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Digestibility and protein utilization responses of soybean and rape seed meal to physical and enzymatic treatments in diets for growing pigs

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Abstract. The effects of extrusion, hydrothermal processing and enzyme pretreatment of soybean meals (SBM) and rapeseed meals (RSM) and the multienzyme supplementation of diets on nutrient digestibility, protein utilization and performance were investigated in growing pigs. The study was comprised of two separate total-collection digestibility and balance trials with 6 × 6 Latin square designs and a production trial with 140 growing pigs. The processes employed had only minor effects on the chemical composition of the treated oilseed meals. Extrusion and addition of enzyme premix improved the organic matter (OM) and protein (CP) digestibilities of SBM ($P<0.05$). These processes also tended to have a positive effect on the nitrogen retention and protein utilization in the pigs. The hydrothermal process had no effect on the nutritive value of SBM, but improved the OM and CP digestibility in RSM ($P<0.05$). Energy values of the treated SBM and RSM tended to increase compared with the untreated meals. There were no significant differences in growth rate, feed conversion or carcase quality between pigs fed diets supplemented with differently treated SBM, relative to untreated control. Partial hydrolysis of the polysaccharides present in SBM and RSM with hydrothermal or enzymatic processing may have resulted in the release of intracellular nutrients in the intestine and improved their absorption and utilization. More consistent responses to these thermal and enzymatic treatments could be expected with younger pigs with less microbial activity in the alimentary canal.

Index words: soybean meal, rapeseed meal, processing, enzymes, digestibility, pig

Introduction

Protein supplementation in pig diets is mainly based on oilseed meals while the use of fish meal is avoided due to its negative effects on meat quality. Proper processing is of great importance in order to ensure the nutritional value of soybean meal (SBM) and rape seed meal (RSM) for pig diets. Heat treatment is necessary to inactivate antinutritional factors present in oilseeds. In soybeans those factors are primarily protease inhibitors and in rape seeds glucosinolates, tannins, myrosinase, rapeseed gums and phytic acid. Other processing methods can also enhance the nutritive value of these oil seed meals as an ingredient in pig diets.

Heat treatment and hydrothermal processing rupture the cell wall matrix and modify the chemical structure of plant constituents. These processes render nutrients more susceptible to enzyme degradation in the small intestine, thus improving the digestibility and utilization, especially of amino acids. The content of structural polysaccharides in the soybean is rather low compared with rapeseed, and is mostly present in the hulls, which compose only 7 % of the soybean. The hull fraction in RSM comprises 25—28 % of the dry matter.

The different types of polysaccharides in defatted SBM hulls are galactomannans (9—11 %), acidic polysaccharides (10—12 %), xylan hemicellulose (9—10 %) and cellulose (40 %) (Aspinall et al. 1967). The lignin content is low in soybean hulls (1.3 %), while in rapeseed hulls it is 28.9 % (Mitaru et al. 1984). Polysaccharides compose 26 % of hulled SBM and the major components are arabino-galactan and acidic polysaccharides belonging to the pectic group of substances (Aspinall et al. 1967). The polysaccharides present in the greatest amounts in dehulled rapeseed are pectins (14.5 %), cellulose residues (7 %), and fuco-amyloid, arabinan and arabinogalactan (together 5 to 6 %) (Bell 1984). Insoluble fibre tends to increase passage rate and to form an insulating coat on the digestible nutrients, thus reducing the nutrient supply. Soluble fibres slow down the transit time, but their gelling, ion-exchange and absorbing characteristics retard digestion and absorption.

The cellulolytic or hemicellulolytic enzymes are potent agents of degradation of poorly digestible or viscous polysaccharides and thus a dietary addition of suitable enzymes (cellulase, β-glucanase, xylanase, mannase and pectinase) may be of practical importance in improving the feeding value of some low-energy feed components for monogastrics. Enzyme supplementation could also be used to break down anti-nutritional substances found in feed raw materials, thus augmenting the digestive capacity of the animal, improving availability of the nutrients in the feed, and increasing release of nutrients in the upper part of the gastrointestinal tract (Chesson 1987, Dierick 1989).

