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Estudos das características físicas e químicas durante o processamento da soja integral utilizada na alimentação de monogástricos

Physical and chemical characteristics studies during the processing of soybean used in monogastric feeding

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Resumo

Este estudo objetivou avaliar o processamento da soja integral, coletada após saída do reator a vácuo. Foram coletadas um total de 10 amostras do produto final, classificadas em 6 grupos: amostra grãos total, inteiros estragados, inteiros queimados, quebrados normais e grãos quebrados queimados. As análises foram realizadas baseadas nos controles de qualidade como: umidade, proteína bruta, proteína solúvel e urease. Verificou-se que a amostra de grãos inteiros normais apresentou valores de proteína bruta, proteína solúvel (Psol), umidade e urease semelhantes (P <0 ,05) à amostra total da soja desativada. No entanto, os resultados das análises bromatológicas encontrados para o grão inteiro normal foram, em sua maioria, diferentes (P < 0,05) daqueles encontrados para as demais amostras avaliadas. Os grãos quebrados queimados tiveram menor (P < 0,05) valor de umidade, proteína bruta, Psol, Urease em relação aqueles obtidos para o grão inteiro normal. Concluiu-se que as amostras de grãos inteiros normais e grãos quebrados normais constituem a maior parte (90%) da parcela total da soja integral, e que possuem valores de Psol e urease adequados para uso em rações de aves e suínos. As amostras restantes possuem pouco valor na qualidade da soja, devido a baixa participação na amostra total. Ainda, de acordo com os resultados obtidos, pode-se inferir que a moagem do grão de soja antes da desativação pode melhorar o processamento, obtendo valores de Psol e urease mais uniformes e maior rendimento aos digestores (capacidade/hora).

Palavras-chave: Qualidade da soja integral, urease, digestão

Abstract

This study was aimed of evaluating the processing of full fat soybean, collected after the reactor exit vacuum. It was collected a total of 10 samples of the final product, classified into six groups: total sample grain; normal whole; spoiled whole; burnt whole; normal broken, and burnt broken. Analyses were performed based on the quality controls such as moisture; crude protein; soluble protein, and urease. It was verified that the sample of normal whole grains presented crude protein, soluble protein, humidity and urease values similar (P < 0.05) to the total sample of deactivated soybean. However, the bromatological analyses results found for normal whole grain were mostly different (P < 0.05) from those found for the other samples evaluated. Burnt broken grains presented lower (P < 0.05) values of

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humidity, crude protein, soluble protein and urease in relation to those obtained for normal whole grain. It can be concluded that normal whole grains and normal broken grains samples constitute the biggest part (90%) of the total sample of full fat soybean and have adequate soluble protein and urease values for the use in poultry and pig feeds. The remaining samples are not of great importance to soybean quality due to the low participation in the total sample. Also, according to the results obtained, it can be infered that grinding soybean grain before deactivation can improve processing and obtain more uniform soluble protein and urease values and higher yield to digestors (capacity/hour).
Key words: Full fat soybean, quality, urease, digestion

Introduction

Genetic evolution of production animals and the increase of food demand have required high quality and digestibility products for animal feeds use. In Brazil, especially in Paraná State, soybean has been given prominence in relation to other cultures due to sale price rises and the knowledge and adoption of production techniques (GOLDFLUS, 2001).

Glycine max (L.) Merril soybean belongs to the legume family, Papilionoideae subfamily, Glycine L genus, which is a legume from the Southeast Asia cultivated for more than five thousand years, rich in protein and oleaginous substances (unsaturated fatty acids and phospholipids), and has been currently used in human and animal food (OPALINSKI et al., 2006). It has presented several applications in (agro) industries and chemical industry. As a result of being easily cultivated due to favorable topography and climate in Brazil, its planted area is in great expansion (GARCIA; MURAKAMI; BRANCO, 2000).

Soybean grain processing makes its use possible in several segments of food supplements, nutraceuticals and isoflavones, protein balance of animal feeds, adhesive, fibers, coatings, foam and agricultural fertilizers industries, among innumerous products (LUDKE et al., 2007).

Although soybean has demonstrated efficiency as protein supplements in animal feeds, several researchers warn for the existence of some problems related to its cultivation and nutritional value (HERKELMAN; CROWELL, 2003).

