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Studies on enzymatic fractionation, chemical composition and biological effects of dietary fibre in rape seed (*Brassica napus* L.)

2. Influence of rape seed dietary fibre on digestibility of protein and organic matter using unprocessed and heated full fat rape seed and isolated dietary fibre fractions added to rat diets

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ABSTRACT

Twenty-three cultivars of double improved rape seeds containing a wide range (19 to 27%) of neutral detergent fibre (NDF) were used in nitrogen balance experiments with rats. Feeding rats with unprocessed seeds supplied in two amounts, 24 and 40%, in the N-free diets showed a low negative but significant correlation between the dietary fibre (DF) intake and the digestibility of protein (TD) and organic matter (OMD). The correlation coefficients for TD values versus the intake of NDF, hemicelluloses (Hem) and DF, measured individually in 115 rats at a 24% content of seeds in the diet were -0.216, -0.268, and -0.349, respectively, whereas for a 40% content of seeds, the values found were -0.252, -0.204 and -0.355, respectively. The correlation coefficients of OMD versus the intake of NDF, ADF and DF were: -0.348, -0.334 and -0.474 on the 24% seed content, and -0.350, -0.363 and -0.580 at the 40% level, respectively. Soluble dietary fibre (SDF) isolated from spring and winter type rape seeds and added to the casein diet did not influence TD, but evidently decreased the biological value of protein (BV), whereas the isolated fraction of insoluble dietary fibre (IDF) decreased TD and to a lesser extent BV. Heating full fat rape seed (1 or 2 h at 110°C, or 1 h at 120°C) resulted in decreasing both TD and BV values. It is concluded that the main activity of the dietary fibre in rape seed is probably related to its ability to bind nutritive compounds, which is augmented by heating, thus decreasing the digestibility of protein and its biological value.

KEY WORDS: biological value, dietary fibre, digestibility of organic matter, double low rape, processing, protein digestibility

INTRODUCTION

The high content of fibre in rapeseed meal is the next, after its glucosinolate content, limitation for its wider use in feed mixtures for monogastrics. Plant breeders in Canada selected and registered several varieties of yellow-seeded rapeseed with thinner hulls. The crude fibre content in the meal was reduced from 11-13% in Canola to 8-9% in yellow seeded *Brassica campestris* spring type forms (Bell,1993). Further selection of improved varieties was connected with reduction of high viscosity compounds (mucilage) interfering in oil production. Słomiński and Campbell (1990) compared the composition of fibre in the meal of yellow-seeded forms to that of Canola. They showed that the reduction in the fibre content in yellow seeds was due to the decreased contents of lignin and other phenolic compounds, while the content of polysaccharides was enhanced. They did not observe better utilization of the meal of Candle compared to Canola in hens. The meal of a yellow-seeded variety fed to pigs (Bell et al. 1981), in the entire period of nutrition, did not improve the body mass gain or feed/gain ratio. Similarly Bell and Keith (1989) showed that the meal of low mucilage strains had no distinct positive effect when fed to pigs.