In dry feeding systems, enzymes can be added directly to the complete feed or used in the pretreatment of feeds and feed raw materials. With the former application, the supplementary enzymes will act in the gastrointestinal tract of the pigs. In pretreatment, the enzymes act on specific poorly-digestible substances in the raw material, thus improving its feed value. In wet feeding systems, enzymes can be added directly, and during the soaking they will break down poorly digestible substances. The enzyme mixtures, their composition and the level of activity used depend on the feed composition and the enzymes' stability under feed-processing conditions.

The objective of this study was to elucidate the effect of thermal processing and addition of enzymes or enzymatic pretreatment on the nutritive value of soybean meals. In one of the experiments, rapeseed meals also were processed in the same way as SBM. In addition, a growth trial was performed to investigate the effect of soybean processing and enzyme supplementation on the performance of the pigs. Preliminary results of the present study have been published previously by Näsi (1988).

Materials and methods

The animal response to physical and enzymatic treatments of soybean meal and rapeseed meal was evaluated in two digestibility and balance trials and in one performance trial with growing pigs.

The treatments of the soybean meals used in Exp. I. were: 1.) normal solvent-extracted SBM, 2.) SBM extruded with a single-screw extruder, exit temperature ca. 100°C, 3) heat-treated, low-degradable SBM for ruminants

(Öpex-process, Öljynpuristamo Oy, Helsinki), 4.) treatment with multienzyme premix (cellulase, protease and β-glucanase, Suomen Rehu Oy, Helsinki) addition of 0.1 %, in dry solvent-extracted SBM diet, 5.) multienzyme premix added at the level of 0.1 % to a wet SBM diet 8 hours before feeding and 6.) SBM conditioned at 60°C and 30 % moisture content, sprayed with enzyme premix 2 h prior to drying. The chemical composition of the experimental feeds is shown in Table 1.

The treatments of the SBM's and RSM's in Exp. II. were: 1.) normal SBM, 2.) SBM conditioned at 60°C and at 30 % moisture for 30 min followed by drying, 3.) SBM treated as above (2.) followed by addition of 0.1% enzyme (Multienzyme premix, containing cellulase and protease-activities, Suomen Rehu Oy, Helsinki), which was allowed to act for 30 min prior to drying, 4.) normal RSM, 5.) RSM treated as SBM in 2.), and 6.) RSM treated as SBM in 3), but with an enzyme premix including xylanase and cellobiase as well. The chemical composition of the experimental feeds is presented in Table 2.

In the first digestibility and balance trial, the variously processed SBM's were used as protein supplements in six isonitrogenous, 150 g crude protein (CP)/kg, barley-based diets. The supplements were fed to growing pigs (30—75 kg) at the inclusion level of 165—185 g/kg diet. In the second experiment, three processed SBM's and three RSM's were used as protein supplements in barley-based diets (160 g CP/kg diet). SBM supplementation was 122—129 g/kg diet and that of RSM 185—209 g/kg. Both experiments had a 6 × 6 Latin square design. The basal diet was evaluated separately. Each period was comprised of 6 days of adjustment and 6 days of faeces and urine total collection. Assay procedures were similar to those reported by Näsi (1984).

The various SBM's were also evaluated in a performance trial, in which the four diets used had processed SBM as the sole protein supplement. SBM supplementation was 170 g and the diets contained 130 g DCP and 8.7 g lysine per kg feed. As a positive control diet a mixture was used in which the protein supplement was 120 g SBM and in addition 40 g/kg fishmeal (140 g DCP and 9.7 g/kg lysine). Pure lysine and methionine were added to adjust the amino acid levels in the rations. The composition of the feeds and their nutrient contents are given in Table 3. The ex-

Table 1. Chemical composition and calculated feed values of the experimental feeds (Experiment. 1).

