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Ruminal and Intestinal Degradation Protein and Cell Wall Constituents in Different Forms of Sida Meal Measured by the Nylon Bag Technique

Rozkład białka i składników ścian komórkowych różnych form suszu z sidy w żwaczu i jelitach, oceniany techniką woreczków nylonowych

The nutritive value of roughage for ruminants is determined by both digestibility and voluntary intake. Roughage intake is primarily limited by the capacity of the rumen, the rate of degradation in the rumen and the passage rate of undegraded feed particles from the rumen.

These factors are very important for the new fodder crop in connection with defining of their utility and nutritive value for animals.

Sida plant (*Sida Hermaphrodita R u s b y*) is worth noticing because in production of biomass it is comparable with maize and with lucerne in regards to protein content, but it also contains much more fibre than either lucerne or maize. The opinions connected with influence of heat treatment and extruding feeds on solubility and rumen degradability of protein are different (B r o d e r i c k et al. 1980; F o c a n t et al. 1990; S a n b e r g et al. 1986). Generally, pelleting or extruding of grains and forages decreases protein solubility but increases protein escaping from the rumen without reducing the quality of protein gastrointestinal absorption sites (A r i e l i et al. 1988; F o c a n t et al. 1990; S t e r n et al. 1985). Many studies are connected with the effects of extrusion-cooking on single concentrates soybean meal, sunflower seeds or cotton seeds (A n d e r s o n et al. 1984; A n n e x t a d et al. 1986; D i j k et al. 1983; D r a c k l e y et al. 1985). A limited amount of data is available on the effect of extrusion-cooking on protein and cell wall digestion of forages and concentrate mixtures. Rumen degradability of protein, dry matter and cell walls (NDF) can be determined from nylon bags incubated in the rumen for various periods of time, according to the methods developed by Ø r s k o v and M c D o n a l d (1979) and others (K r i s t e n s e n et al. 1982; L i n d b e r g 1981). Similar mobile nylon bag techniques have been used to measure intestinal digestibility of feeds (H v e l p l u n d et al. 1991).

The promising results obtained from utilization of dried extruded sida plant in practical animal feeding (T a r k o w s k i et al. 1991) were a basis for evaluation of the extent of ruminal and postruminal degradation of the nutrients of sida.

The objective of the present work was to evaluate the extent of protein and NDF degradation in rumen and the intestinal protein digestibility of the sida meal and the extruderates of sida with horse bean and triticale meal.

MATERIAL AND METHODS

The experiment was conducted to study the ruminal and intestinal nylon bag degradation of sida meal, horse meal, triticale meal and two extruderates of sida meal with horse bean and sida meal with triticale. Components of these two extruderates were mixed in a ratio 1:1. The extruderates were obtained in the single screw extruder type S-45 made in Poland. Sida meal used for the extrusion-cooking process was obtained from two cutting periods, namely, sida 1-early cut, sida 2-late cut.

The ruminal degradation of the feeds was studied by using the nylon bag technique described by Kristensen et al. (1982). The samples of 1 g (CP) and 3 g (DM, NDF) were incubated in nylon bags (36 μm pore size, measuring 7×10 cm), placed in the rumen of three ruminally and duodenally canulled Frisian cows. The bags were incubated for 2, 4, 8, 16, 24 and 48 hours (CP) and for 8, 24, 48, 72, 96 and 144 hours to estimate the NDF degradation. All the bags were machine washed for 15 min. in cold water and dried at 60°C for 24 hours.

The degradability data for experimental feeds were fitted to the equation:

$$p = a + b\,(1 - e^{-ct})$$

where p = the actual degradation after time, t; a = instantly degradable fraction; b = slowly degradable fraction; c = rate constant for b; by Ørskov et al. (1979).

The digestibility of feed protein was determined by using the mobile nylon bag technique described by Hvelplund et al. (1991). For this, 1 g of feed was weighed into small polyester bags (3,5 × 5,0 cm; 10 μm pore size), preincubated in pepsin-HCl solution and introduced into duodenum of three fitted cows. Bags collected from the faeces, machine washed in cold water and dried at 60°C for 24 hours. Protein intestinal digestibility was calculated as loss of nitrogen from the mobile bags after the passage through the intestine.

The feeds and their residues were analyzed for dry matter and Kjeldahl-N, according to the A. O. A. C. method. Neutral detergent fibre (NDF) was determined by the method described by Goering and Van Soest (1970).

DISCUSSION

The sida meal is the feed which contains protein similar to typical meals obtained from lucerne and grasses (Kwakhel et al. 1986; Styk 1982; Tarkowski et al. 1987), but the high level of NDF is different. These nutrients are the main factors which decide about the availability of these feeds in animal nutrition. Extruded sida meal with leguminous seed (horse bean) and triticale can be an interesting contretate for ruminants nutrition. The selection of extruderate components is important in connection with the possibility of utilization and degradation of ther nutrient after treatment.