The fibre fraction in plant products is composed of many different substances, not digested by the enzymes of monogastric animals. Trowell et al. (1976) described it as "non-starch polysaccharides (NSP) and lignins". Asp et al. (1988) and Theander et al.(1993) postulated including additional indigestible components in the definition of dietary fibre, i.e. those closely associated with traditional DF constituents: cell-wall proteins, Maillard reaction products, oligosaccharides of the raffinose family and low molecular weight (LMW) phenolic derivatives. Most protein is associated with the insoluble fraction of fibre (IDF). The amino acid composition of IDF-associated protein was similar to the composition of seed protein (Ochodzki et al.,1995). Protein associated with the soluble fraction (SDF) was very rich in some exogenous amino acids. Bjergegaard et al. (1991) studied the physiological and antinutritional effects of SDF and IDF isolated from dark and yellow-seeded spring type rapeseed meal added to a casein diet at levels of 2 and 6%, in N-balance trials on rats. According to the authors, the negative influence of DF on protein digestibility was due to the low availability of DF-associated protein. An additional effect of the SDF fraction on the intestine, on the consistency of digesta (more slimy) and increased flatus was observed. To avoid the great capacity of rape seed DF to associate with protein and basic amino acids during meal processing (Maillard products), only raw, not defatted seeds were used in our preliminary investigation. Four winter and four spring type cultivars were taken for comparison. The natural variability in NDF content (17%-27%) in Polish strains (Ochodzki et al., 1995), provides an opportunity to study the direct influence of rape seed fibre *in situ* on protein and organic matter digestibility. Among different chemical methods of fibre determination, the NDF (Van Soest and Wine, 1967) method comprise the largest spectrum of hardly digested compounds. In some of the samples, total dietary fibre was determined by an enzymatic method (Asp, 1983), which was used in the isolation of rape seed fibre fractions.

The aim of the presented investigations was to show to what extent protein digestibility and biological value of rape seed are affected by naturally occurring fibre components, compared to changes in meal composition induced by processing. To simulate meal processing, raw seeds of one variety were temperature-treated to show the changes in TD and BV values caused by heating.

MATERIAL AND METHODS

Four double low (low erucic acid and low glucosinolate content) winter type rape seed varieties (*Brassica napus* L.): Mar, Ceres, Librawo, Panter, fifteen new winter type cultivars selected for the different NDF contents, and four spring type varieties: Bronowski, J0023-1-2-5, J0024-1-3-3 and J0024-1-5-2 were used in the study. The chemical composition of rape seeds was presented in our previous paper (Ochodzki et al., 1995). Based on analytical results, 15 rape seed strains with the most varied NDF contents (19%-27%), and similar protein and fat contents were used in the N-balance experiments on rats. The rape seed variety Bolko, not defatted, was used to check the influence of processing, including moisturizing (15% water) and heating in an oven under aluminum foil for one or two hours at 110^{0}C, and for one hour at 120^{0}C.

Experiment 1. A mixture of whole rape seeds of each cultivar and N-free wheat starch (5:2) was milled in a coffee mill to 50 Mesh size, and used at a level of 24% in the experimental diets for the balance trials. Rape seeds were the only source of protein, fat and DF. The diets were supplemented with a mineral mixture (4%) and vitamins (1%) according to the requirements of rats (AIN, 1973). N-free wheat starch was included in the diets up to 100%. The levels of protein, fat, DF, NDF, and ADF in the experimental diets derived from the rape seeds are presented in Table 1.

Experiment 2. The seeds of the mentioned cultivars were included in amounts constituting 40% of the experimental diets and supplemented with minerals, vitamins and N-free wheat-starch as described above.

TABLE 1

Content of some rape seed components in diets used for N–balance trials with rats, %

Cultivar	Milled whole rape seeds	Protein	Fat	DF	NDF	ADF
Spring type						
Bronowski	24	6.75	10.58	5.16	3.64	3.15
	40	10.63	17.96	8.60	6.07	5.25
J0023-1-2-5	24	6.69	10.18	4.99	2.78	2.33
	40	10.25	16.96	8.32	4.61	3.88
J0024-1-3-3	24	5.88	10.18	4.39	2.86	2.29
	40	9.81	16.94	7.32	4.77	3.81
J0024-1-5-2	24	6.25	9.91	4.41	3.12	2.69
	40	10.13	16.52	7.36	5.20	4.48
Winter type						
Mar	24	4.90	10.54	5.27	3.66	3.11
	40	8.16	17.56	8.78	6.11	5.19
Ceres	24	4.85	10.46	4.68	3.13	2.46
	40	8.08	17.44	7.80	5.22	4.11
Librawo	24	4.92	10.61	4.60	2.70	2.22
	40	8.20	17.68	7.66	4.50	3.71
Panter	24	4.94	10.10	5.37	3.23	2.44
	40	8.24	16.84	8.95	5.38	4.07

Experiment 3. Diets containing 40% processed rape seeds (three heat treatments) were used in order to reveal any effect of processing. A diet with 40% unprocessed rape seeds functioned as a control. As in experiments 1 and 2, rape seed constituted the only source of DF, fat and protein, and the diets were supplemented according to the requirements of rats.