The standardization of the industrial process to inactivate antinutritional factors, as well as, defined laboratorial methodologies to monitor quality is a relevant variable which should be considered in the soybean nutritional evaluation. Many national researches developed by Gerber, Penz Junior and Ribeiro (2006), Rostagno et al. (2001), Goldflus (2001) and Opalinski et al. (2006) show the negative interferences of misprocessed soybean in the nutritional value of soybean to poultry and pigs. Among the antinutritional factors present in soybean grains, antitrypsin and chymotrypsin (proteases) factors, hemagglutinin (lectins), saponins, allergic factors, lipoxygenase and soluble non amylaceous polysaccharides should be mentioned. They can be distributed through the process at high temperatures with the exception of non amylaceous polysaccharides (BIELORAI; HARDUF; ALUMONT, 1997).

The necessity of thermal treatment of full fat soybean for the use as animals feed supplement besides the incentive to genetic research and selection of cultivars with low content of antinutritional factors implemented a variety of available methods in the market for full fat soybean processing aiming mainly at deactivating such factors without causing damage to nutrients.

Studies conducted by Opalinski et al. (2006) defend that among antinutritional factors, the trypsin inhibitor is the factor which is given most importance as when it is inactivated by heating, the other thermolabile factors are already controlled.

According to Zhang et al. (1993), Gerber,

Penz Junior and Ribeiro (2006) suggests that in quality evaluation of soybean grains thermally processed, protein digestibility, amino acid availability, preferably lysine and metabolized energy determination, should be considered.

Material and Methods

The experiment was developed at the State University of Maringá, in Maringá/PR. The methodology, the material and the procedures adopted refer to the classification of six groups of soybean grain samples evaluated according to their physical state as follow:

Category 01 – Total Sample; Category 02 – Normal Whole Grains; Category 03 – Spoiled Whole Grains; Category 04 – Burnt Whole Grains; Category 05 – Normal Broken Grains, and Category 06 – Burnt Broken Grains.

The equipment contains two different reactors of soybean vacuum deactivation with capacity for 20 tones/hour, DELTA brand (agro industrial equipment industry Ltd). Material collection was carried out at the exit thread after the soybean deactivation process, with a total of 10 samples.

After samples acquisition, a physical classification was carried out according to the groups previously mentioned. The bromatological analyses were conducted such as Humidity, Crude Protein, Soluble Protein and Urease for each group.

Statistical analysis

The statistical analyses were processed using the System of Statistical Analyses (SAEG) developed by "Universidade Federal de Viçosa" (1992). Humidity, crude protein, soluble protein and urease values were analyzed in a totally randomized design and the averages were compared through the Tukey test at 5% probability. The statistical model used for the analysis was according to the following mathematical equation:

$$Y_{ij} = \mu + T_i + e_{ij}$$

In which:

Y_{ij} = experimental unit observation

μ = general average

T_i = treatment

e_{ij} = casual error associated with each observation

Results and Discussion

The procedures adopted in this study are aimed at analyzing the quality of full fat soybean produced by a Company (cooperative) located in the West of Paraná through bromatological analyses evaluating antinutritional levels present in full fat soybean produced and used in poultry and pig feeds. Values obtained for full fat soybean are evaluated below in (Table 1).

After analyzing the results obtained, it is possible to verify that the samples participation of spoiled whole grains (02), burnt whole grains (03), normal broken grains (04), burnt broken grains (05) and impurities correspond to 23.53% of the total sample, in which the participation of each individual sample is not significant enough to influence the result of the total sample with the exception of normal broken grains, which constitute 13.57% of the sample and can have a stronger effect on the result of the bromatological analysis on full fat soybean in relation to the other variable studied (BORGES; SALVADOR; IVANOVSKI; 2003).

Table 1. Percentage of particles of deactivated soybean in the rector after grain processing (toasting).

Particles	Total Sample	01	02	03	04	05	06
Average	100 (g)	76.47	2.31	1.85	13.57	2.93	2.87

01 – Normal Whole Grains; 02 – Spoiled Whole Grains; 03 – Burnt Whole Grains; 04 – Normal Broken Grains; 05 – Brunt Broken Grains; 06 – Strange Material (Impurity).

Results of the bromatological analysis carried out in different samples of full fat soybean are presented in (Table 2) and they are in agreement with "Sindirações" standard (2002), Café et al. (2000) and Rostagno et al. (2005) for commercialization and use in poultry and pig feeds.

Humidity, crude protein, soluble protein and urease values found for the total sample were similar ($P<0.05$) to those obtained in the sample of normal whole grains (01). However, it can be infered that the highest participation of normal whole grains 76.47% in the total sample was responsible for the similarity among the results evaluated. On the other hand, bromatological results found for normal whole grain were mostly different ($P<0.05$) from those found for samples 02, 03, 04 and 05 (FEDALTO, 1993).

Table 2. Bromatological analysis of different particles of deactivated full fat soybean after processing.