g/kg DM	Soybean meals						Barley
	Normal	Extruded	Rumen escape treated	Enzyme added dry	Enzyme added wet	Enzyme pre-treated	
Crude protein	482	497	508	492	493	493	97
Ether extract	33	40	31	29	28	28	31
Crude fibre	75	73	70	65	65	65	46
Nitrogen free extract	347	325	325	352	352	351	804
Neutr. deterg. fibre	131	134	134	120	120	123	286
Acid deterg. fibre	93	92	91	81	86	89	64
Lysine, g/160 g N	62	61	59	62	61	62	41
Threonine »	40	39	40	41	41	41	35
Methionine »	15	15	16	17	16	20	19
Cystine »	17	16	15	17	16	17	24
Available lysine »	60	58	56	59	58	58	40
FU/kg DM	1.01	1.09	1.03	1.08	1.07	1.07	1.14
Kg/FU	1.13	1.03	1.08	1.06	1.10	1.11	1.03
DCP, g/kg DM	394	427	417	426	433	438	68
ME, MJ/kg DM	14.77	16.01	15.14	15.86	15.75	15.79	14.71

Table 2. Chemical composition and calculated feed values of the experimental feeds (Experiment. 2).

g/kg DM	Soybean meals			Rapeseed meals			Barley
	Normal	Hydro-thermal proces.	Enzyme treat.	Normal	Hydro-thermal proces.	Enzyme treat.	
Crude protein	471	487	494	361	352	349	138
Ether extract	53	34	32	102	100	98	36
Crude fibre	63	77	70	134	123	125	45
Nitrogen free extract	303	331	338	329	351	352	758
Neutr. deterg. fibre	111	121	101	247	237	235	172
Acid deterg. fibre	57	72	62	182	171	170	41
Acid deterg. lignin				78	73	77	
Lysine, g/160 g N	59	60	61	59	57	55	35
Threonine »	38	39	39	43	45	44	33
Methionine »	19	15	14	25	24	24	20
Cystine »	15	16	15	27	25	25	27
Available lysine »	56	57	59	56	54	52	34
FU/kg DM	1.00	0.91	1.06	0.80	0.92	0.88	
Kg/FU	1.13	1.25	1.12	1.40	1.17	1.31	
DCP, g/kg DM	359	398	368	288	268	272	
ME, MJ/kg DM	14.8	13.6	15.7	12.0	13.7	13.0	

perimental animals numbered 140, seven replicates of four pigs being used in each treatment. The pigs were assigned at random to the different feeds, with the variation in starting weight between the groups kept as small as possible. The pigs were weighed every two weeks and and the feed consumption was determined for each pen. Feeding was made according to the weight-based schedule of SALO et al. (1982). The individual pigs were slaughtered at an average weight of 100 kg, at which time the carcase weight was recorded and the carcase classified.

Results and discussion

Only small differences were found in the proximate composition of the processed SBM's. Enzyme-treated SBM had slightly lower crude fibre, NDF and ADF than normal or extruded SBM. However the differences were quite small. The different SBM's were similar in their amino acid composition except that the SBM treated for ruminants had a lower lysine and available lysine content. Small reductions in lysine were also evident in other processed SBM's (Table 1). Excessive heat treatment during processing can lead to the destruction of amino acids and the formation of biologically unavailable amino acid carbohydrate complexes such as Maillard reaction products (MAURON 1981). Total lysine may be lost during heating but available lysine is depressed even more (ROACH et al. 1967). VELTMAN et al. (1986) have shown that increased cooking temperature reduces CP content of a SBM treated for rumen escape and decreases amino acids such as lysine, methionine and threonine.

