

EFFECT OF FEED ON THE BASIS OF SOYBEAN IN PIG NUTRITION

**Dragan MILIĆ¹, Vladislav STANAČEV¹, Ana MARJANOVIĆ - JEROMELA²,
Vidica STANAČEV^{3*}, Nikola PUVAČA³, Sava ZARIĆ³**

¹Perutnina Ptuj, Topiko doo, Petefi Brigade 2, 23400 Bačka Topola, Serbia.

²University of Novi Sad, Institute for Field and Vegetable Crops, Maksima Gorkog 30, 21000 Novi Sad, Serbia.

³University of Novi Sad, Faculty of Agriculture, Department of Animal Science, Trg Dositeja Obradovića 8, 21000 Novi Sad, Serbia.

Corresponding author email: vidica.stanacev@stocarstvo.edu.rs

Abstract

This paper is a review of summarizing the results of researchers who have studied the effect of soybean meal and soybean grits in the diet of certain categories of pigs. As for the sows and fattening pigs soybean meal may be the only protein feed in the diet, which meets the needs of these groups in proteins, typically without correction of amino acids with synthetic amino acids. If the meal is properly heat treated, diet of fattening pigs is possible without the use of fish meal, and when that does not deteriorate the basic parameters of production. Soybean meal in addition to high quality protein and contains significant amounts of fat, which is of particular importance in the nutrition of young pigs that have not yet developed a system for efficient enzymatic digestion of cereals, the only source of energy in the diet. The use of soybean grits increased daily gain of piglets and improves feed efficiency compared to the group in which was used powdered milk. The maximum level of soybean grits in the diet of piglets is 30% and soybean meal in the diet of fattening pigs and sows 30%.

Key words: Soybean meal, soybean grits, pigs

INTRODUCTION

Soybean (*Glycine hispida*) as the most widespread oilseed is mentioned in ancient China five thousand years before our era. At that time it was used as an ornamental plant and as a medicine plant, and only the forties of the twentieth century became an important factor in crop production and an important source of food in world [17].

Soybean is the most important vegetable protein feed used in the feeding of all types and categories of domestic animals. It can be used whole grain in the form of full-fat soybean, soybean meal and then as a by product of food industry and many other products made from modern technology.

Its importance is growing in the period when the indigenous livestock do not leave productive breeds of pigs and poultry hybrids and moves to more productive animals, which have a higher content of meat and less fat. In such conditions, increasing needs of animals in which soy protein gains importance as a crop

that has the highest and best protein quality [12, 20].

Nutritional valuable raw soybeans is relatively low, what more raw soybeans may adversely affect the health of animals as a result of the presence of biologically active compounds with anti nutritious effect, ie. compounds that reduce the nutritional value affecting the availability and metabolism of nutrients.

A prerequisite for high quality soy protein and efficient use in non ruminant nutrition is adequate processing of grain, with the inactivated antinutritive factors with methods based on the thermal processing of nutrients. In soybean there are different concentrations of inhibitors that exert a significant negative effect in nutrition. The best known and most important of them is trypsin inhibitor and urease enzyme, hymotripsin and then haemagglutinin lypoksigenazes, saponins and other compounds.

Inactivating these compounds which have the structure of proteins is usually done by applying high temperature, which depends on particle size, moisture content and duration of

heat treatment. It is important to note that it is harmful as too lenient and too harsh thermal treatment. Short time of treatment and low temperature will inactivate inhibitors and they will reduce the protein digestibility. Too high temperature and long duration destroys inhibitors, but the protein is already present in the grain. In addition, high temperature reduces the solubility of proteins and can lead to other changes that will reduce their efficiency. Determination of the quality of treated soybeans is done by physical and chemical properties and biological test methods with domestic animals, with the following production parameters and animal health [16, 11, 7, 8, 10, 15, 12, 2, 22].