Experiment 4. SDF and IDF fractions were isolated from the winter and spring type rape seed varieties and were added to 500 g of a basal casein diet in amounts corresponding to their content in 100 g of seed material. Casein diet was enriched with 1 % of methionine, N-free wheat starch, minerals and vitamins according to the requirements of rats; it was fed also to the control group of rats.

The isolation procedure for IDF and SDF comprised enzymatic digestion of rape seed according to the principles of Asp et al. (1983), modified as described by Bjergegaard et al. (1991). Gelatinization and addition of the starch degrading enzyme Termamyl were omitted because of the small content of starch in rape seed. After enzymatic digestion, IDF were filtered, washed with ethanol and acetone, and freeze-dried. SDF were precipitated with 80% ethanol, filtered, washed with ethanol, acetone, and freeze-dried. The characteristics of isolated IDF and SDF were presented in Part 1 (Ochodzki et al., 1995).

N-balance trials were conducted according to Eggum (1973). Groups of five rats (six weeks old) were used. The influence of intact unprocessed and heated whole rape seed, or rape seed DF isolated form (IDF and SDF) on protein utilization and organic matter digestibility was evaluated by determination of TD, BV, and DOM. In all N-balance experiments Lehmann's (1969) formulas for metabolic and endogenous N losses were applied since this is uniformly accepted in Poland. In order to show the best method of fibre estimation for selection purposes, the following correlation coefficients were analyzed: TD vs DF, NDF, ADF and hemicellulose intake separately at the 24% rape seed level and 40% rape seed level in rat diets. BV values at the 40% rapeseed level (8.5-10% protein content) were correlated versus lysine level in different strains. Statistical evaluation of data was performed using QuattroPro 3.0, Borland International Inc., USA for calculation of linear regression and correlation coefficients.

The design of the balance experiments with single levels (24 or 40%) of unprocessed seeds permits observation of the influence of variable fibre content in the seeds of rape on protein and organic matter digestibility. It was difficult to prepare diets for balance experiments using intact full fat seeds of rape, which is very rich in fat. Therefore, for comparative purposes two levels of 24 or 40% of seeds with different levels of NDF were used.

In experiment 4, soluble and insoluble fibre isolates from spring and winter type rape seed were added to the standard casein diet enriched with 1% methionine for the direct observation of the influence of fibre-protein complexes on TD and BV coefficients. The use of both intact unprocessed and heated rape seeds as well as IDF and SDF isolated from unprocessed rape seed was chosen in order to reveal any differences in effects provoked by the state of DF.

RESULTS

Increasing levels of spring type rape seed in the experimental diets for rats (Experiment 1 and 2) were in general without effect on the TD value (mean

TABLE 2

Chemical composition of seeds, digestibility of protein (TD) and organic matter (DOM) of double low spring type rape seed (Experiments 1 and 2), included at the level of 24 and 40% in the diets, %

Variety	Content in seeeds			TD	DOM	TD	DOM
				24% of rape seed		40 % of rape seed	
	NDF	Fat	Protein				
Bronowski	26.4	44.9	22.2	86.8±2.4	91.9±0.7	86.5±1.5	88.4±0.9
J0023-1-2-5	21.7	42.4	22.1	88.0±2.5	92.3±0.8	90.1±1.1	91.0±0.8
J0024-1-3-3	22.8	42.4	22.3	87.1±1.9	92.9±1.3	84.4±0.3	89.3±0.5
J0024-1-5-2	23.3	41.3	22.6	87.5±2.4	91.9±0.8	87.1±3.0	89.5±0.8

