one cake using a Rosedown press from seeds heated to over 80°C (REC No. 6), and one was an industrially prepressed cake from seeds heated to over 80°C (REC No. 7). The fat content in the cakes ranged from 10.3 to 23.2% DM. The glucosinolate content in the cakes ranged from 13.4 to 55.1 mM/g FFDM and was close to that in raw seeds when compared on a fat-free DM basis.

Energy value (AME_N) of REM cakes and REC No. 7 determined on chicken varied widely (8.55 to 14.60 MJ/kg DM) and was positively correlated with their fat content. Biological value (BV) of protein of four REM, two REC and solvent meal determined in rats varied from 80.1 to 96.7, despite rather uniform total and available lysine contents. BV, feed intake and weight gain of rats fed on REM tended to decrease while relative thyroid weight tended to increase as the glucosinolate content in cakes rose.

It is concluded that the nutritional value of rapeseed expeller cakes produced from mildly heated seeds may vary considerably, the main factor affecting AME_N being fat content, while that affecting protein value being the glucosinolate content.

KEY WORDS: rapeseed expeller cake, glucosinolates, lysine, energy, protein utilization

INTRODUCTION

Recent interest in expelling oil from double-low rapeseed has been stimulated by the need for a more cost effective technology than prepressing/solvent extraction, and also by the higher energy value of expeller cakes than solvent extracted meals. The nutritional value of rapeseed cakes depends on the quality of seeds, particularly on the level of glucosinolates, and on the technology of expelling, which may affect myrosinase activity, glucosinolate, and total and available lysine contents.

Increasing amounts of double-low rapeseed grown in Poland are processed in small rural mills equipped with screw press expellers (Podkówka and Podkówka, 1993; Podkówka et al., 1994). The effects of introducing rapeseed 00 expeller cakes to poultry and pig diets were investigated by several authors (Kinal et al., 1990; Smulikowska et al., 1990; Tywończuk et al., 1994; Frankiewicz et al., 1995), little is known, however, about the variability of their composition and nutritional value. According to Podkówka et al. (1994) the fat content in 12 samples of rapeseed 00 expeller cake produced over a several-month period using the same press was rather uniform (12-15% DM), while the content of other components varied to a small extent depending on the degree of oil removal.

The present study was undertaken to assess the variability of the chemical composition, glucosinolate content and nutritional value of rapeseed 00 expeller cakes produced on screw expellers from mildly heated seeds (REM), and to compare them with the cakes produced from rape seeds heated to over 80°C (cooked) prior to pressing (REC). Metabolizable energy value of expeller cakes was determined in chickens, while their protein value was assayed in rats.

MATERIAL AND METHODS

Material

Seven samples of expeller cakes and one sample of solvent extracted meal (RSM) produced from 00-type rape seed of unknown varieties were evaluated.

Five samples (REM No.1 to 5) were manufactured in small rural mills using the 02 ZVO type screw press expeller of Polish production. Prior to pressing, the seeds were mildly heated to 40-50°C (Podkówka and Podkówka, 1993), the temperature during pressing was about 75°C (personal information).

Two cakes (REC No. 6 and No. 7) were produced from seeds cooked with steam to a higher temperature. REC No. 6 was manufactured from seeds heated for 90 min at temperatures increasing from 60°C to 100-105°C (unpublished data) and next pressed on a Rosedown type screw expeller (de Smet technology). REC

No.7 was an industrially prepressed cake from seeds heated to over 80°C, while solvent meal (RSM) was produced by industrial extraction of REC No. 7 followed by toasting.

Experiment on chickens

Samples of REM No. 1 to 5 and the REC No. 7 were evaluated. Apparent metabolizable energy value corrected for zero N balance (AME_N) and apparent digestibility of nutrients were determined on 4-week-old broiler cockerels (Starbro) with a mean initial body weight of 774 g. The birds were housed individually in balance cages, 10 birds per treatment, and were fed a cold pelleted basal diet (Table 3) or diets containing 60% of basal diet and 40% of ground expeller cakes combined on a DM basis. All the diets contained 0.3% Cr_2O_3 as a marker. The diets were fed at the level of 90 g/bird/day, in three meals. After two days of preliminary feeding the birds were fasted during 14 h then fed on the same diets for 3 days, and fasted for 14 h. Feed intake was recorded during the whole time, while during last 86 h of the experiment, excreta were collected, frozen, kept at – 18°C, and freeze-dried for analysis.