Feedstuffs as a result of soybeans processing

Soybean meal is the residue after extraction of oil from soybeans that during the production process exfoliates, thermal processing and extraction with organic solvents extract of oil. At the end of the process, previously pulverous toasted grain husk can be restored, or not. In modern facilities, processing of soybeans is computerized and allows continuous production, which provides almost complete separation of oil and getting a meal which contain easily digestible proteins, a reduced content of inhibitors in optimal limits range [19, 6, 7]. Soybean meal is the best known and most widely used protein feed. In the process of refining, grain is grounded into flakes, separating the shell and extracts the oil. Depending on whether the shell is returned to the meal or not, there is „standard” meal with about 44% protein, which contains more crude fibre because of the added shell, and high protein meal with about 48-50% protein, which do not contain shell and because of it contains less crude fibre and higher energy (Table 1). Meal with 44% protein is used in the diet of all categories of pigs, while those with 50% protein is intended primarily for feeding piglets, but it can be used in feed of other categories [13, 15]. The use of soybean meal in the diet of pigs that are not accustomed to eating coarse food, which dominate plant nutrients, can cause serious and long delays and disorders in the digestive tract, especially in younger piglets with a lower body mass. Therefore, the use of

this meal for piglets is limited. According to some researchers, soybean meal is not suitable for feeding early weaned piglets. A problem creates the complex of protein and carbohydrates that are not cleaved in the process of heat treatment of meal. This complex causes in piglets, in the first 14 days, serious damage to the lining of the digestive tract and thickening of the intestinal villi, which reduces the capacity of the digestive tract [11]. Therefore, the products of soy protein concentrate, which contains about 60-65% protein and a significant reduction of carbohydrates, and is used exclusively in the diet of piglets. Soy protein isolate is the feed from which most of the carbohydrates is extracted, so that the protein content is very high and ranges from 80-85% (Table 1) according to Boatright and Hattiarchchy [4].

Table 1. The content of nutrients in the feed from soybean

Nutrient	Soybean meal		Concentrate protein	Protein isolate	Soybeans
	With shell	Without the shell			
Dry matter, %	89	90	90	94	89
Crude protein, %	43.8	47.5	64.0	88.5	37
Fat, %	1.5	3.0	3.0	1.5	18.0
Crude fibre, %	7.4	3.4	-	1.5	6.0
SE, kcal/kg	3430	3570		4940	4200
ME, kcal/kg	3180	3235	3500	4350	3945
NE, kcal/kg	1935	2020	2000	2000	2880
NDF, %	3.13	8.9	-	-	12.0
ADF, %	9.4	5.4	-	-	8.4
Mineral substances					
- Calcium, %	0.32	0.34	0.35	0.19	0.25
- Phosphorus, %	0.65	0.69	0.81	0.62	0.57
- Manganese, %	0.27	0.30	0.32	0.14	0.29
Amino Acids					
- Lysine, %	2.83	3.02	4.20	5.26	2.35
- Met. + Cystine, %	1.31	1.41	1.90	2.20	1.15
- Threonine, %	1.73	1.85	2.80	3.17	1.44
- Tryptophan, %	0.61	0.65	0.90	1.08	0.48
- Histidine, %	1.17	1.28	1.8	2.25	0.96

Feed is primarily intended for the production of milk as a replacer for calves and for the production of compound feeds prestarter in early weaned piglets according to Boatright and Hattiararchy [5]. Soybean grits is processed soybeans from which oil is not extracted. Because of this protein content in the soybean grits is lower in comparison with soybean meal (35-38%), but the level of oil (18%) and digestible energy (17.5 MJ) is significantly higher [13]. Soybean grits is a nutrient that can be used in the diet of all categories of pigs, but not as the only source of protein, because of high oil content. Primarily is used in the diet of piglets, due to the fact that piglets can effectively use oil as an energy source. In sows nutrition soybean grits is also recommended because oils in feeds has led to increased milk and fat content in milk of sows [12, 14, 15]. In fattening pigs nutrition soybean grits can be used in large quantities only in the first period of fattening while the use of this nutrient in the second stage of fattening may lead to the deposit of oil reserves in the fat, which negatively affects the quality and firmness of bacon [13].

Effect of soy based feeds in the pigs diet

Soybean meal in the diet of certain categories of pigs

Soybean meal is the most used protein feed in the diet of all categories of pigs. As for the sows and fattening pigs soybean meal may be the only protein feed in the ration [12, 21]. Inevitably it is the most used protein feed which quality can fulfil needs of these animals in proteins, typically without correction amino acid contents with synthetic ones. If the meal is properly heat treated, diet of fattening pigs is possible without the use of fish meal, and that does not deteriorate the basic parameters of in kind production (Table 2).