Many studies are connected with the effects of extrusion-cooking of soybean meal and other concentrates (Anderson et al.1984; Annestad et al. 1985; Drackley et. al. 1985). Very little data is available on the effects of extrusion-cooking of roughage with concentrates and their influence on the rumen degradability of protein and cell walls (Bjorck et al. 1983; Tarkowski et al. 1991).

Generally, the heat treatment of seeds and forages substantially decreased the protein solubility and degradation of protein in rumen (Arieli et al. 1988; Sahlu et al. 1984; Stern et al. 1985). This is very important for leguminous seeds, which are characterized by a high protein solubility.

Table 1. Rumen degradability of protein at different incubation times, %
Degradacja żwaczowa białka w różnych okresach inkubacji, w %

Feed name	Protein % of DM	Rumen incubation time, h						S.D.
		2	4	8	16	24	48	
Sida meal 1	13.7	61.0	67.4	82.7	88.2	90.3	91.3	0.30-1.79
Sida meal 2	13.9	79.5	81.0	92.2	94.2	95.0	95.1	0.17-1.12
Horse bean meal	27.6	89.6	93.7	97.0	96.7	97.5	98.4	0.17-1.18
Triticale meal	13.6	69.4	89.4	96.6	97.8	98.1	98.6	0.17-0.69
Extrud. sida 1 + horse bean	21.0	76.4	78.2	86.0	87.8	94.0	96.3	0.17-0.98
Extrud. sida 2 + triticale	13.9	75.4	76.6	86.6	86.8	91.7	96.3	0.14-1.57

Table 2. Rumen degradability of dry matter at different incubation times, %
Degradacja żwaczowa suchej masy w różnych okresach inkubacji, w %

Feed name	Dry matter %	Rumen incubation time, h						S.D.
		8	24	48	72	96	144	
Sida meal 1	89.2	46.5	59.6	61.3	66.5	70.2	73.4	0.51-2.50
Sida meal 2	90.7	51.2	63.0	66.4	67.4	69.1	70.5	0.41-2.30
Horse bean meal	90.7	81.6	86.6	90.9	92.4	93.6	95.2	0.61-1.78
Triticale meal	89.2	90.9	94.9	96.5	97.4	97.4	97.8	0.26-1.40
Extrud. sida 1 + horse bean	90.7	62.3	75.6	79.4	83.9	83.9	84.0	0.15-0.91
Extrud. sida 2 + triticale	91.5	72.1	80.3	83.7	84.6	85.6	86.9	0.41-1.21

Table 3. Rumen degradability of neutral detergent fiber at different incubation times, %
Degradacja żwaczowa neutralnego włókna detergentowego w różnych okresach inkubacji, w %

Feed name	NDF % of DM	Rumen incubation time, h						S.D.
		8	24	48	72	96	144	
Sida meal 1	48.9	13.1	26.4	35.5	41.0	47.6	52.5	1.31-2.70
Sida meal 2	49.4	18.4	32.8	41.0	42.7	48.2	53.1	1.11-3.11
Horse bean meal	17.9	23.3	47.9	62.9	67.8	75.2	79.8	0.41-2.40
Triticale meal	15.4	59.7	67.5	81.2	83.7	85.4	88.4	0.91-1.51
Extrud. sida 1 + horse bean	34.2	15.4	38.4	47.7	52.4	54.8	58.7	0.71-1.51
Extrud. sida 2 + triticale	32.2	31.9	46.7	54.3	56.0	64.1	64.3	0.82-2.11

In our experiments, the experimental feeds obtained high protein rumen degradability in 48 h incubation periods, above 95% (Table 1). With this technique, the extruded sida protein was more degradable than the raw sida. Protein degradation of both extruderates was very high and similar to their components, particularly of horse bean and triticale one should notice a rapid increase of protein degradation of sida meal and both extruderates from 8 hours of incubation, assuming higher value 91.3-96.3% in 48 hours. These results do not conform with several studies which describe the negative influence of pelleting or extrusion-cooking on the protein degradation in the rumen (A r i e l i et al. 1988;, B r o d e r i c k et al. 1980; S a n b e r g et al. 1986).