Experiment on rats

Four samples (No. 1 to 4) of REM, REC No. 6 and No. 7, and solvent extracted meal (RSM-sample No. 8) from the same processing as cake No. 7 were evaluated. The semisynthetic diets contained the expeller cakes or RSM as the only source of protein at a level corresponding to 9.5% CP. Crude fat content was equalized in all diets to 7.3% by addition of rape seed oil, and crude fibre content to 4.6% by addition of cellulose. The diets were supplemented with minerals according to NRC (1976) and vitamins according to AOAC (1975), 12% sucrose and wheat starch to 100 per cent.

True digestibility (TD) and biological value (BV) of protein were determined according to the Thomas-Mitchell method in a balance experiment performed on 29-day-old male outbred IF_χ JAZ rats with mean initial body weight 78 g, seven animals per treatment. The rats were housed individually in balance cages and were fed 11 g of experimental diets per day during 10 days. Feed intake was recorded, and faeces and urine were collected during the last 6 days. TD and BV were corrected for metabolic and endogenous urinary N, respectively, according to Lehman et al. (1968). Net protein utilization (NPU = BVxTD) and utilizable protein (NPV = NPUxCP content,%) values were calculated.

Growth performance was assayed on 25-day-old male outbred rats with mean initial body weight 59 g, seven animals per treatment. The animals were fed on the diets *ad libitum* during 21 days, feed intake and body weight were recorded

weekly. At the conclusion of the experiment the animals were killed, the livers and thyroids were excised and immediately weighed.

Chemical and statistical analysis

Chemical composition of expeller cakes, chick diets and excreta, and N content in rat diets, faeces and urine were determined by standard methods (AOAC, 1994). NDF and ADF content in cakes and meal were determined according to Van Soest (1967) on a Fibertec M (Tecator) apparatus, glucosinolates were determined by HPLC according to the ISO-9167 method (1991). Total lysine was assayed using a type 6300 Beckman Analyzer, while available lysine by the method of Booth (1971). In chicken excreta, crude fat was determined by ethyl ether extraction without acid hydrolysis, faecal N by Ekman et al. (1949). Gross energy of cakes, chick diets and excreta was measured on a Perr adiabatic oxygen bomb calorimeter KL-10, chromic oxide was determined spectrophotometrically following wet ashing according to the procedure described by Hinsberg et al. (1953). Apparent digestibility of nutrients and AME_N value of the diets were calculated relative to the ratio of Cr_2O_3 to the content of gross energy or nutrient in question in food and droppings. AME_N was corrected to zero nitrogen balance using 1.96 MJ/g nitrogen retained (Hill and Anderson, 1958). AME_N and the apparent digestibility of crude protein, crude fat and NFE of cakes was calculated from the difference between respective values of basal and experimental diets according to Campbell et al. (1983) and Pesti and Ware (1986). Experimental AME_N values were compared with values calculated from chemical composition using formulas for rapeseed expeller meal according to European Table of Energy Values for Poultry Feedstuffs (1989).

The results were subjected to one way analysis of variance. The significance of differences among groups was estimated by the Duncan multiple range test using „Statgraphics Plus" ver. 7 software.

RESULTS

Chemical composition

The chemical composition of rapeseed expeller cakes and RSM is given in Table 1 while their glucosinolate and lysine contents in Table 2. Fat content varied from 10 to 15% DM in four samples of REM and in REC, while it exceeded 21% DM in REC from the oil factory (No. 7) and in REM No. 4. Protein content was lower than in the RSM and was slightly greater in the expeller cakes having a lower fat level. Crude fibre content varied from 10.8 to