Table 2. Production of pigs in experiment with soybean meal [12]

Group	I	II
Source of protein	Soybean meal	Soybean meal + Fish meal
Number of pigs	80	80
Body weight, kg		

- At the beginning of the experiment	23.55	23.74
- At the end of the experiment	97.25	99.5
Daily gain, g	599	617
Feed consumption, kg		
- Per kg of gain	3.41	3.48
- Per hr. day	2.04	2.14
Indexes, %		
- Daily gain	100.00	103.00
- Conversion	100.00	102.05
- Consumption	100.00	104.94

However, if soybean meal is not properly heat treated, can lead to a large decrease in daily gain and feed conversion rates, which extends the fattening period and causes great economic losses (Table 3). Such condition was present at the time of the start of the domestic soybean processing plant, which where competed with all other mills that are processed primarily sunflower, and were not equipped for the efficient processing of soybeans.

Table 3. The effect of soybean meal from different oils facilities on the production of fattening pigs [12]

	Origin of soybean meal				
	"Soy Protein" Bečej	A	B	C	D
Number of pigs	48	48	48	48	48
Body weight of piglets, kg					
- At the beginning of the experiment	23.52	23.58	23.88	23.99	23.82
- At the end of the experiment	96.85	97.65	80.10	78.81	86.55
Daily gain, g	594	603	454	445	504
Feed consumption, kg					
- Per kg of gain	3.41	3.41	3.98	3.89	3.70
- Per feed day	2.02	2.05	1.49	1.42	1.86
Indexes, %					
- Daily gain	100	101.51	76.43	74.92	84.89
- Conversion	100	100.00	116.42	114.08	108.50
- Consumption	100	101.49	88.61	85.51	92.08

Table 4. The effect of soybean meal from different oils facilities on production of weaned piglets, [12]

	Origin of soybean meal				
	"Soy Protein" Bečej	A	B	C	D
Number of piglets	46	46	46	46	46
Weight of piglets, kg					
- At the beginning of the experiment	6.4	6.3	6.3	6.4	6.3
- At the end of the experiment	7.22	7.22	7.17	2.21	8.21
Daily gain, g	360	349	237	319	330
Feed consumption, kg					
- Per kg of gain	2.26	2.12	3.14	2.37	2.5
- Per feed day	0.79	0.74	0.66	0.75	0.80
Indexes, %					
- Daily gain	100	96.9	65.8	88.6	91.7
- Conversion	100	93.8	138.9	104.9	101.6
- Consumption	100	93.7	83.5	94.9	101.3

In the case of piglets feeding soybean meal is an important and high quality protein source, when is properly heat treated, only if pigs were accustomed to feed consumption before weaning and efficient use of feed as a source of protein which is dominated by soybean meal (Table 4). In terms of tests, whose results are shown in Table 4, next to soybean, 6% of fish meal was included in mixture. However, this could not compensate for poor quality of soybean meal used in some groups of piglets [22].

Soybean meal in the piglets diet

Fullfat soybean grits is thermal processed soybeans from which oil is not extracted. Grits is the name given because, as the grinding of grain during the processing is rough, however fine grinding can create manageable problems in the manipulation of the feed. Soybean grits in addition to high quality protein contains significant amounts of fat. This is of particular importance in the nutrition of young pigs which are not able to efficiently digest carbohydrates from grains, as the only source of energy in diet. The presence of oil also is important for nutrition of sows [8, 9, 3]. Thermal treatment of grains can be made by toasting or extrusion [2,

18, 16]. In terms of inactivation of inhibitors present both methods are effective, but extrusion have some advantages because of the high pressure and mechanical friction, which causes destruction of cell membranes, and thus to increase the digestibility of nutrient substances. Table 5 shows the results of the production of piglets fed toasted soy grits [12].