TABLE 3

Chemical composition of seeds, digestibility of protein (TD) and organic matter (DOM) of double low winter type rape seed (Experiments 1 and 2), included at the level of 24 and 40% in the diets, %

Variety	Content in seeds			TD	DOM	TD	BV	DOM
	NDF	Fat	Protein N x 6.25	24% of rape seed		40 % of rape seed		
Mar	27.9	43.9	20.2	87.9±1.2	92.8	80.9±2.6	97.4	87.9
Cereres	23.6	43.6	20.2	87.4±2.0	93.2	81.1±3.0	98.8	89.0
Librawo	21.6	44.2	20.5	84.1±3.3	92.8	85.6±2.4	88.6	90.4
Panter	22.5	42.1	20.6	87.3±2.1	93.0	83.6±2.3	100.0	89.2
3523	19.5	41.7	23.0	89.8±1.6	93.6	89.2±0.5	89.6	90.1
3613	20.6	43.2	22.5	90.6±1.6	93.8	87.6±1.0	88.1	90.3
3559	21.3	43.8	22.6	89.0±1.0	93.4	88.1±1.4	87.7	90.4
3533	24.5	43.3	23.1	87.6±1.1	92.8	86.9±1.4	90.8	88.9
3513	25.4	43.0	22.7	86.7±0.6	92.1	85.2±1.6	94.7	87.6
3640	20.9	42.6	22.6	85.5±2.5	92.8	83.8±2.7	93.1	89.4
3532	21.9	42.9	23.2	86.1±3.4	92.1	85.5±1.9	92.5	88.8
3569	20.6	43.0	22.5	85.8±2.0	91.9	83.2±2.1	91.5	86.7
3625	20.3	43.1	22.7	85.7±3.1	91.9	83.4±2.0	93.4	87.4
3603	19.6	43.7	23.0	88.6±0.4	92.4	84.2±1.8	88.3	88.0
3563	22.0	43.0	22.5	87.0±1.7	92.1	85.3±1.3	94.4	87.3
3670	24.0	43.0	23.0	85.4±0.8	92.7	85.7±2.9	93.6	89.1
3515	21.9	43.0	22.8	86.2±1.9	93.1	85.4±1.5	96.1	88.9
3508	21.8	43.1	22.1	86.2±1.5	92.8	85.5±3.2	93.8	89.0
3544	21.5	43.6	22.0	86.8±0.3	93.3	84.8±1.1	97.7	88.7
Mean	22.2	43.2	22.2	87.0	92.7	85.2	93.2	88.8
Min – Max	19.5-27.9	41.7-44.2	20.2-23.2	84.1-90.6	91.9-93.8	80.9-89.2	87.7-100	86.7-90.4

TABLE 4

Correlation coefficients for TD and DOM versus DF, NDF, ADF and HEM intake by rats in N–balance trials fed diets with 24 or 40% raw rape seeds

Correlated factors	24% of rape seed (n=115)	40% of rape seed (n=115)
TD vs NDF	-0.216*	-0.252**
TD vs ADF	-0.126	-0.194*
TD vs Hemicell	-0.268**	-0.204*
TD vs DF	-0.349[a]*	-0.355[a]*
DOM vs NDF	-0.348***	-0.350***
DOM vs ADF	-0.334***	-0.363***
DOM vs Hemicell	-0.153	-0.097
DOM vs DF	-0.474[a]**	-0.580[a]***

