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DIETARY FIBRE IN PIG NUTRITION

VLAKNINA KRME U HRANIDBI SVINJA

J. Salobir

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ABSTRACT

Almost all feedstuffs used in pig nutrition contain dietary fibre. Feedstuffs do not differ only in the fibre content but also in their chemical and physical properties. The content and properties of fibre fractions determine their effect in digestion and metabolism. In order to explain the effects of fibre fractions in the digestive process it appears appropriate to distinguish between insoluble and soluble fibre. While the insoluble cell wall fibre acts as a barrier against digestive enzymes and reduces the nutrients digestibility rate, the soluble fibre increases the intestinal viscosity reducing thereby the diffusion rate of enzymes in the intestinal content, the diffusion of digested nutrients to the gut wall, and the intestinal rate of digesta transport. All this is associated with a reduced nutrient and energy digestion and absorption. The dietary fibre also has many favourable effects on digestive process, gut integrity and animal health, especially in piglets. The negative effects of fibre on nutrient and energy digestibility can be eliminated to some extent by adding appropriate non-starch polysaccharide degrading enzymes.

INTRODUCTION

Almost all feedstuffs used in pig nutrition also contain dietary fibre. Feedstuffs do not differ only in the fibre content but also in their chemical and physical properties. The content and properties of fibre fractions determine the effect on digestion and metabolism. In the last decade this issue has been brought to attention. It has been demonstrated that fibre has a great influence, not only on energy and nutritive value of the feedstuffs, it also influences the digestion of nutrients of other feedstuffs in the diet, and furthermore, in influences the conditions in the intestines, microbial fermentation, state of health of the intestine and of the animal.

ABOUT FIBRE IN GENERAL

Dietary fibre - definition content

A number of different definitions exists concerning dietary fibre. It is hard to briefly describe a group of substances with such a variety of chemical structures and with so many different effects on digestion and methabolism. According to Trowell et al. (1976) the fibre is "the sum of lignin and the polysaccharides that are not digested by

Prof. dr. sc. Janez Salobir, Univerza v Ljubljani, Biotehniška fakulteta, Oddelek za zootechniko - Inštitut za prehrano, 1230 Domžale, Groblje 3, Slovenija.

the endogenous secretions of the digestive tract". For practical purposes the definition could be shortened (Low, 1993) to the "sum of non-starch polysaccharides (NSP) and lignin", where from the definition resistant starch and indigestible oligosaccharides are eliminated. The non-starch polysacharides most commonly found in pig nutrition are listed below:

- Cellulose: composed of β-glucopyranose units, joined by (1→4) β-glycosidic bonds; found in smaller or greater proportion in parts of the cell walls of all feeds.

- Mixed-linked glucans:composed of β-glucopyra-nose units, joined by (1→3) or (1→4) β-glycosidic bonds. Mainly found in grains (barley, oats, wheat....).

- Xylans: the main chain is composed of β-xylopyranose units (therefore also pentosans) joined by (1→4) β-glycosidic bonds to which side chains of α-arabinose are substituted. Besides arabinose (therefore also arabinoxylans) other molecules also are linked (glucorinic acid, ferulic and acetic acid). Found mainly in grains (wheat, rye...).

- Pectins: linear polymers of D-galacturonic acid joined by α 1→4 glykosidic bonds in which the carboxyl groups of the galacturonic acid are partly esterified with methanol and the remaining free carboxyl groups are partly neutralized. Included among the sugars are arabinose, galactose, and to a lesser extent, glucose, xylose and rhamnosa. Mainly found in sugar beet pulp.

Feedstuffs do not only differ in the dietary fibre the content. The physical and chemical properties are also very important. From the nutritional point of view, one of the most important properties is fibre solubility (in water) and ability to form viscous solutions (thus also gel-forming polysaccharides). NSP in solutions form a net in which a great amount of water can be linked. Viscosity of such solutions depends on the type of non-starch polysaccharides, or rather, on the physical and chemical structure of a molecule, on the pH, concentration of of electrolytes in the neighbouring fluid. Consequently, the fibre in different parts of the digestive tract behave differently (Low, 1993).