TABLE 1

Chemical composition of rapeseed press cakes and solvent meal, % DM

Product	DM, %	Protein	Ether extract	Crude fibre	NFE	ADF	NDF
Cake REM 1[1]	92.51	34.0	10.3	11.8	36.8	18.4	20.7
REM 2[1]	92.31	31.5	14.3	11.8	35.7	18.8	20.6
REM 3[1]	92.29	31.0	14.8	12.6	34.9	18.5	20.0
REM 4[1]	91.70	30.0	23.2	10.8	30.4	14.7	17.5
REM 5[1]	90.88	32.2	14.5	12.3	34.5	18.3	19.6
REC 6[2]	95.61	32.3	13.0	15.5	32.4	21.3	29.6
REC 7[3]	92.07	28.7	21.2	10.5	33.8	21.6	24.8
Meal RSM 8[4]	89.56	36.8	3.9	12.8	40.8	23.2	33.8

[1] seeds mildly heated and pressed with 02 ZVO press
[2] seeds cooked and pressed with „Rosedowns" press
[3] seeds cooked and prepressed from standard processing in oil factory
[4] solvent extracted and toasted meal

15.5% DM. Total lysine content in all expeller cakes ranged between 5.90 to 6.41/16 g N and was higher than in RSM (5.26 g/16g N). Available lysine content was rather uniform in the cakes except cake No. 5 (4.76 g/16g N), it was also lower in the RSM (4.42 g/16g N). The glucosinolate content in REM samples varied from 13.4 to 30.4 mM/g fat free DM (Table 2), it was the highest in the REC and RSM from the oil factory (55.1 and 42.3 mM/g fat free DM, respectively).

TABLE 2

Glucosinolates, and total and available lysine contents in rapeseed products

Product	Glucosinolates				Lysine, g/16g N	
	mM/gDM		mM/gFFDM		total	available
	cakes	seeds	cakes	seeds		
Cake REM 1[1]	15.5	8.3	18.9 (112)[x]	16.9	6.40	5.29
REM 2[1]	16.6	11.6	21.3 (89)	23.8	6.33	5.06
REM 3[1]	23.6	17.0	30.4 (84)	36.4	6.41	5.30
REM 4[1]	23.2	18.6	33.9 (92)	36.5	6.24	5.28
REM 5[1]	10.2	nd	13.4	nd	6.16	4.76
REC 6[2]	24.4	nd	29.5	nd	6.22	5.25
REC 7[3]	39.1	23.3	55.1 (112)	49.1	5.90	5.07
Meal RSM 8[4]	36.2	23.3	42.3 (86)	49.1	5.26	4.42

[1, 2, 3, 4] - as in table 1
nd – non determined
[x] – percent of content in the seeds

TABLE 3

Composition of basal diets, in %. Experiment on chicken

Ingredients	%
Soyabean meal	28.0
Wheat	67.7
Calcium carbonate	1.4
Dicalcium phosphate	1.6
NaCl	0.6
Vitamin-mineral premix*	0.7

* supplied per kilogram of diet: vit. A 14000 IU; vit. D_3 2800 IU; vit. E 21 mg; vit. K 2.8 mg; vit. B_1 1.4 mg; vit. B_2 5.6 mg; vit. B_6 2.8 mg; vit. B_{12} 0.0168 mg; niacin 21 mg; pantothenic acid 14 mg; folic acid 0.7 mg; biotine 0.07 mg; choline 280 mg; Mn 84 mg; Zn 70 mg; Fe 28 mg; Cu 8.4 mg; J 0.56 mg; Se 0.21 mg; Co 0.28 mg

Glucosinolate content expressed on DM basis was higher in cakes than in unprocessed seeds from which the cakes were produced, however, if expressed on a fat-free dry matter (FFDM) basis, the average content of glucosinolates in the expeller cakes was from 84 to 112% of that in the seeds, the observed differences were rather the effect of analytical error.

Digestibility of nutrients and metabolizable energy for chickens

The digestibility of crude protein, crude fat and NFE varied to great extent among the cakes (Table 4), and was the greatest in REM No. 4 (83.0, 83.1 and 68.3%, respectively) and the lowest in REM No. 5 (69.5, 72.7 and 37.1% respectively), which had also the lowest available lysine content (Table 2).