a: n = 40

significant at : * – P=0.05

** – P=0.01

*** – P=0.001

value = 86.9) (Table 2), whereas increasing levels of winter type rape seed reduced TD (Table 3) from a mean value of 87.0 with 24% rape seeds in the diet to a mean value of 85.2 with 40% rape seeds in the diet. This reduction was statistically significant at the P = 0.001 level. Calculation of the correlation coefficients for fibre intake versus TD at the 24% level of seeds in the diet for all of the unprocessed rape seed varieties tested (experiment 1 and 2) showed values in the range of -0.216, -0.126, -0.268 and -0.349 for NDF, ADF, HEM (NDF-ADF) and TDF intake, respectively (Table 4). The negative correlations on the level of 40% of rape seed in the diet were in similar range. All of the correlation coefficients are low, however, for NDF and DF they were significant at P = 0.05, for HEM at P = 0.01. At 24 % level, the digestibility of organic matter was less affected than the digestibility of protein, but much more affected at the 40% seed content with OMD decreasing from a mean value of 92.3% (24% rape seed) to a mean value of 89.6% (40% rape seed) for the unprocessed spring type varieties, while the corresponding figures for the winter type varieties were 92.7 and 88.8%, respectively. The correlations between NDF, ADF, Hem and DF intake and OMD were negative, as in the case of TD. Correlation coefficients were significant (P = 0.001) for the 24 and 40% rapeseed level, except for the HEM intake (Table 4).

BV of the unprocessed cultivars (Experiment 2) fed to rats at a 40% level in the diet ranged from 87.7 to 100. There was a positive relationship (r = 0.857) between the BV values and the lysine concentration in the rape seed used (Figure 1).

Processing rape seeds (Experiment 3) resulted in decreased TD, BV, and OMD. Heating at 110^{0}C for 2 h had the most pronounced effect on TD and OMD, reducing the values for the control group from 86.3 and 89.3 to 82.9 and 87.2 for the group fed the processed rape seed. The BV value was only slightly influenced by the mild heat treatment (110^{0}C, 1 h), whereas heating for a longer period (2 h) or at a higher temperature (120^{0}C) had a pronounced effect (Table 5).

In experiment 4 in which isolated SDF or IDF was fed to rats in balance trials, the effect on protein and organic matter digestibility differed, depending on the

TABLE 5

Protein digestibility (TD) and biological value (BV), net protein utilization (NPU) and lysine available content of diets containing 40% unproceesed or heated rape seed cv. Bolko (Experiment 3)

Processing type	TD	BV	NPU	DOM	Lysine available g/16gN
Non-heated seeds	86.3 ± 1.0	96.4 ± 3.5	83.2	89.3 ± 1.2	5.94
Heated 110^{0}C, 1h	85.8 ± 0.98	95.4 ± 1.9	81.9	89.1 ± 1.0	5.14
Heated 120^{0}C, 1h	84.7 ± 2.15	88.8 ± 2.6	75.2	87.4 ± 0.8	4.49
Heated 110^{0}C, 2h	82.9 ± 0.45	89.9 ± 1.3	74.5	87.2 ± 0.6	4.45

TABLE 6

The effect of adding SDF and IDF isolated from spring and winter type double low rape seed varieties to a standard casein diet (composition described in the text) on protein digestibility (TD), biological value (BV) and organic matter digestibility (OMD), % (Experiment 4)

Diet	TD	BV	OMD
Control casein	98.7±0.8	100	98.0±0.2
Control casein + spring rape SDF	98.3±0.6	93.0±1.4	97.8±0.2
Control casein + spring rape IDF	89.6±1.1	98.9±0.8	92.9±0.3
Control casein + winter rape SDF	98.0±1.0	90.7±1.2	97.8±0.2
Control casein + winter rape IDF	89.3±1.2	97.8±1.9	93.6±0.4

fraction (Table 6). SDF were in general without influence on TD, whereas there was a pronounced negative effect on BV, especially for SDF isolated from the winter type rape seed varieties. Addition of IDF to the diets resulted in a marked reduction in TD, whereas the effect on BV was less pronounced.