Most of the fibre is located in the cell wall, and are thus also called structural carbohydrates. The contents and type of fibre within individual parts of a grain can differ greatly. Cell walls of the pericarp and testa are thick and rich in non-starch polysaccharides and to some extent lignified; the cells of the aleurona layers are larger, contain a lot of protein and fat and are surrounded by a thin unlignified cell wall (Bach-Knudsen and Hansen, 1991a). It is important to take into consideration that grains do not only differ from each other in the total contents of NSP, but also in their characteristics and their arrangement (for example, in grains the cell wall of endospermal and aleuronic layers) (Table 1 and 2).

Table 1. Polysaccharide composition of endosperm and aleurona cell walls of barley and wheat. Values are expressed as percentage of total carbohydrates (Fincher and Stone, 1986; cit. Chesson, 1991)

Tablica 1. Sastav polisaharida endospermalne i aleuronske stanične stijenke ječma i pšenice; izraženo kao postotak ukupnih ugljikohidrata (Fincher i Stone, 1986; cit. Chesson, 1991

	Barley - Ječam		Wheat - Pšenica	
	Endosperm	Aleurone	Endosperm	Aleurone
Mixed-linked glucan - Miješani vezani glukani	75	26	20	29
Cellulose - Celuloza	2	2	4	2
Arabinoxylan - Arabinoksilan	20	67	70	65

Table 2. The total and water-soluble arabinoxylan and β-glucan (g kg^{-1}) content of cereal grains and the percentage contribution of the arabinoxylan and β-glucan of starchy endosperm walls to the grain total (Chesson, 1993)

Tablica 2. Sadržaj ukupnih i vodotopivih arabinoksilana i β-glukana (g kg^{-1}) u zrnju žitarica i postotni doprinos arabinoksilana i β-glukana u stijenkama škrobnog endosperma u cijelom zrnu (Chesson, 1993.)

	Arabinoxylan			β-Glucan - β-glukan		
	Grain total Zrno ukupno (g kg^{-1})	Grain solu. Zrno topivo (g kg^{-1})	Endosperm (%)	Grain total Zrno ukupno (g kg^{-1})	Grain solu. Zrno topivo (g kg^{-1})	Endosperm (%)
Barley - Ječam	56.9	4.8	22	43.6	28.9	99
Oats - Zob	76.5	5.0	12	33.7	21.3	47
Rye - Raž	84.9	26.0	44	18.9	6.8	71
Wheat - Pšenica	66.3	11.8	35	6.5	5.2	48

INFLUENCE OF FIBRE ON THE DIGESTIVE TRACT AND ENZYMATIC DIGESTION AND ABSORPTION

Different types of fibres have, in the process of digestion, in the different parts of the intestines quite different characteristics and produce different effects. For this matter, it would be appropriate to distinguish two types of fibres - soluble and insoluble fibres.

In the stomach and in the small intestine the insoluble fibres of cell walls hinder the contact of digestive enzymes with the nutritious cell contents; that is, for example, in grains starch and protein (Chesson, 1987; Drochner, 1993). This phenomenon could be referred to as the "cage effect". It seems that, for example, the negative influence of oat bran on the digestibility of fat and protein is mainly connected to the insoluble fraction, present in a great quantity in the aleurona and to lesser extent in the subaleurona cell walls. Cell walls of the aleurona and subaleurona layers of oat bran actually function as a barrier to the digestive enzymes and in this way reduce ileal and total digestibility of fats (Bach-Knudsen et al., 1993b). Due to the cage effect, a fraction of valuable nutrients in the small intestines is digested slowly or not at all and is only by microbial fermentation in the large intestine. However, microbial degradation of highly nutritive, yet enzymatic digestible substances is not favoured. For example, the microbial fermentation of starch, because of heat and substance losses, reduces the energy capture up to 30-40%. Microbial digestion of protein in the large intestine does hardly results in any absorption of amino acids. The product of microbial digestion of proteins are also ammonia and amines which exhibit negative effects on the metabolism of the animal.