Parameters	Total Sample	01	02	03	04	05	VC (%)*
Humidity	10.50 a	10.59 a	11.03 a	10.65 a	11.67 a	9.18 b	4.70
Crude Protein	37.07 b	37.05 b	36.96 b	37.43 b	36.04	39.27 a	0.73
Soluble Protein	82.41 ab	85.23 a	73.18 c	71.28 c	79.61 b	58.96 d	2.58
Urease	00.03 a	00.03 a	00.01 b	0.02 ab	0.02 ab	00.01 b	42.65

01 – Normal Whole Grains; 02 – Spoiled Whole Grains; 03 – Burnt Whole Grains; 04 – Normal Broken Grains; 05 – Burnt Broken Grains.
Average followed by different letters in the same line differ through the Tukey test ($P<0.05$).
* VC – Variance Coefficient.

Humidity and soluble protein values of burnt broken grains were low ($P<0.05$) in relation to those obtained for other variables studied. In contrast, sample 5 urease presented lower value than normal whole grains, but did not differ from other samples analyzed. These results are in agreement with the ones usually obtained in quality control of raw materials in animal feed factories where low soluble protein value is followed by lower values of urease (CAFÉ et al., 2000).

It is possible to infer that the biggest ratio of superficial area to burnt broken grains mass (found in smaller pieces in relation to normal whole grains) contributed to a decisive action of the reactor's temperature on these soybean particles. The highest temperature reached in these particles might be responsible for reducing the enzyme urease value (thermolabel) and hence causing Maillard undesirable reactions, those of which provide darker coloring for such particles reducing protein solubility, and consequently the availability of some amino acids, mainly lysine (BIELORAI; HARDUF; ALUMONT, 1997). However, considering that the percentage of burnt broken grains is 2.93% of the

total sample, little importance should be attached to this full fat soybean sample.

The difference (P<0.05) in values of soluble protein and urease found between spoiled whole grains and normal whole grains, similar to what happened to burnt broken grains, might have occurred due to the smaller size of soybean particles of this sample as they are formed by deformed grains, which have higher ratio of superficial area to mass for contact with vapor and high temperatures reached in the digestor. This way, soybean grain temperature increases, reducing its soluble protein and urease values in relation to normal whole grain (PARSONS et al., 1992).

Soluble protein and urease of normal broken grains are in agreement with the standard for use in animal feeds for poultry and pigs (ZHANG et al., 1993). The percentage of this sample part together with normal whole grains correspond to 90% of the total sample, in which the values obtained from the other samples are of little importance for the final result of deactivated full fat soybean bromatological analyses. Although normal broken grains soluble protein value is 7% lower (P<0.05) in relation to normal whole grains, the 79.61% value obtained is adequate for inclusion in animal feeds without causing significant loss in protein and amino acid solubility ingested by animals. The reduction in values obtained for urease presented the same behavior as the one observed for soluble protein, in which absolute values were reduced in 41%. However, such value was not statistically significant (P>0.05) through the Tukey test. This fact can be explained by higher variation coefficient obtained for urease in relation to soluble protein.

Lower values of soluble protein and urease found in the analysis of normal broken grains indicate the possibility of increasing productivity of processing when reducing the ratio of surface to mass through grinding soybean grain. Cooking grains increases the surface of contact so that vapor and temperature act in a more uniform way on the processed material, in which constant values of soluble and urease can be obtained in the total sample maintaining quality standards according to data published by (ZHANG et al., 1993).

Conclusion

It is possible to conclude that samples of normal whole grains and normal broken grains constitute the biggest part (90%) of the total sample of full fat soybean which have adequate soluble and urease values for the use in poultry and pig feeds. The remaining samples are less important on soybean quality due to low participation in the total sample. Also, according to the results obtained, it can be infered that grinding soybean grain before deactivation can improve processing and obtain more uniform soluble protein and urease values and higher yield to digestors (capacity/hour).

References

BIELORAI, R.; HARDUF, Z.; ALUMONT, E. The free amino acid pattern of the intestinal contents of chicks fed raw and heated soybean meal. *Journal Nutrition*, v. 102, p. 1377-1382, 1997.

BORGES, S. A.; SALVADOR, D.; IVANOVSKI, R. A. Utilização da soja desativada na dieta de monogástricos. In: SIMPÓSIO SOBRE NUTRIÇÃO DE AVES E SUÍNOS, 2003, Cascavel, PR. *Anais*... Cascavel, PR. CBNA, 2003. p. 21-66.

CAFÉ, M. B.; SAKOMURA, N. K.; JUNQUEIRA, O. M.; CARVALHO, M. R. B.; DEL BIANCHI, M. Determinação do valor nutricional das sojas integrais processadas para aves. *Revista Brasileira de Ciências Avícola*, Campinas, v. 2, n. 1, p. 67-74, 2000.