DISCUSSION

With 24% unprocessed rape seeds in the diets (Experiment 1) TD was about 87, which is among the highest coefficients obtained in rats for rape seed products when the metabolic N by Lehmann's formula is applied. The TD value for processed rape seed meal is significantly lower and ranges, after Grala et al.(1994) from 79.5 to 83.1. The negative correlation coefficients of TD versus NDF intake from diets containing 24% dark rape seeds, with NDF content in seeds from 19 to 27% was low, but statistically significant (-0.26).

Lack of differences of TD values for diets including 24% (Experiment 1) or 40% (Experiment 2) in three among the four tested spring rape seeds deserves attention. It should be noted that the TD of Canola (Canadian spring variety of *Brassica campestris*) meal is usually higher (Grala and Pastuszewska, 1993) compared to Polish rapeseed meals deriving from the winter type of *Brassica napus* varieties. The above differences, however, can rather be ascribed to the processing conditions. In 18 samples of winter type rape seed, TD coefficients ranged from 84.1 to 90.6 on diets containing 24% seeds, while from 80.9 to 89.2 with 40% seeds.

Temperature treatment of non-defatted seeds (Experiment 3) also had a negative effect on TD. This result is in agreement with the results found for rats by Grala and Pastuszewska (1993), showing much lower TD values for processed rape seed protein. This large reduction is probably caused by the severe processing conditions, as stressed also by Michaelsen et al.(1991). In the present study, the lower BV obtained for heated rape seeds also indicates that the heat treatment may have caused some damage to the rape seed protein by binding protein to other seed components, reducing the availability of lysine (Jensen et al., 1990). Results of protein analysis of unprocessed rape seed protein indicated thus a high positive correlation between lysine content and BV.

Experiment 4 using isolated SDF and IDF suggested the influence of IDF on the coefficient of protein digestibility. Results of previous studies (Bjergegaard et al., 1991) are in accordance with this, showing a correlation coefficient around -0.9 for TD vs IDF intake on 2 levels of added IDF. The influence of DF on protein digestibility may be mediated by various factors. Part of the explanation lies probably in the presence of DF-associated proteins, which are thought to have a low availability in the small intestine, due to the resistance of DF towards endogenous enzymes. *In vitro* experiments (Ochodzki et al., 1995) have shown that about 47% of rape seed protein is undigested by pepsin and pancreatin, using the procedure of Asp et al. (1983). Part of this protein (about one third) has, however, to be digestible *in vivo*, including the activity of intestinal microflora, when faecal Dt is measured.

Other factors involved in the DF effect on protein digestibility include a possible direct inhibitory effect on proteases, although this may be partially counteracted by increased secretion of enzymes (Calvert et al., 1985; Schneeman and Gallaher, 1986; Longstaff and McNab, 1991). An increased rate of transit caused by DF may leave less time for degradation and absorption, and also increased bulk or more viscous content of the intestine may affect digestibility in a negative way (Stanogias and Pearce, 1985; Potkins et al., 1991; Staniforth et al., 1991). Moreover, effects of DF on the intestinal epithelium may be a possible factor (Cassidy et al., 1982; Lupton et al., 1988; Fuse et al., 1989). A concomitant stimulation of microbial N excretion may complicate the interpretation of data, and there is therefore no doubt that clarification of mechanisms of DF on protein digestibility requires further investigation. The influence of the IDF fraction added to the casein diet induced the decrease of TD values by 9 units, while the BV values only by 1.1 unit (isolate from spring type rape) to 2.2 units (winter type). The N derived from this fraction and consumed by rats in the amount of 90 mg/rat/5 days, induced faecal excretion by 87 to 90 mg (Figure 2).

The higher effect of SDF on BV compared to IDF was not supported by results from Bjergegaard et al. (1991) who fed rats isolates of SDF and IDF of different origins. The main effect of the SDF fraction on the BV coefficient, with almost no influence on TD and OMD, is induced by enhanced excretion of N in urine of rats (Figure 1). N intake derived from the SDF isolate was 89.6 mg; 77 mg was excreted in urine, and 16.6 mg of N in faeces. Protein left after the enzymatic treatment may, especially in the SDF fraction, also derive from the isolation procedure itself (in the amount of 30%), as discussed previously (Ochodzki et al., 1995).