While the insoluble fibre in the upper part of the digestive tract hinders the contact of digestive enzymes with the cell contents, the function of soluble fibres is different. Soluble fibres are capable of creating viscous solutions increasing thereby the viscosity of the intestine contents. The viscosity and the thickness of the unstirred water layer on the absorptive side of the mucous membrane also increase. The increased viscosity in the intestine influences the course and efficiency of digestion. The passage and the mixing of the intestine content are hindered. Therefore the diffusion rate of enzymes in the intestinal content and the diffusion of digested nutrients to the gut wall are reduced (Chesson, 1990; Wiesman and Inborr, 1990; Campbell and Bedford, 1992; Davidson and McDonald, 1998.

Because of the reduced efficiency of enzymes and less favourable conditions for absorption, the digestion and absorption of energy , dry matter, starch, protein, fat and minerals measured in the small intestine or in the faeces are reduced (Ikegami et al., 1990; Bach Knudsen and Hansen, 1991, 1993a; Mosenthin et al., 1994). The transit time in the stomach is increased (Bach Knudsen and Hansen, 1991), the feeling of satiety fortified

(Davidson and McDonald, 1998), the rate of passage of the soluble part of the intestinal contents from the stomach to the duodenum reduced (Chesson, 1990), the rate of the passage through the entire digestive tract is also reduced (Bach Knudsen and Hansen, 1991). Bach Knudsen et al. (1993a) have demonstrated that the addition of oat bran, rich source of soluble NSP, especially soluble β-glucans, significantly reduces the ileal digestibility of fat in pigs.

The fact that the effect of NSP is independent of the cage effect was demonstrated by Mosenthin et al. (1994). In the experiment on 70 kg pigs it was proven that the addition of 7,5% of crude pectin had a negative influence on the apparent digestibility of organic matter, proteins, essential and non-essential amino acids (Table 3). Since pectin did not influence the amount of the secreted pancreatic juice and the secretion of lipase, trypsine and chymotrypsin, the authors concluded that the reason for the decreased ileal digestibility could lie in the increased endogenous protein secretion which reduced the efficacy of protein digestion and absorption.

Table 3. The effect of pectin on the apparent digestibility (%) of organic matter (OM), crude protein (CP), essential (EAA) and non-essential (NEAA) amino acids in growing pigs, measured in the ileum and overall (adopted from Mosenthin et al., 1994)

Tablica 3. Utjecaj pektina na prividnu probavljivost (%) organske tvari (OT), sirovih bjelančevina (SB), esencijalnih (EAA) i ne-esencijalnih (NEAA) aminokiselina kod prasadi, mjereno u ileumu i ukupno (adaptirano po Mosenthin i sur., 1994.)

Diet - Hrana	Ileal digestibility - Ilealna probavljivost				Faecal digestibility - Fekalna probavljivost			
	OM - OT	CP - SB	EAA*	NEAA*	OM - OT	CP - SB	EAA*	NEAA*
Control - Kontrola	85.9	83.8	84.3	83.1	96.4	91.5	90.7	90.8
Pectin-fed Hranidba pektinom	74.1	69.0	70.2	65.5	94.7	85.8	83.6	83.9

* average - prosjek

The fibre content of the diet also influences the volume and weight of the intestine. High amount of fibre in the diet results in an increase in the volume of the large intestine in piglets and in an increase in the volume of the stomach and the large intestine in gilts (Drochner, 1993; Salobir, 1993; Mosenthin and Schindler, 1999).

Increased viscosity of the intestine content correlates with the increased water content in faeces and increased incidence of sticky faeces. This does not concern poultry only, where this phenomenon is best known ("sticky droppings"), but also the pig. Feeding diets with high amounts of barley may result in problems with manure disposal (Chesson, 1993).