In Expt. II processing did not have any effect on the fibre composition of SBM's and only a small reduction was noticed in the NDF and ADF content of treated RSM's (Table 2). Processing reduced the lysine content and availability in RSM's. According to the data of INBORR et al. (1988), hydrothermal and enzymatic processing decreased the content of lysine and available lysine in barley meal. The same observation was made for processed oats by NÄSI (1988, unpublished data) when methods of processing similar to the present experiments were applied. The processing conditions should be optimal for the action of the enzymes, but at the same time care has to be

Table 3. Chemical composition and calculated feed values of the experimental feeds (Experiment. 3).

g/kg DM	Contr. posit.	Soybean meals			
		Normal	Rumen escape treated	Extruded	Extruded Enzyme-pretreated
Ingredients, g/kg					
Barley	717	707	701	699	690
Oats	50	50	50	50	50
Molasses	20	20	20	20	20
Soybean meal					
normal	117	161			
rumen escape (Öpex)			167		
extruded				169	
extruded, enzyme pret.					178
Fishmeal	40				
Skimmilk powder	10				
Fat mixture	10	20	20	20	20
L-lysine	1.0	1.2	1.2	1.2	1.2
DL-methionine	0.3	0.3	0.3	0.3	0.3
Mineral + vitamin prem.	35	35	35	35	35
Calculated nurtients					
Digestible CP, g/kg	140	129	129	129	129
FU/kg feed	1.00	1.00	1.00	1.00	1.00
Lysine, g/kg	9.7	8.7	8.7	8.7	8.7
Meth. + cyst., g/kg	6.2	5.6	5.6	5.6	5.6
Threonine, g/kg	6.3	5.8	5.8	5.8	5.8
Calcium, g/kg	9.0	9.0	9.0	9.0	9.0
Analysed composition, g/kg DM					
Dry matter	886	892	886	890	889
Ash	57	57	57	56	57
Crude protein	186	171	170	169	170
Ether extract	37	45	44	46	45
Crude fibre	53	52	56	57	57
Nitrogen free extract	666	675	673	671	671

Table 4. Digestibilities of processed soybean meals and protein utilization of the diets (Experiment 1).

	Soybean meals						SEM	Statis. signif.
	Normal	Ex-truded	Rumen escape treated	Enzyme added dry	Enzyme added wet	Enzyme-pretreat.		
Organic matter	0.795	0.851	0.801	0.851	0.837	0.864	0.027	NS
Crude protein	0.817	0.860	0.821	0.865	0.879	0.887	0.017	*
Ether extract	0.497	0.708	0.642	0.649	0.704	0.735	0.103	NS
Crude fibre	0.415	0.522	0.425	0.393	0.422	0.355	0.072	NS
Nitrogen free extract	0.876	0.927	0.891	0.930	0.874	0.875	0.037	NS
N intake, g/d	47.1	48.3	47.6	47.9	47.9	48.8	0.321	NS
N excr. in faeces, g/d	10.9	10.1	10.9	10.1	9.7	9.7	0.408	*
N excr. in urine, g/d	16.2	17.2	16.8	17.1	17.6	17.6	0.492	NS
N retained, g/d	20.0	20.9	19.9	19.9	20.5	21.5	0.713	NS
of intake	0.425	0.437	0.423	0.423	0.430	0.448	0.022	NS
of absorbed	0.561	0.559	0.558	0.538	0.542	0.561	0.022	NS
UreaN excr. in urine, g/d	17.2	14.8	14.8	20.3	17.6	17.3	0.637	NS
Biological value	0.643	0.638	0.639	0.618	0.621	0.637	0.013	NS

SEM = standard error of the means; significance: NS (non-significant), * ($P<0.05$), ** ($P<0.01$).

taken to avoid destruction of amino acids and their availability.