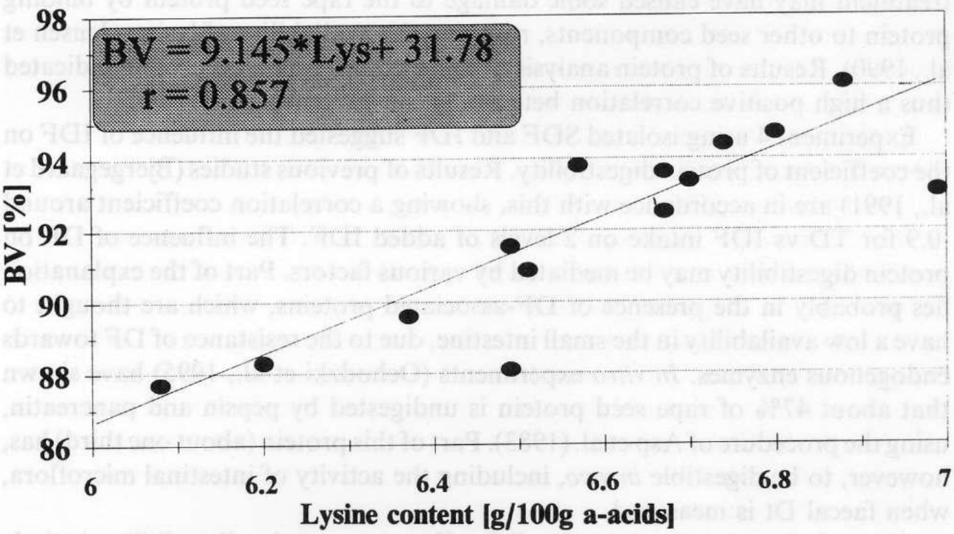

Figure 1. Biological value (BV) of rape protein depending on lysine content in not heated seeds