For the human nutrition it is of special importance that the increased viscosity of the small intestine content results in slower digestion and absorption of carbohydrates in the lower part of the small intestine (Schneeman, 1998). As a consequence lower glycemic index could be observed, which is favourable from the point of view of metabolism. Furthermore, soluble fibres bind with bile acids and increase their excretion with faeces. Consequently, they decrease the concentration of the total and LDL-cholesterol in the blood and thus decrease the risks of coronary diseases (Jenkins et al., 1998).

Furthermore, the fibre also influences the absorption of cation minerals. These can bind with fibres and so become unavailable. The effect is connected mainly with soluble fibres, for example with pectin, particularly low-esteryfied, which has many free sites for the binding of cations (Davidson and McDonald, 1998).

MICROBIAL FERMENTATION OF FIBRE

For the digestion of fibre, pigs, as well as other animals, do not form digestive enzymes. The digestion of fibre depends on the efficiency of microbial fermentation, which in pigs is limited mainly to the large intestine. Microbial fermentation of fibre starts in the stomach, however, it is very limited (Drochner, 1993). The fibre increases in the stomach the retention time and stimulates the secretion of hydrochloric acid and pepsinogen (Low, 1993). Fibre also stimulates the secretion of saliva which buffers the stomach content.

As shown in the research carried out by Graham et al. (1986 and 1989) and Drochner and Mayer (1991) part of the fibre is already digested in the small intestine under the influence of microbes (Table 4 and Table 5). The comparison of cellulose, arabinoxylans and β-glucans digestibility in tables 4 and 5 show that with age, or rather, with the development of the digestive tract, hence the development of microflora, the ability to digest fibre increases. Pigs can digest part of the pectin already in the small intestine, in the large intestine, they can completely digest greater amounts of pectin (Drochner and Mayer, 1991).

Table 4. Apparent duodenal, ileal and faecal digestibility (%) of components of a barley-based diet in 30-50 kg pigs (Graham et al., 1986)

Tablica 4. Prividna duodenalna, ilealna i fekalna probavljivost (%) obroka na osnovi ječma kod 30 do 50 kg prasadi (Graham i sur., 1986.)

	Duodenum	Ileum	Faeces
Starch - Škrob	26.6	95.5	99.3
NSP:			
- total - ukupno	6.6	35.2	57.5
- cellulose -celuloza	4.5	38.3	45.2
- arabinoxylans arabinoksilani	2.4	16.7	43.5
- β-glucans β-glukani	27.3	68.0	100

Table 5. Apparent ileal and faecal digestibilitiy (%) of a components of a barley-based diet in 80 kg pigs; the effect of pelleting and β-glucanase supplementation (Graham et al., 1989)

Tablica 5. Prividna ilealna i fekalna probavljivost (%) hranjivih tvari obroka na osnovi ječma kod 80 kg prasadi; utjecaj peletiranja i dodatka β-glukanaze (Graham i sur., 1989.)

	Ileal				Faecal			
	Control	Pellet	Enz	Pel+enz	Control	Pellet	Enz	Pel+enz
Starch - Škrob	90.3	94.9	92.7	95.8	98.3	99.7	99.0	99.7
NSP:								
- total - ukupno	57.2	55.4	58.2	61.7	73.8	71.4	74.8	74.7
- cellulose -celuloza	29.9	21.2	20.7	28.2	56.2	49.7	49.5	50.7
- arabinoxylans - arabinoksilani	43.1	40.9	46.4	49.0	66.2	62.6	67.2	68.1
β-glucans - β-glukani	95.6	95.8	97.2	96.9	100	100	100	100