The digestibility of nutrients affected the metabolizable energy value determined with chickens ($AME_N e$) which varied from 8.55 MJ/kg DM in REM No. 5 to 14.60 MJ/kg DM in REM No. 4. $AME_N e$ of the cakes was positively correlated with their fat contents ($r = 0.82$; $P \leqslant 0.05$).

The metabolizable energy content calculated from the chemical composition of cakes according to the equations given in the European Table of Energy Values of Poultry Feedstuffs (1989) varied from 9.83 to 13.43 MJ/ kg DM and was positively correlated with experimental values ($r = 0.85$; $HP \leqslant 0.05$). The greatest discrepancy between experimental and calculated values was found in cakes differing in nutrient digestibility, in REM No. 4 $AME_N e$ being 1.17 MJ/kg DM higher while in REM No. 5-2.27 MJ/kg DM lower than respective values calculated from chemical composition, the standard deviation for the last value was considerably greater than average.

Utilization of gross energy (AME_N/EB ratio) varied from 38 to 60%.

TABLE 4

Apparent digestibility of crude protein (CP), crude fat (CF) and NFE, AME_N (MJ/kg DM) and metabolizability of energy (AME_Ne/GE in %), in evaluated rapeseed expeller cakes. Experiment on chickens

Product	Apparent digestibility, %			$AME_N \pm SD$	AME_Nc	AME_Ne/GE
	CP	CF	NFE			%
REM 1	76.6^{cdC}	77.4^{abAB}	47.7^{A}	9.84 ± 0.81	9.83	45.7^{bB}
REM 2	71.6^{abAB}	74.6^{aA}	41.4^{A}	9.77 ± 0.64	10.82	43.3^{bAB}
REM 3	78.6^{dCD}	74.4^{aA}	42.0^{A}	11.83 ± 0.73	10.87	52.9^{cC}
REM 4	83.0^{eD}	83.1^{bB}	68.3^{B}	14.60 ± 0.64	13.43	60.4^{dD}
REM 5	69.5^{aA}	72.7^{aA}	37.1^{A}	8.55 ± 1.12	10.82	38.1^{aA}
REC 7	74.8^{bcBC}	75.6^{aAB}	40.7^{A}	12.37 ± 0.86	12.62	52.8^{cC}
SEM	0.86	1.42	2.83			2.13

* AME_Ne – metabolizable energy value obtained in experiment; AME_Nc – metabolizable energy value calculated from chemical composition according to equation after European Table of Energy Values for Poultry Feedstuffs (1989): AME_N(kJ/kg) = 13,71 x CP + 34,94 x CFat + 5,543 x NFE (CP, CFat and NFE in g/kg DM)

$^{a, b, A, B}$ – a, b – $P \leqslant 0.05$; A, B – $P \leqslant 0.01$

Nutritional value of cake and meal protein for rats

True digestibility of protein of the cakes determined in the experiment on rats was rather uniform (Table 5), the only significant difference was found between the TD of REM No. 1 (85.5) and No. 4 (79.9).

The biological value of REM protein varied from 80 in REM No. 4 to over 96 in REM No. 1 and was negatively correlated with the glucosinolate content in the cakes ($r = -0.90$), the relationship was not, however, confirmed statistically

TABLE 5

Nutritional value of cake and meal protein for rats

Product	True digestibility TD	Biological value BV	Net protein utilization NPU	Net protein value NPV
Cake REM 1[1]	79.9^{a}	96.3^{dC}	76.9^{bAB}	26.1
REM 2[1]	83.0^{ab}	90.5^{cBC}	75.1^{abAB}	23.6
REM 3[1]	83.3^{ab}	88.7^{bcB}	74.0^{abAB}	22.9
REM 4[1]	85.5^{b}	80.1^{aA}	68.6^{aA}	20.6
REC 6[2]	82.4^{ab}	96.7^{dC}	80.2^{bB}	23.8
REC 7[3]	82.7^{ab}	89.1^{bcB}	73.8^{abAB}	21.2
Meal RSM 8[4]	81.2^{ab}	84.6^{abAB}	68.8^{aA}	25.3