The digestibility of CP in the different SBM's varied from 0.817 to 0.887, and differed significantly between untreated and enzyme-pretreated SBM ($P<0.05$). Addition of enzyme to the diet or extrusion of SBM tended to improve both OM and CP digestibility (Table 4). Enzymatic processing also improved the OM and ether extract digestibility of SBM ($P<0.05$) in Exp. II, but not of RSM, while hydrothermal processing of RSM increased OM and CP digestibility ($P<0.05$, Table 5). SBM treated for ruminants in order to decrease protein degradability had the same digestibility as normal SBM. This has practical importance, since the same lots of oil seed meals can be used for both ruminants and monogastrics. Addition of enzyme, wet feeding and pretreatment of SBM resulted in higher mean nitrogen retention than diets with other SBM but differences were not significant ($P>0.05$, Table 4). It is also possible that the addition of enzyme to SBM in wet feeding can have an effect on the barley in the diet and that this is partly responsible for the improved nutrient utilization. A small improvement is achieved by enzyme, mainly β-glucanase, supplements in barley-based diets (GRAHAM et al. 1986, INBORR et al. 1988, THACKER et al. 1988). Acid resistance of the enzyme supplements in applying direct addition in diet is of great importance because in pig stomach there is very low pH.

It has been well established that the nutritive value of vegetable protein is improved by heat treatment. Industrial applications of heat treatment for feeds are extrusion, toasting, pressure cooking and infrared radiation. With some exceptions heat treatment may result in an increased accessibility of protein to enzymatic attack (VAN DER POL 1990). Heating primarily inactivates the proteinaceous antinutritive factors in oilseed meals. Improved energy values of the processed oilseed meals found in present study are in agreement with previous studies, in that extrusion has been found to improve organic matter and energy digestibility of grain or grain, SBM and wheat middlings diets (NOLAND et al. 1976, SKOCH et al. 1983, FADEL et al. 1988, HERKELMAN et al. 1990).

No affect on the utilization of protein or lysine at the terminal ileum was observed in the study of HERKELMAN et al. (1990), while NOLAND et al. (1976) reported improved protein digestibility following by extrusion in agreement with the present observations. Present finding that enzyme pretreatment of meals and hydrothermal processing of RSM improved ADF and NDF digestibilities is supported by the higher NDF digestibility noticed after pressure cooking (VAN DER POL et al. 1989). Extrusion or other hydrothermal processes have also resulted in 0.19 more ileal digestion of soluble non-starch polysaccharides (NSP) and 0.13 more lower tract digestion of insoluble NSP (FADEL et al. 1988).

In this study a mixture of enzymes having several activities was used, while the response of pigs to supplementation of diets with proteolytic enzymes alone has been very poor (review of DIERICK (1989). Only in baby pigs did proteolytic enzymes improve live weight gain and feed conversion (LEWIS et al. 1955, BAKER et al. 1956). However, ZAMORA and VEUM (1979) found that growing pigs have a greater growth rate and net nitrogen utilization due to improved amino acid availability when heated whole soybeans fermented with some fungi were fed compared with heated unfermented whole soybeans.

Pigs do not secrete endogenous enzymes which break down NSP found in most raw materials of plant origin. Degradation of the cell wall matrix and the structural polysaccharides in rapeseed fibre by physical or other means promotes the release of intracellular nutrients in the small intestine for digestion and absorption. The addition of enzyme preparations with cellulolytic and hemicellulolytic activities has improved feed utilization in pigs, but the results have not always been consistent (review of DIERICK 1989). Recently improvements in performance were noted when diets for early-weaned pigs were supplement-

Table 5. Digestibilities of processed soybean meals and rape seed meals and protein utilization of the diets (Experiment 2).