According to Bach Knudsen and Hansen (1991) wheat bran has a high proportion of insoluble lignified cell walls with little or no effect on digestion and absorption in the small intestine. In the large intestine, wheat bran is resistant to microbial degradation. Consequently, wheat bran, due to its physical presence, is one of the most effective dietary fibre sources that increases the faecal bulk and mouth-to-anus transit time. In contrast to wheat bran, oat bran and oat, products derived from oat endosperm contain a high proportion of soluble dietary fibre (especially mixed linked β-glucans). These, in turn, can increase the viscosity of the intestine content, and so delay stomach emptying, increase the transit time through the intestine and reduce the, rate of absorption in the small intestine (Bach Knudsen and Hansen, 1991). This has consequences for fat and carbohydrate metabolism. Oat bran has been demonstrated to provide a significant hypocholesterolaemic effect (Chen and Anderson, 1986). Oat bran, like other sources of soluble dietary fibre, is assumed to be readily fermented in the large intestine by colonic micro-organisms and has therefore only marginal effect on faecal bulk and mouth-to-anus transit time.

Feedstuffs with high fibre content cause a more regular flow of substrate in the large intestine (ileal-caecal flux) and for that create more favourable conditions for continuous fermentation (Drochner, 1993). The fermentation of fibres in the large intestine has, besides, a favourable effect on the increased faecal bulk and the properties of the intestinal content, also a favourable effect on the large intestine itself. The absorption of volatile fatty acids from the colon stimulates the sodium absorption from the intestinal lumen and thus provides an efficient mechanism for the re-absorption of water. In this context, volatile fatty acids must be seen as antidiarrhoeal and failure in their production leads to disturbances of salt and water balance (Mosenthin et al., 1999). Since they are rapidly absorbed, they do not contribute to the osmotic load in the lumen of the large intestine.

The production of butyrate is very important for the large bowl, butyrate is the most desired fuel for the cells of the epithelium of the large intestine (Bingham, 1990). Short chain fatty acids and especially butyrate favourably act on the development of cells of the large intestine; acetate, propionate and butyrate stimulate physiological proliferation of cells at the base of the crypts. Butyrate hinders excessive proliferation of cells on the apical part of the crypts (Sakata, 1987; Scheppach et al., 1997). Importantly it has also been found that butyrate reduces the risk of development of the colono-rectal cancer (Bingham, 1990; Scheppach et al., 1997). The discovery is, of course, of greater importance for the humans.

Comparatively speaking, little is known about the role of digestion in the large intestine in piglets (Aumaitre et al., 1995). The activity of fermentation in the large intestine in suckling piglets is not very well developed. Thus at the time of weaning the large intestine is poorly prepared for the efficient digestion of greater amounts of NSP.

Table 6. Influence of straw meal on gut characteristics of weaner piglets; weaning at 35th day (Bolduan, 1988)

Tablica 6. Utjecaj brašna iz slame na karakteristike crijevnog sadržaja kod prasadi odbijene s 35 dana (Bolduan, 1988.)

Crude fibre in the diet (%) - Sirova vlaknina u hrani (%)		Starter alone Starter sam	Starter + 5% straw Starter + 5% slame
		2.8	4.9
Transit time (hours) - Vrijeme prolaza (sati)		130	107
Proportion of the digesta in the hindgut (%) Udio digesta u zadnjem crijevu (%)		15	33
Days with diarrhoea (%) - Dani s proljevom		6.0	3.5
Metabolites of microbes (mmol)[1] - Metaboliti mikroba:			
Stomach – Želudac	- lactic acid - mliječna kiselina	5.6	2.8
	- volatile fatty acids - hlapive masne kiseline	5.4	4.0
	- ammonia - amonijak	6.6	3.2
Colon – Debelo crijevo:	- volatile fatty acids - hlapljive masne kiseline	12.4	23.9
	- ammonia - amonijak	3.7	6.2

[1] in the whole part of the gut - u cijelom dijelu crijeva

The stress caused by weaning and the simultaneous diet alteration can lead to low-absorption syndrome (Kyriakis, 1989). One of its manifestations is the prolonged intestinal transit time, which extends from the usual 50-70 hours to 150-200 hours (see also Table 7) (Bolduan, 1984). Retention of feed in the digestive tract increases the possibility of excessive development of (pathogenic) microbes, and in healthy animals causes to some extent the increased secretion of volatile fatty acids and carbohydrates in faeces, watery faeces and degenerative modification of the intestinal mucous.