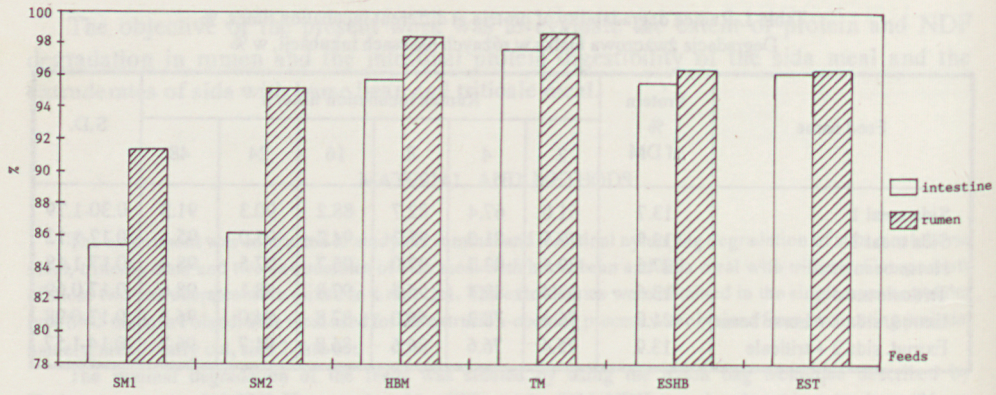

Fig. 1. Digestion of protein measured by nylon bags technique in rumen and intestine
Strawność białka oceniana techniką woreczków nylonowych w żwaczu i jelicie

The cell wall (NDF) degradation rates have been determined by many more different forms of forages (A r o n e n et al. 1991; K w a k h e l et al. 1986; V a r g a et al. 1983). However, information is not available for concentrates and pelleting or extruding feeds. Apart from this, very little information is available in literature on the effectt of extrusion-cooking on fibre feeds.

The rumen degradability of dry matter and NDF in experimental feeds were different, but the pictures of these changes were similar to protein degradation (Table 2 and 3). The extent of NDF degradation for sida meal is typical of grasses (K w a k h e l et al. 1986; V a r g a et al. 1983). The raw sida meal, which had a high content of NDF was degraded more slowly than the extruded forms.

The horse bean and triticale meals, in general, had faster NDF determination than the extruderate. However, NDF in both extruderates was degraded more extensively than the sida meal. The differences in the NDF content between the experimental feeds were reflected in the differences of the maximum potential of the NDF and dry matter degradability.

The results suggested that both extruderates as a combination of forages (sida meal) and concentrates (horse bean, triticale) had an influence on he rates of the NDF degradation. The rate of the NDF degradation in extruderates was a result of that degradation in adequate components. The lower content and rapid degradation of NDF in the triticale meal and horse bean meal had an influence on higher degradation of the adequate extruderates.

The obtained results are in agreement with several studies which describe that NDF from concentrates or formulated sources had higher potential of digestion than NDF from single forages (L i n d b e r g 1981; V a r g a et al. 1983).

Generally, all the experimental feeds had high intestinal protein digestibility (Figure 1). The high protein digestibility was similar to protein degradation in the rumen incubation time. These results suggested that using adequate components for production of extruderates has influence on their protein digestibility. The protein degradation in the rumen and intestinal digestibility of extruderates were directly related to the degradability of the ingredients and their proportion in the concentrate. These results are partly different from the data demonstrating a decrease of protein degradability and intestinal digestibility in feeds after heating or the extrusion-cooking process (A r i e l i et al. 1988; F o c a n t et al. 1990; S t e r n et al. 1985).

More experiments are carried out with single feeds and the effect of extrusion can by different when blending several forages.

CONCLUSIONS

1. Experimental extruderates were of similar values to protein degradation, but the extruded sida with triticale meal was more resistant to microbial degradation.

2. The content of NDF in components including extruderates had a significant influence on the degradation of NDF in final product.

3. The protein degradation in the rumen and intestinal digestibility in both extruderates were related to the degradability of components creating an adequate extruderate.

4. Extrusion-cooking forage meals with leguminous or cereal seeds can be useful in partial protection of high solubility leguminous protein and because of an increased flow of these protein into duodenum.

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STRESZCZENIE

Badania nad żwaczową degradacją białka i składników ścian komórkowych (NDF) suszów z sidy i ekstruderatów suszu sidy z mączkami bobiku i pszenżyta przeprowadzono na trzech kaniulowanych krowach. Strawność jelitową białka oznaczano przy użyciu techniki mobilnych woreczków nylonowych.

Degradacja białka i NDF w obu ekstruderach była wysoka (>96%) i zbliżona do ich komponentów. Rozkład żwaczowy NDF, inkubowanego przez 144 godz., w suszach z sidy był niższy (52,5-53,1%) aniżeli w suszu z sidy z mączką z bobiku (58,7%) i pszenżytem (64,3%). Strawność jelitowa białka była wysoka i wynosiła odpowiednio dla suszów z samej sidy 85,3 i 86,1 oraz dla ekstruderatów 95,5 i 96,1%.