	Soybean meals			Rapeseed meals			SEM	Significance of effect				
								SBM vs. RSM	Soybean meals		Rapeseed meals	
	Normal	Hydro-thermal proces.	Enzyme treat.	Normal	Hydro-thermal proces.	Enzyme treat.			Compar. A	Compar. B	Compar. A	Compar. B
Organic matter	0.815	0.754	0.847	0.609	0.694	0.667	0.0228	***	NS	*	*	NS
Crude protein	0.762	0.742	0.790	0.642	0.701	0.684	0.0153	***	NS	NS	*	NS
Ether extract	0.757	0.517	0.725	0.639	0.766	0.700	0.0669	NS	NS	*	NS	NS
Crude fibre	0.485	0.465	0.639	0.322	0.410	0.382	0.0962	NS	NS	NS	NS	NS
Nitrogen free extract	0.977	0.807	0.984	0.679	0.766	0.743	0.0453	***	*	NS	NS	NS
Neutr. deterg. fibre	0.523	0.288	0.607	0.206	0.343	0.306	0.1403	NS	NS	NS	NS	NS
Acid deterg. fibre	0.527	0.403	0.669	0.177	0.292	0.258	0.1214	**	NS	NS	NS	NS
Hemicellulose	0.542	0.152	0.539	0.297	0.488	0.445	0.1738	NS	NS	NS	NS	NS
Cellulose	0.553	0.454	0.671	0.376	0.490	0.425	0.1006	NS	NS	NS	NS	NS
N intake, g/d	53.1	53.0	53.2	53.2	53.3	53.3	0.03	***	NS	*	NS	NS
N excr. in faeces, g/d	10.0	10.5	9.6	12.9	11.5	12.1	0.29	***	NS	NS	**	NS
N excr. in urine, g/d	20.9	20.7	20.9	18.4	20.2	19.0	0.73	*	NS	NS	NS	NS
N retained, g/d	22.2	21.8	22.8	22.0	21.6	22.2	0.67	NS	NS	NS	NS	NS
of intake	0.418	0.414	0.426	0.411	0.405	0.423	0.0135	NS	NS	NS	**	NS
of absorbed	0.520	0.519	0.524	0.544	0.522	0.552	0.0185	NS	NS	NS	NS	NS
UreaN excr. in urine, g/d	15.3	14.8	14.4	23.4	14.5	14.3	0.86	NS	NS	NS	NS	NS
Biological value	0.593	0.592	0.596	0.619	0.597	0.625	0.0174	NS	NS	NS	NS	NS

ed with enzyme preparations containing amylase, proteases, β-glucanase and cellulases (HOGEBERG et al. 1983, COLLIER and HARDY 1986a, b), indicating that the animals' own digestive enzyme system seems to be limiting in some way. Some antinutritive factors as glucosinolates in rapeseed meal could be eliminated with enzymatic treatments followed by fermentation as reported by STARON (1984). Dense populations of cellulolytic and pectinolytic anaerobes have been measured in the intestines of pigs fed different diets (CHESSON et al. 1985). This suggests that bacterial fibre-degrading capacity in growing pigs may be sufficient to degrade reasonable NSP enabling proper digestion. A component of the response to the treatments may be affected by the age of the experimental pigs. Probably treatment responses would have been greater in piglets as indicated by INBORR and OGLE (1988).

In the performance trial there were no significant effects of dietary treatments on the average daily gain or the feed conversion ratio ($P > 0.05$, Table 6). In this experiment the positive control group was fed a diet containing fish meal protein supplement and a higher protein content. Fish meal is now avoided in the diets of growing pig due to offflavor which are detected in the meat followed by lower eating quality. Formulas have been made using only oilseed meals to supplement protein. The aim of this study was to elucidate which processing methods can improve the value of oilseed meal in pig diets. Extrusion of SBM tended to improve the performance as compared with the group on the normal SBM and gave the same daily gain and FCR as the positive control having a greater protein supply. This observation is in agreement with the results obtained in the balance trial. In this performance test the enzymatic process had a rather small effect, in contrast to the results obtained in the digestibility trial, but it is possible that during preparation of the feed inactivation of the enzymes occurred. Hydrothermal or enzymatic treatments of barley fibre, a by-product with a high hemicellulose content from intergraded starch-ethanol process, containing diets for growing pigs did not result in improved performance in an earlier study (NÄSI 1989).

Hydrolysis of structural plant polysaccharides is generally of nutritional benefit. The

Table 6. Performance of pigs on diets supplemented with soybean meals processed with different methods (Experiment. 3).