$^{1, 2, 3, 4}$ – as in table 1

$^{a, b, A, B}$ – as in table 4

TABLE 6

Growth performance of rats fed on cake and meal diets and relative weight of thyroid and liver

Product	Feed intake g/21 days	BGW[5] g/21 days	FCR[6] g feed/g BWG	Thyroid mg/100 g LBW[7]	Liver g/100 g LBW[7]
Cake REM 1[1]	235.9^{e}	76.9^{e}	3.08^{ab}	12.7^{a}	6.38^{abc}
REM 2[1]	189.9^{b}	49.8^{b}	3.83^{bcd}	14.4^{abc}	6.14^{abc}
REM 3[1]	173.4^{ab}	46.2^{ab}	3.79^{bc}	15.1^{abc}	6.01^{ab}
REM 4[1]	145.1^{a}	32.3^{a}	4.62^{d}	20.2^{cd}	6.78^{bc}
REC 6[2]	231.0^{e}	83.5^{e}	2.93^{a}	19.1^{bc}	6.46^{abc}
REC 7[3]	184.1^{b}	54.2^{b}	3.42^{abc}	24.8^{d}	6.81^{c}
Meal RSM 8[4]	184.6^{b}	46.9^{ab}	4.05^{cd}	14.0^{ab}	5.97^{a}

[1, 2, 3, 4] – as in table 1

[a, b, A, B] – as in table 4

[5] body weight gain

[6] feed to BWG ratio

[7] live body weight

because of the small number of samples. BV of protein of REC No. 6 was very high.

Growth performance of rats fed on diets containing the evaluated rapeseed expeller cakes as the protein source varied considerably (Table 6). Among groups fed on REM, feed intake ranged from 145 to 236 g, body weight gain (BWG) during 21 days varied from 32 to 77 g, and feed/gain ratio from 3.08 to 4.62 g/g in REM No. 4 and 1,respectively. Feed intake and BWG were negatively correlated with glucosinolate content in REM ($r = -0.92$ and -0.86, respectively), however, as for BV, significance did not reach the 0.05 level of probability. The rats receiving REC No. 6 had the greatest BWG and the lowest feed to gain ratio.

Relative thyroid weight in rats fed on REM varied from 12.7 in animals fed on REM No. 1, to 24.8 mg/100 g LBW in those fed REC from the oil factory. The thyroid weight in rats fed the diet with RSM was significantly lower than of those fed on the respective REC (14.0 vs. 24.8 mg/100 g BW, respectively), despite the rather small difference in glucosinolate content between cake and meal (Table 2).

Relative liver weight did not differ between rats fed on all the expeller cakes, while it was significantly smaller in rats fed on the RSM than on the respective REC (5.97 vs. 6.81 mg/100 g LBW).

DISCUSSION

The range of fat content in the expeller cakes produced by 02 ZVO press (10.3 to 23.2% DM) in different small mills was greater than that found by Podkówka

et al. (1994) in expeller cakes sampled during a several-month using the same press (12-15% DM). Fat content in the press cake from the oil factory was high and was very close to the mean fat content in twenty-eight samples of canola press cake from seven oil factories in Canada (Keith and Bell, 1991). The range of oil content reported by these authors was 17.5 to 26.7%, the differences being greater among the factories than among sampling periods.

Fat content in the cakes under study was also greater than the mean value found by Rakowska and Ochodzki (1995) for four cakes of unknown origin (10.4% DM). The results of the present study and those of other authors indicate that the fat content in the expeller cakes may be rather variable.

Protein content in the evaluated cakes was lower than average content in the rapeseed 00 meal and tended to be lower in the press cakes with greater fat contents.

The glucosinolate content in two samples of rape seeds processed in rural mills and in the seeds processed in the oil factory exceeded 25 mM/g fat-free DM considered the upper limit in commercial low glucosinolate rape seeds (Krzymański, 1993). Due to removing part of the oil, the glucosinolate content in DM of expeller cakes was higher than in the respective seeds. This agrees with the data reported by Schöne (1995) that glucosinolate content on dry matter basis increased from 15 mM/g of seeds to 18 mM/g in expeller cakes produced by a small screw press. However, when calculated on a fat-free dry matter basis, the glucosinolate level in the expeller cakes was close to that in respective seeds. Similar results were reported by Keith and Bell (1991) who found only a very small difference (38.4 and 35.8 mM/g fat-free DM, respectively) between glucosinolate content in seeds and expeller cakes produced from flaked and cooked canola seed.