FEDALTO, L. M. *Efeitos da utilização da soja integral Glycine max (L.) Merril, sobre o desempenho e características de carcaça de suínos*. 1993. Tese (Doutorado em Zootecia) - Universidade Estadual de São Paulo, Jaboticabal.

GARCIA, E. R. M.; MURAKAMI, A. E.; BRANCO, A. F. Efeito da suplementação enzimática em rações com farelo de soja e soja integral extrusada sobre a digestibilidade de nutrientes, o fluxo de nutrientes na digesta ileal e o desempenho de frangos. *Revista Brasileira de Zootecnia,* Viçosa, v. 29, n. 5, p. 1414-1426, 2000.

GERBER, P. L. F.; PENZ JUNIOR, A. M.; RIBEIRO, A. M. L. Efeito da composição do farelo de soja sobre o desempenho e o metabolismo de frangos de corte. *Revista Brasileira de Zootecnia,* Viçosa, v. 35, n. 4, p. 1359-1365, 2006.

GOLDFLUS, F. Ingredientes derivados do processamento de soja aplicados na nutrição animal. In: SIMPÓSITO SOBRE MANEJO E NUTRIÇÃO DE AVES E SUÍNOS E TECNOLOGIA DE PRODUÇÃO DE RAÇÕES, 2001, Campinas. *Anais*.... Campinas: CBNA, 2001. p. 97-88.

HERKELMAN, K. L.; CROMWELL, G. L. Utilization of full-fat soybeans by swine reviwed. Feedstuffs. Feedstuffs, p. 15-22, dez. 1990. In: BORGES, S. A.; SALVADOR, D.; IVANOVSKI, R. A. Utilização da soja desativada na dieta de monogástricos. In: SIMPÓSIO SOBRE NUTRIÇÃO DE AVES E SUÍNOS, 2003, Cascavel. *Anais*... Cascavel: CBNA, 2003. p. 21-66.

LUDKE, M. C. M. M.; LIMA, G. J. M. M.; LANZNASTER, M.; ARDIGÓ, R. Soja integral processada de diferentes formas para uso em dietas para suínos em crescimento e terminação. *Revista Brasileira de Zootecnia*, Viçosa, v. 36, n. 5, p. 1566-1572, 2007. Suplemento.

OPALINSKI, M.; MAIORKA, A.; CUNHA, F.; SILVA, E. C. M.; BORGES, S. A. Adição de níveis crescentes de complexo enzimático em rações com soja integral desativada para frangos de corte. *Archives of Veterinary Science*, Curitiba, v. 11, n. 3, p. 31-35, 2006.

PARSONS, C. M.; HASHIMOTO, K.; WEDEKIND, K. J.; HAN, Y.; BAKER, D. H. Effect of overprocessing on availability in soybean meal. *Poultry Science*, Honduras, v. 71, n. 1, p. 133-140, 1992.

ROSTAGNO, H. S.; NUNES R, V.; BUTERI, C. B.; NUNES, C. G. V.; ALBINO, L. F. T. Fatores antinutricionais dos ingredientes destinados à alimentacão animal. In: SIMPÓSIO SOBRE INGREDIENTES NA ALIMENTAÇÃO ANIMAL, Campinas, SP. *Anais*... Campinas, SP: CBNA, 2001. p. 235-245.

ROSTAGNO, H. S.; ALBINO, L. F. T.; DONZELE, J. L.; GOMES, P. C.; SOARES, F. A.; OLIVEIRA, R. F. de; LOPES, D. C. *Tabelas brasileiras para aves e suínos:* composição de alimentos e exigências nutricionais. 2. ed. Viçosa, MG: UFV, Imprensa Universitária, 2005. 186 p.

SINDIRAÇÕES/ANFAL/ASBRAM. *Manual de boas práticas de fabricação para estabelecimentos de produtos para alimentação animal.* São Paulo: Comunicação em Agronegócios e Meio Ambiente. 2002. p. 19-48.

UNIVERSIDADE FEDERAL DE VIÇOSA - UFV. SAEG. Central de processamento de dados UFV/CPD. *SAEG - Sistema de análise estatística e genética*. Viçosa, MG: Universidade Federal de Viçosa, 1992. 59 p.

ZHANG, Y.; PARSONS, C. M.; WEINGARTNER, K. E.; WIJERATNE, W. B. Effects of extrusion and expelling on the nutritional quality of conventional and Kunitz trypsin inhibitor-free soybeans. *Poultry Science*, Honduras, v. 72, n. 12, p. 2299-2308, 1993.