The feed restriction after weaning, sometimes used in practice, can extend the duration of the already prolonged transit time. Therefore, some are of the opinion that the increase of the fibre content in the diet (around 5-6%) is more beneficial (Bolduan et al., 1984, 1988). To achieve a normal transit time, Bolduan et al., (1988) suggests that starter diet should contain 25-30% wheat bran, 10% dehydrated alfalfa or 5% straw meal. This kind of feedstuff should not be given for a period longer than three weeks after weaning. The addition of fibre rich feedstuffs should not exceedingly influence the concentration of energy and nutrients in the feed. It has been shown that increase in the fraction of NSP in the diet (even when highly indigestible like straw) stimulates fermentation in the gut of the piglets (Table 6). The results in the table show that piglets are able to adapt to feedstuffs rich in fibre rapidly.

Favourable influence of crude fibre in weaning piglets is based on the following: decreased intestinal transit time overall (Table 7), through the stomach and small intestine, fermentation in the large intestine, reduced frequency of diarrhoea (Figure 1, Table 8), reduced formation of amines, increased secretion of N through faeces and reduced through kidneys. The former effects are associated with the increased volatile fatty acids production which is associated with a decrease in pH and binding of NH_3 with hydrogen to produce NH_4^+ that is non-diffusable (Mosenthin et al., 1999). The shorter intestinal transit time leads to faster secretion of potentially pathogenic bacteria and their toxic products. This effect is very important in people. Shorter intestinal transit time and the increased volume of the intestinal contents reduce the contact of the bowl mucous membrane with toxic, mutagenic and carcinogenic substances. Thus reducing the risk of cancer development in the large bowl (Christl, 1997).

Table 7. Effect of wheat bran supplementation of a weaner diet after 35 days suckling period on intestinal transit time (80% recovery) (Schnabel et al., .1983)

Tablica 7. Utecaj dodatka pšeničnih posija u krmnim smjesama kroz vrijeme potrebno za izlučenje 80% indikatora (Schnabel i sur., 1983.)

% CF/OM SV/OT	Weeks post weaning -Tjedni nakon odbića			
	1.	2.	3.	4.
0.5	192	361	215	141
2.2	155	113	111	103
3.9	133	118	118	92
5.5	117	98	63	78