It may be concluded that pressing has a small effect on glucosinolate level either in cake produced from seeds mildly heated (40-50°C) (REM) or exposed to higher temperature (REC).

The lack of glucosinolate degradation in seeds heated to over 80°C may be explained by the inactivation of myrosinase during the flaking-cooking phase. This is not the case in the expeller cakes produced with the 02 ZVO press where seeds are heated to 40-50°C before and to about 75°C during pressing. According to Schöne (1995) the main reason of the lack of glucosinolate cleavage in the expelling process is the low water content in the seeds, insufficient for enzyme activity.

In all the cakes, except cake No. 5, the glucosinolate concentration was greater than 15 mM/g fat-free DM, recommended as the upper limit for solvent extracted rapeseed 00 meal (Krzymański, 1993). A significant reduction of the glucosinolate level in the RSM takes place during desolventizing-toasting, however, the solvent meal used in our study had a very high content of glucosinolates.

The results of the study indicate that the glucosinolate level in rapeseed 00 expeller cakes produced from mildly heated seeds, and untreated after pressing, depends almost entirely on their content in the seeds. This finding highlights the importance of using the seeds with a very low glucosinolate content for production of press cakes used in animal nutrition.

The energy values of cakes, measured on chickens (AME_Ne), varied highly (from 8.5 to 14.60 MJ/kg DM), the fat content being the main factor affecting metabolizable energy value as confirmed by the significant correlation between these two parameters ($r=0.82$). However, three samples of cakes produced on the 02 ZVO press and having very close fat levels (cake No. 2, 3, and 5) had significantly different AME_Ne values (9.77, 11.83 and 8.55 MJ/kg DM, respectively) which indicates that some other factors may also be responsible for the variability of energy content. Chibowska et al. (1993) have demonstrated that metabolizable energy value and energy utilization of rapeseed meal is strongly affected by its fibre content. In the present experiment, however, the differences in both crude fibre and ADF and NDF fractions among expeller cakes No. 2, 3 and 5 were too small to explain the differences in AME_N. Crude protein in cakes with lower AME_N values was less digestible; lower availability of lysine was also found in cake No. 5. It is probable that the temperature during expelling of sample No. 5 may have exceeded 75°C, which decreases the available lysine content and may make protein less susceptible to enzymatic digestion.

The metabolizable energy values of cakes calculated from their chemical composition were positively correlated with experimental ones, but were less variable.

The AME_Ne value of REM No. 5 was close to the average value for solvent extracted 00 rapeseed meal which is 8.25 MJ/kg DM according to European Tables of Energy Values for Poultry Feedstuffs (1989) while values for other cakes were substantially higher. Probably due to the short time of feeding in the balance experiment, no correlation was found between digestibility of protein, fat and NFE as well as AME_Ne values and glucosinolate content in the cakes. However, in a previous experiment (Smulikowska et al., 1990) it was found that increased glucosinolate content in the diet due to substituting rapeseed 00 solvent extracted meal by expeller cake did not affect feed conversion ratio, but caused enlargement of thyroid glands and lower growth rate of broiler chickens.

It may be concluded that feeding rapeseed expeller cake to poultry may be an effective way of increasing the energy concentration of diets, but due to the great variation of fat content, the AME_N value of cakes should rather be calculated from their chemical composition. More should be known about other factors affecting digestibility of nutrients and energy utilization of expeller cakes.

Total and available lysine contents in expeller cakes were uniform and comparable with respective values found in other studies for seeds and

pre-pressed cakes from the oil factory, as reported by Keith and Bell (1991) and Grala et al. (1994). These values are considerably higher than usually found in solvent rapeseed meals which may contain as little as 3.5-4.0 g of available lysine/16 g N due to the losses occurring during the desolventizing/toasting phase of the process (Mińkowski, 1996). It may be concluded that the pressing technology is less destructive to lysine than solvent extraction and that rapeseed press cake is a better source of this amino acid than RSM.