Table 5. Production of pigs in the experiment with fullfat toasted soy grits in the diet [12]

Group	I	II	III	IV
Source of protein	Control	Milk powder	Toasted soy grits	
		10%	5%	10%
Daily gain, g				
- Averages	373	381	398	400
- Index, %	100.00	102.14	106.70	107.24
Feed conversion, kg				
- Averages	2.05	2.03	1.94	1.92
- Index, %	100.00	99.02	94.63	93.66
Feed consumption, kg				
- Averages	0.76	0.76	0.76	0.77
- Index, %	100	100	100	101.32

The use of this feed increases the daily weight gain of piglets and improves feed efficiency (Table 5). The results indicate that the soybean grits led to an increase in daily gain and reduced feed consumption compared to the control group in which soybean meal was used, but also in the experimental group in which powdered milk was used. Extruded soybean grits is a feed containing 38% protein, 18% fat and 3% crude fibre, ash and up to 6% and 8% moisture. Nutrient content of toasted soybean meal is the same as extruded [15]. The difference between toasted and extruded soybean grits is in the way of dehulled seed thermal processing. Toasting is the thermal treatment of a strictly controlled temperature, so not to damage the protein, and to inactivation trypsin inhibitor [10]. This method has no effect on carbohydrate complex. Unlike the toasting process, extrusion is a combination of temperature, pressure and moisture. In addition to inactivation of inhibitor materials, extrusion has an impact on the structure of proteins and carbohydrates. Extrusion leads to gelatinization of starch in which large

molecules of polysaccharides are split and thus increases the utilization. Table 6 shows the effect of toasted and extruded soybean grits on the production of weaned piglets [12].

Table 6. Effect of toasted and extruded soybean grits on the production of weaned piglets [12]

Group	I	II	III	IV
Treatments	Control	Skim milk	Soybean grits	
			Toasted	Extruded
Number of piglets	24	24	24	24
Body weight, kg				
- At the beginning	6.08	5.92	6.08	6.06
- At the end	25.08	27.09	27.91	28.50
Daily gain	347	385	397	408
Feed consumption, kg				
- Per feed day	0.72	0.72	0.73	0.73
- Per kg of gain	2.07	1.87	1.84	1.76
Indexes, %				
Daily gain	100.00	110.95	114.41	117.58
Feed consumption	100.00	100.00	101.39	100.00
Feed conversion	100.00	90.34	88.89	85.02

The maximum level of feedstuffs in the pigs diet

The nutritive value of certain feedstuffs is different and affected by the content of basic nutrients, their structure and digestibility, as well as the presence of antinutritive substances or substances that provide nutrients unfavourable or unpleasant taste and odor. All this has an impact on the convenience of use of nutrients in the diet of certain types and categories of animals [20]. Of course this has an impact on the cost of feed. Because there was a need to define the maximum participation of nutrients in the mixtures of certain categories of pigs, so as to prevent an excessive share of less valuable and less expensive feed, which would impact on the reduction of gain and deterioration in feed conversion, and in some cases it could cause health disorders [1]. Of course, the main objective is optimization of compound structure to find the cheapest feed in the circumstances, but it must be a mixture that will enable the efficient production of pigs. Limiting participation less valuable nutrients in

the mixtures is necessary [9]. Table 7 shows maximum participation of some feedstuffs in the diet of different categories of pigs.

Table 7. The maximum participation of soybean, rapeseed and sunflower meal in the diet of certain categories of pigs, % [1, 9]

Feed	Starter	Pigs for Fattening	Sows	
			Pregnant	Lactating
<i>Austin (2000)</i>				
- Soybean meal	15	25	15	20
- Soy protein concentrate	20	0	0	0
- Soy Protein Isolate	10	0	0	0
- Soybean grits	0	20	10	10
- Rapeseed meal	0	15	15	15
- Sunflower meal	0	20	10	0
<i>Christiansen (2005)</i>				
- Soybean meal	15 (30)	30	30	30
- Soybean grits	15 (30)	15	20	20

CONCLUSIONS

Based on the summarized results of the use of soybean meal and soybean grits in the diet of different categories of pigs the following conclusions can be drawn. If properly heat treated, soybean meal can be used as the only protein feed in pig fattening that meets the needs of the animal in protein. Maximum level of soybean meal in the diet of fattening pigs and sows is 30% and in piglets. Use of soybean grits in the diet of piglets, improved production results when it is compared to the milk powder and the maximum level of soybean grits is 30%. In the diet of fattening pigs amount of soybean grits is 15% and 20% in sows diet.

ACKNOWLEDGEMENTS

This paper is a part of the project TR 31033 and III 46012 which is financed by Ministry for Science and Technological development of the Republic of Serbia.