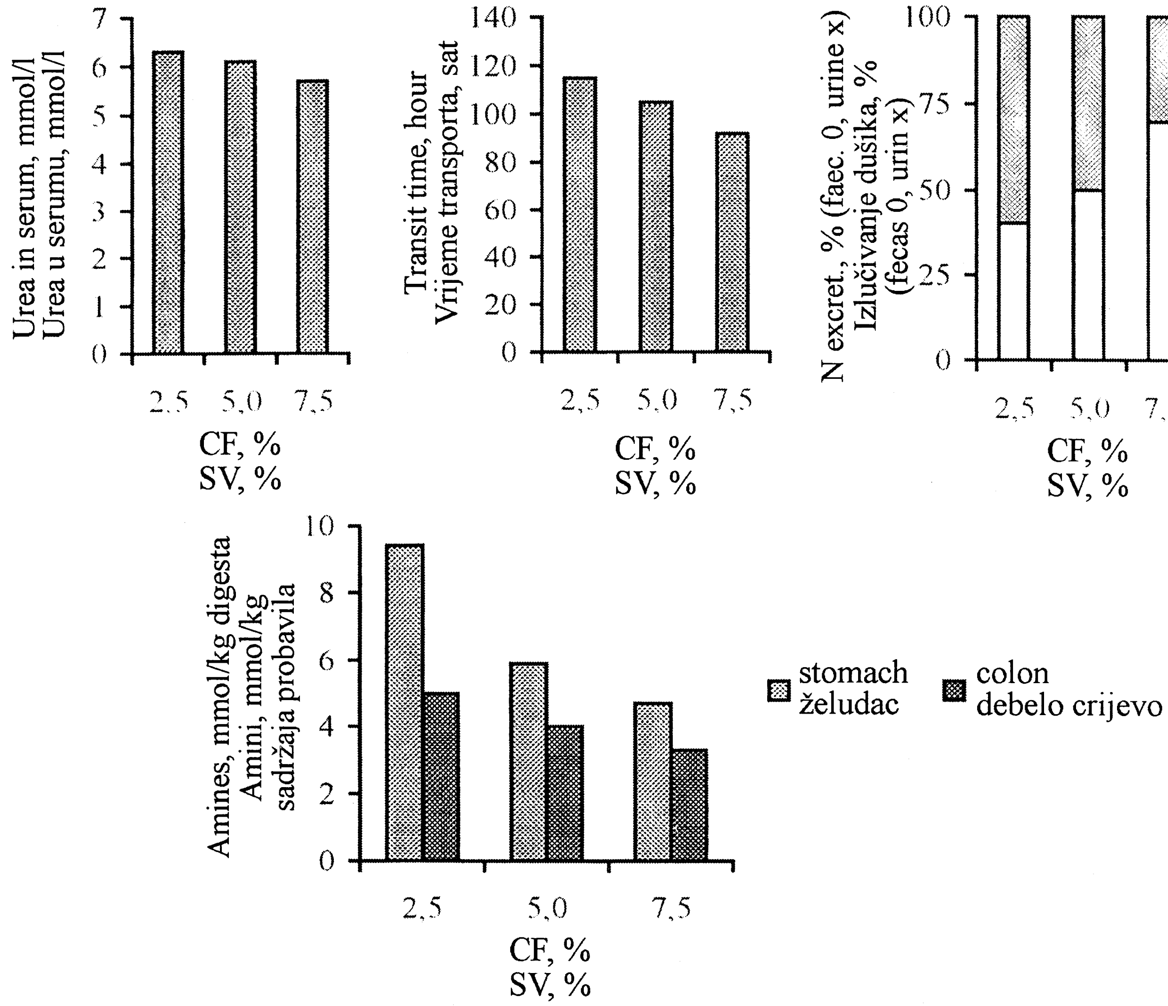
Table 8. The effect of sugar beet pulp on the frequency of diarrhoea (5-6 weeks after weaning) (Ball and Aherne, 1982)

Tablica 8. Utjecaj rezanaca šećerne repe na učestalost proljeva (5 do 6 tjedana poslije odbijanja) (Ball i Aherne, 1982.)

	Control Kontrola	Control + sugar beet pulp Kontrola + repini rezanci
No of herds – Broj stada	7	7
No of litters - Broj legala	71	71
No of weaned piglets Broj odbitih odojaka	678	650
Mortality between 3rd and 8th week, % Uginuća između 3. i 8. tjedna, %	4.3	4.3
Frequency of postweaning diarrhoea, % Frekvencija proljeva poslije odbića, %	36	21

Figure 1. **Effect of increasing crude fibre content of starter mixture by adding wheat bran to feed of piglets 3 weeks after weaning (amines as the sum of cadaverin, putrescine, histamine and tyramine) (Bolduan et al., 1988)**

Slika 1 . **Utjecaj povećanja sadržaja sirove vlaknine u starteru sa dodatkom pšeničnih posija kod prasadi tri tjedna poslije odbijanja (amini kao zbir kadaverina, putrescina, histamina i tiramina) (Bolduan i sur., 1988.)**