Despite a uniform lysine content there were large differences between the cakes in the biological value of protein (Table 5). Within expeller cakes produced with the 02 ZVO press, REM No. 1 to 4, BV tended to decrease as the glucosinolate content increased. This relationship could not be extended on the cakes cooked prior to pressing (REC No. 6 and 7) which had considerably greater glucosinolate content than the REM of similar BV.

Lowering the biological value of dietary protein for rats as a result of glucosinolate and myrosinase presence in the diet was reported by Bille et al. (1983) while Raj et al. (1995) found significant depression of protein utilization (N retained as % of digested) in pigs fed on diets balanced in protein and lysine, but containing increasing amounts of glucosinolates from raw 00 rape seeds.

The results of our study indicate a more marked negative response of protein metabolism in rats to glucosinolates from mildly heated seeds than from those heated to over 80^{0}C, probably due to the higher myrosinase activity in the raw material.

Glucosinolates present in REM negatively affected feed intake, BWG and FCR in rats in a linear, although insignificant, manner. Deterioration of growth performance was accompanied by thyroid hypertrophy, both being characteristic symptoms of feeding rapeseed products containing glucosinolates (for review see Mawson et al., 1994 a,b).

The magnitude of differences of all parameters of nutritional value of protein between the best (No. 1) and the worst (No. 4) REM cake highlights the importance of using rape seeds with a very low glucosinolate content in technology of expelling without cooking .

The expeller cake produced with the Rosedown press from seeds heated to a higher temperature had a very high protein value determined both in balance and growth tests, significantly higher than the cake and solvent meal from the oil factory. It was comparable to that of expeller cake produced using an industrial technology of pressing as described by Nyström et al. (1996).

Although based on a study of limited number of samples, the present results demonstrate great variability of composition and nutritional value of rapeseed expeller cakes produced on 02 ZVO presses.

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STRESZCZENIE

Skład chemiczny oraz wykorzystanie energii i białka wytłoków rzepakowych wyprodukowanych przy zastosowaniu różnej technologii

Oznaczono skład chemiczny, zawartość glukozynolanów oraz lizyny ogólnej i dostępnej w siedmiu próbach wytłoków rzepaku „00" i jednej próbie śruty poekstracyjnej. Pięć prób wytłoków wyprodukowano za pomocą prasy 02 ZVO z nasion ogrzewanych do 40-50°C (REM), jeden za pomocą prasy Rosedown z nasion ogrzewanych w temperaturze powyżej 80°C (REC No. 6), a jeden pochodził z przemysłowego przerobu nasion ogrzewanych w temperaturze powyżej 80°C w olejarni (REC No. 7) Zawartość tłuszczu w wytłokach wynosiła od 10,3 do 23,2% s.m., glukozynolanów od 13,4 do 55,1 mM/g beztłuszczowej s.m. i była zbliżona do zawartości w surowych nasionach.

Oznaczona na kurczętach wartość energetyczna (AME_N) wytłoków REM i REC No. 7 była bardzo zróżnicowana (od 8,55 do 14,60 MJ/kg SM) i skolerowana dodatnio z zawartością tłuszczu. Biologiczna wartość (BV) białka czterech prób wytłoków REM, dwóch REC i śruty poekstrakcyjnej, oznaczona na szczurach, była różna i wynosiła od 80,1 do 96,7, mimo zbliżonej zawartości lizyny ogólnej i dostępnej. U szczurów otrzymujących wytłoki REM wystąpiła tendencja do obniżania się BV, pobrania paszy i przyrostów masy ciała, natomiast do zwiększania się względnej masy tarczycy w miarę wzrostu zawartości glukozynolanów w diecie.

Otrzymane wyniki pozwalają na wyciągnięcie wniosku, że wartość pokarmowa wytłoków wyprodukowanych z nasion ogrzewanych w niskiej temperaturze może być bardzo zróżnicowana. Głównym czynnikiem wpływającym na wartość energetyczną wytłoków jest zawartość tłuszczu, a na wykorzystanie białka – zawartość glukozynolanów.