REFERENCES

- [1] Austin, L., 2000. *The Effects of Dietary Protein Concentration on Performance and Visceral Organ Mass in Finishing Barrows and Gilts*, Nebraska Beef Cattle Reports. 56: 323-328.
- [2] Babić, M., Babić Lj., 2001. *The combined action of extrusion processing of soy*, PTEP 5: 1450-5029.
- [3] Beuković, M., Beuković, D., Kovčín, S., Stanačev, V., 2008, Rough soybeans in the diet of fattening pigs, Symposium "Animal husbandry, veterinary medicine and economics in the production of safe food" with international participation, Book of Abstracts, p-185.
- [4] Boatright, W.L., Hattiarachy, N.S., 1995. *Effects of lipids on soy protein isolate solubility*, J. Food Sci. 72: 1439-1447.
- [5] Boatright, W.L., Hattiarachy, N.S., 1995. *Soy protein isolate solubility and surface hydrophobicity as affected by antioxidants*, J. Food Sci.60: 798-810.
- [6] Božović, I., Polić, Đ., 1994. *Thermal processing and nutritional value of soybeans*, Contemporary Agriculture. 42(5): 99-106.
- [7] Božović, I., Žilić, S., Radosavljević, M., Jovanović, M., Terzić, D., 2001. *Nutritional benefits of soy protein feed energy obtained using the ST-HT treatment*, IX Symposium Technologies fodder "Step into the future," 8-13. May, Zlatibor, 182-189.
- [8] Chiba, I.L., 2011. *Protein supplements*, In: Lewis, JA and LL Southern Swine Nutrition, CRC Press, Boca Raton, London, New York, Washington, DC.
- [9] Christiansen, P.J., 2005. *The Basics of Pig Production*, Danish Agricultural Advisory Service, National Centre, Landbrugsforlaget.
- [10] Filipović, S., Ristic, M., Sakač, M., 2001. *The possibility of processing soybeans in protein-energy feed for animals*, IX Symposium Technologies fodder "Step into the future," 8-13. May, Zlatibor, 96-109.
- [11] KeShun, L., 2000. *Soybean, chemistry and application technology*, An Aspen Publication, Aspen Publishers, Inc.; Gaithersburg, Maryland.
- [12] Kovčín, S., Pejić, N., Živković, S., 1988. *Soy products as animal feed*, Faculty of Agriculture, Novi Sad.
- [13] Kovčín, S., 1993, *Pigs nutrition*. Faculty of Agriculture, Novi Sad.
- [14] Kovčín, S., Stanačev, V., Zarić, B., 2003. *Effect of extrusion on the solubility of soybean protein content and inhibitor*, 44. Savetovanje: Production and processing of oilseeds, Proceedings 93-98, Budva.
- [15] Kovčín S., Stanačev, V., 2004. *Soy Protein in the diet of weaned pigs*, Proceedings of the 45th Advice "Production and processing of oil crops" with international participation, 113-119, Petrovac.
- [16] Leszek, M., 2011. *Extrusion, Effect of physical and chemical properties*, Encyclopedia of Earth Sciences Series, Encyclopedia of Agrophysics, Part 5: 284-287.
- [17] Miladinović, J., Hrustić, M., Vidić, M., 2011. *Soybean*, Institute of Field and Vegetable Crops, Novi Sad and Sojaprotein, Bečej, p.-511.
- [18] Riaz, M., 2005, Extrusion processing of oilseeds meals for food and feed production, Bailey's industrial oil and fat products, Book Chapter.
- [19] Savić, S., Stanačev, V., Kovčín, S., 2001. *Protein production of oilseeds in animal biomass*, 42. Savetovanje: Production and processing of oilseeds, Proceedings 42: 99-102.
- [20] Stanačev, V., Kovčín, S., 2003. *Nutrients and technology based animal feed and feeding of livestock - Practicum*, Faculty of Agriculture Novi Sad.
- [21] Tokachi, D.M., Dritz, S.S., Godbrand, N., 2003. *Nutritional requirements of the weaned pig*, In: Pluska, JR, J.Le Dividich, MWA Verstegen Weaning the pig Concept and consequence, Wageningen Academic Publishers.
- [22] Žilić, S., 2004. *Nutritional characteristics of soybeans and soybean products*. Doctoral dissertation, Faculty of Agriculture Novi Sad.