	Contr. posit.	Soybean meals				Statist. signif.
		Normal	Rumen escape treated	Extruded	Extruded Enzyme-pretreated	
No. pigs in test	28	27	25	28	28	NS
Initial liveweight, kg	29.5	29.2	29.5	29.5	29.5	NS
Final liveweight, kg	99.6	97.4	98.7	100.3	98.5	NS
Days in test	86.8	90.0	90.5	88.2	88.8	NS
Daily gain, g	815	762	766	807	781	NS
Feed intake, kg/d	2.32	2.26	2.26	2.29	2.25	NS
Feed/gain, kg/kg LWG	2.87	2.99	2.95	2.85	2.90	NS
Carcase weight, kg	71.1	69.4	70.0	71.4	70.1	NS
Dressing	0.714	0.712	0.710	0.712	0.711	NS
Carcase grading, %						
E + glass	22.2	18.5	16.0	21.4	21.4	
E	25.9	29.6	32.0	21.4	28.6	
I	51.9	48.2	52.0	57.2	46.4	
I—					3.6	
Withdrawal		3.6				

See footnote Table 4.

breakdown of the cell walls makes nutrients available which would otherwise be protected from digestive processes. Legume seeds contain specific gel-forming polysaccharides and the destruction of these polysaccharides by hydrothermal processing or the application of enzymes tended to give better performance than feeding untreated material in this study.

Endo-enzymes produce random hydrolysis of linkages within a polysaccharide chain. Cleavage of relatively few linkages rapidly leads to chain shortening and subsequent loss of gel-forming properties (Chesson 1987). Fekete (1984) has suggested that the greatest benefit from the addition of cellulase to pig diets is an improvement in nitrogen utilization rather than enhanced utilization of fibre. When only one enzyme activity is added to the diet, the structural polysaccharides in the plant cell wall may remain intact. A multienzyme additive with cellulolytic and proteolytic activities can degrade the polysaccharides more effectively, promoting release of intracellular nutrients in the small intestine for digestion and absorption. This may be more important in younger pigs than those used in the present experiment, since the oligosaccharides, especially raffinose and stachyose of SBM have been reported to cause diarrhea in young pigs.

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SELOSTUS

Lämpö- ja entsyymikäsittelyjen vaikutus soija- ja rypsirouheen rehuarvoon lihasikojen ruokinnassa

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Tutkimuksessa selvitettiin erilaisten lämpö- ja entsyymikäsittelyjen sekä entsyymilisäysten vaikutusta soija- ja rypsirouheiden rehuarvoihin ja valkuaisen hyväksikäyttöön lihasikojen ruokinnassa. Tutkimus käsitti kaksi sulavuus- ja tasekoetta (6 × 6 latinalaiset neliöt) sekä tuotantokokeen, jossa oli 140 lihasikaa. Rouheiden prosessointeina oli ekstrudointi, kostea lämpökäsittely ja entsymaattinen käsittely. Entsyymiseosta lisättiin myös käsittelemättömään soijarouheeseen sikojen ruokinnan yhteydessä joko kuivaan rehuun tai 12 tuntia ennen ruokintaa kostutettuun soijarouheeseen. Ekstrudointi ja entsyymikäsittely paransivat soijarouheen orgaanisen aineen ja raakavalkuaisen sulavuutta. Lämpökäsittely lisäsi rypsirouheen sulavuutta. Käsittelyt lisäsivät myös hieman valkuaisen hyväksikäyttöä sekä laskennallista energia-arvoa. Tuotantokokeessa eri tavoin käsitellyt soijarouheet eivät poikenneet merkitsevästi käsittelemättömästä, ekstrudoinnin ollessa kuitenkin toisia parempi. Saatujen tulosten perusteella sekä fysikaalisilla että entsymaattisilla käsittelyillä oli rouheiden käyttökelpoisuutta parantava vaikutus sikojen ruokinnassa. Vaikutus perustui ilmeisesti kuituaineksen ja solunseinämien pilkkoutumiseen ja sitä kautta ravintoaineiden parantuneeseen sulavuuteen ja imeytymiseen.