FIBRE AND ENZYME SUPPLEMENTATION

As described, large quantities of NSP in the diet negatively influence digestion and absorption of nutrients and also the nutritional and energetic values of the diet. The effect of soluble NSP on pre-caecal digestion, especially in older pigs, is not very pronounced and is much smaller than, for example, in poultry (Miller et al., 1994). A part of the difference between gross and metabolic energy value of feedstuffs (e.g. grains) can be explained through the effects of NSP (Haberer and Schulz, 1998). It has been shown that the addition of appropriate NSP degrading enzymes can eliminate or at least reduce some of the negative effects. An extensive overview of literature given by Haberer and Schulz (1998) showed that the addition of NSP breaking enzymes (especially β-glucanase and xylanase), improves pre-caecal digestibility of dry matter, proteins and fat, increases the feed consumption and daily gain in fattening pigs. However, the improvement in pigs is smaller and more variable than in poultry. The reasons that the effect of adding enzymes is greater in poultry than in pigs are:

- pigs differ physiologically from chicks in that the water content in the intestine is higher (in layers it is similar to that in pigs) (Campbell and Bedford, 1992),

- the length of the small intestine and the transit time (period of nutrient retention) are relatively longer in pigs (Graham et al., 1986),

- the microbial population, which produces enzymes for the degradation of NSP is smaller in poultry than in pigs (Dierick, 1989). This is also why digestibility of fibre in pigs is more efficient than in poultry. With the development of normal microflora in pigs the efficacy of added enzymes becomes less evident,

- in contrast to pigs exogenous enzymes in poultry act already in the crop for several hours due to favourable conditions (Dierick, 1989; Campbell and Bedford, 1992)

- the conditions in the stomach of pigs are very unfavourable for the enzymes; the pH is rather lower than in poultry, the stomach transit time is much longer and the presence of digestive proteolitic enzymes can play a major role (Campbell and Bedford, 1992),

- deactivation of enzymes with microbial flora is smaller in poultry (Dierick, 1989).

It is known that the genotype (variety) and the environmental conditions influence the content and solubility of NSP in grains and consequently the intestinal viscosity and energy value in poultry (Dusel et al., 1997; Salobir et al., 1999). The knowledge of differences in NSP content and solubility are important for the optimal composition of an enzyme preparation (Salobir, 1998 and Salobir et al., 2000). At present, no similar research has been done on pigs yet. However, the importance of the differences in NSP content and solubility in grains could be to some extent expected in younger pigs. Its importance is less probable in older pigs, with completely developed intestines.

CONCLUSION

Fibre plays a major role in pig nutrition due to its specific characteristics, resulting from its chemical and physical activity. Understanding and acknowledging the influences of fibre on the intestine itself, the digestibility, metabolic processes and on the state of health of the animals, enables its proper evaluation in diets and feed mixtures for different categories of pigs in practice.

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SAŽETAK

Skoro sva krmiva koja se upotrebljavaju u hranidbi svinja sadrže određeni udjel vlaknine hrane. Krmiva se ne razlikuju samo u udjelu vlaknine nego i u njihovim kemijskim i fizikalnim svojstvima. Udio i svojstva vlaknine determiniraju njihov utjecaj u probavi i metabolizrnu. Da bi se moglo objasniti utjecaj pojedinih frakcija vlaknine u probavnim procesima podjela na netopivu i topivu vlakninu čini se povoljnom. Netopiva vlaknina stanične stijenke djeluje kao barijera prema probavnirn enzimima i smanjuje probavljivost hranjivih tvari. Topiva vlaknina povećava crijevnu viskoznost te se time smanjuje stupanj difuzije enzima u crijevnom sadržaju, difuzija hranjivih tvari do crijevne stijenke i stupanj transporta crijevnog sadržaja, što sve dovodi do smanjenja probavljivosti i apsorpcije hranjivih tvari i energije. Vlaknina hrane ima i mnoge povoljne učinke u procesu probave, na integritet probavila i zdravstveno stanje životinja, naročito kod prasadi. Nepovoljne učinke vlaknine na probavljivost hranjivih tvari i energije moguće je eliminirati do neke mjere dodavanjem odgovarajućih enzima koji razgrađuju neškrobne polisaharide.