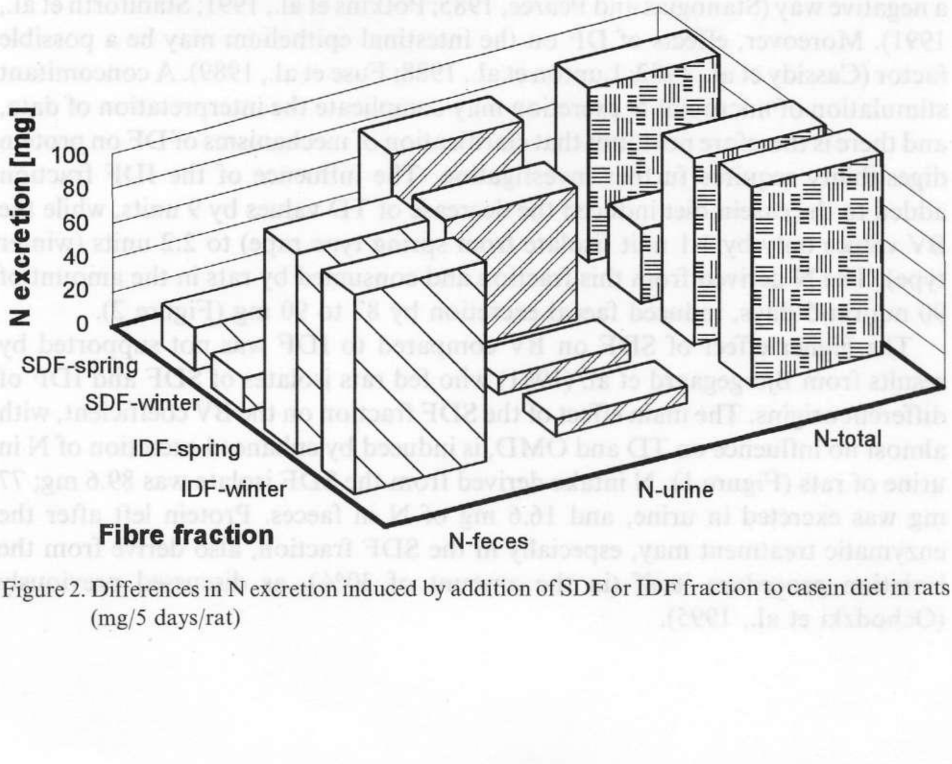

Figure 2. Differences in N excretion induced by addition of SDF or IDF fraction to casein diet in rats (mg/5 days/rat)

The effects found for IDF and SDF on digestibility of organic matter clearly demonstrate the differences in DF components present in the two fractions. Whereas SDF is mainly composed of relatively easily fermentable polymers (pectins and soluble hemicelluloses), IDF contains more insoluble types of compounds such as lignins, cellulose, insoluble hemicelluloses and so on. Moreover, the difference in the effect on OMD was also reflected in the effect of IDF and SDF on TD.

Heating of rape seed decreased protein digestibility in the present study. Excessive temperatures reduced both TD and BV, as well as OMD, which might be connected with further binding of protein and blocking lysine of the rape seed protein. Techniques other than the traditional heat treatment may, however, have different results. Clarification of mechanisms behind the observed effect on protein utilization obviously requires further investigation. Moreover, identification of the most important DF components in this connection requires attention. This could be turned to good use in plant breeding for selecting rape seed varieties with a more appropriate DF composition.

CONCLUSIONS

About 15% of protein in raw, unprocessed rape seed was not digested when measured in rat faeces in nitrogen balance experiments. The amount of indigestible protein increased after heat treatment.

The low negative correlation coefficient of protein and organic matter digestibility versus variable fibre contents in dark rape seeds measured as NDF or ADF does not support the use of these components for selection purposes.

The insoluble dietary fibre fraction is mostly responsible for decreasing protein digestibility, while the soluble dietary fibre fraction influenced the biological value coefficient.

The highest negative correlation coefficients of TD and DOM versus TDF measured by the enzymatic method of Asp, shows that more attention should be paid to particular components of TDF.

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STRESZCZENIE

Badania nad enzymatycznym frakcjonowaniem, składem chemicznym i działaniem biologicznym włókna pokarmowego rzepaku podwójnie ulepszonego. 2. Wpływ włókna pokarmowego rzepaku na strawność białka i masy organicznej u szczurów przy stosowaniu rzepaków nienaruszonych, ogrzewanych lub izolowanego włókna pokarmowego, dodanych do diety.

W doświadczeniach na szczurach oznaczono strawność białka (TD) i substancji organicznej (OMD) oraz wartość biologiczną (BV) białka nasion dwudziestu trzech odmian i rodów rzepaku, dodanych do diety bezbiałkowej w ilości 24 i 40 %. Przy 24 %wym udziale nasion stwierdzono niską lecz znamienną korelację między TD a spożyciem NDF (-0,216), hemiceluloz (-0,268) i włókna pokarmowego (DF) (-0,349) oraz między OMD a spożyciem NDF (-0,348), ADF (-0,334) i DF (-0,474). Przy 40 %-wym udziale nasion korelacje te były również istotne i wynosiły dla TD odpowiednio -0,252, -0,204 i -0,355 a dla OMD: -0,350, -0,363 i -0,580. Rozpuszczalne włókno pokarmowe nasion rzepaku jarego i ozimego dodane do diety kazeinowej nie miało wpływu na TD lecz wyraźnie obniżyło BV białka; dodatek włókna nierozpuszczalnego obniżył TD a nieznacznie tylko wpłynął na BV. Ogrzewanie nasion rzepaku (1 i 2 h w 110°C lub 1 h w 120°C) obniżyło zarówno TD jak i BV.