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ENERGY, PROTEIN AND FIBRE DIGESTIBILITY OF SOYA BEAN HULLS FOR RABBITS

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ABSTRACT : Twenty New Zealand White x Californian growing rabbits between 46 and 51 d of age were used to determine energy, protein and fibre digestibilities of soya bean hulls. The nutritive value was determined by the substitution method using a basal diet formulated for a high energy and protein content (11.4 MJ DE kg^{-1} and 19.7% CP, respectively) to balance the low nutritive value of the soya bean hulls. This feedstuff was substituted at a 24% in the basal diet. Energy, protein and NDF digestibilities (%) of soya bean hulls calculated by difference were 34.5(±3.28), 30.0(±4.28) and 30.6(±4.70), respectively, and digestible energy value was 6.17(±0.60) MJ kg^{-1} DM. Standard errors of these estimations were similar respect to that obtained with other fibre by-products studied previously. The nutritive value of soya bean hulls was relatively low compared with other results from literature.

RESUME : Digestibilité de l'énergie, des protéines et des fibres des cosses de soja chez le lapin.
Vingt lapins en croissance Néo-zélandais Blanc x Californien âgés de 46 à 51 jours ont été utilisés pour déterminer la digestibilité de l'énergie, des protéines et des fibres des cosses de soja. La valeur nutritionnelle a été déterminé par la méthode de substitution en utilisant un aliment témoin formulé pour contenir un taux élevé de protéines et d'énergie (11,4 Mj DE kg^{-1} et 19,7 % de protéines brutes, respectivement) pour compenser la faible valeur nutritionnelle des cosses de soja. Dans l'aliment expérimental, les cosses de soja ont remplacé 24 % de l'aliment témoin. La digestibilité de l'énergie, des protéines et des NDF (%) des cosses de soja, calculée par différence, est de : 34,5 (±3,28), 30,0 (±4,28) et 30,6 (±4,70) respectivement et la valeur de l'énergie digestible est de 6,17 (±0,60) MJ kg^{-1} MS. L'erreur standard de ces estimations sont semblables à celles obtenues pour d'autres sous produits préalablement étudiés. Cette valeur nutritive des cosses de soja est relativement faible par rapport à celle que l'on peut trouver dans la littérature.

INTRODUCTION

Soya bean hulls is a concentrate of fibre, which represents about two thirds of its dry matter content. Cell wall is low lignified and then potentially highly degradable through microbial fermentation. However, rate of degradation of soya bean hulls is slow due to the presence of a palisade shaped parenchyma (GRENET and BARRY, 1987) which makes microbial adherence difficult. *In situ* fermentation studies (DE SMET *et al*, 1995; ESCALONA *et al*, 1995) have shown that DM and NDF degradations, respectively, reach levels of only 38% after 12 h of fermentation, although digestion is almost complete after 72 h.

As a consequence, nutritive value of soya bean hulls is highly dependent on time of fermentation and then quite variable among animal species. In this way, digestible energy contents assigned to this ingredient for ruminants, pigs and poultry are, respectively, 14.9, 8.9 and 4.25 MJ kg^{-1} DM (FEDNA, 1997).

The aim of this work was to determine the nutritive value (fibre, protein and energy digestibility) of soya bean hulls for growing rabbits using the substitution method.

MATERIAL AND METHODS

Diets

A basal diet composed by 39.9% of barley, 28.2% of sunflower meal, 15.2% of wheat bran and 14.7% of wheat straw was formulated for a high digestible energy (DE) and protein (DCP) content to compensate the low digestible nutrient content of the studied feedstuff. Another diet, in which 24.4% of soya bean hulls substituted the basal diet, was evaluated. The diets were supplemented with sodium chloride (0.5%), dicalcium phosphate (0.5%), calcium carbonate (0.5%) and a mineral-vitamin premix (0.5%) containing (g kg^{-1}): Mn, 13.4; Zn, 40; I, 0.7; Fe, 24; Cu, 4; Co, 0.35; riboflavin, 2.1; calcium pantothenate, 7.3; nicotinic acid 18.7; vitamin K_3, 0.65; vitamin E, 17; thiamin, 0.67; pyridoxine, 0.46; biotin, 0.04; folic acid, 0.1; vitamin B_{12}, 7 mg kg^{-1}; vitamin A, 6,700.000 IU kg^{-1}; vitamin D_3,

Table 1 : Chemical composition (% DM) of soybean hulls and diets

	Soya bean hulls	Basal diet	24% soya bean hulls diet
Dry Matter	*90.4*	*91.2*	*90.5*
Ash	5.20	10.7	8.95
Ether Extract	2.06	4.2	4.00
Crude Protein	12.9	19.7	17.9
Crude Fibre	39.7	13.2	21.3
NDF	64.8	31.3	42.3
ADF	50.9	20.4	23.7
ADL	3.15	6.90	4.42
CP-NDF	5.47	-	-
CP-ADF	1.28	-	-
Gross Energy, MJ kg^{-1}DM	17.88	17.25	17.63

Table 2: Digestibility coefficients of the experimental diets

Digestibility Coefficient	Basal diet	24% soya bean hulls diet	SEM[1]	Significance
Dry Matter	63.1	55.2	0.52	0.001
Gross Energy	66.2	57.0	0.56	0.001
Crude Protein	78.5	70.3	0.60	0.001
NDF	27.2	26.5	1.39	0.726

[1] n = 10

940,000 IU kg^{-1}. Chemical composition of soya bean hulls and the experimental diets are shown in Table 1.

Digestibility Trial

The digestibility trial was conducted according to the European Reference Method (Perez *et al*, 1995). Twenty New Zealand White x Californian rabbits between 46-51 days old and weighing 1.3-1.6 kg were used. Animals were alloted randomly to the diets (10 rabbits per diet). Following a 10-d period of adaptation to each diet, feed intake was recorded and total faecal output collected during 4 consecutive days. Faeces produced daily were stored at -20°C, then dried at 80°C for 48 h and ground for their analyses. Faeces were analyzed for DM, NDF, CP and energy to determine diet digestibility. The nutritive value of soya bean hulls was calculated by difference between the digestible nutrient contents of experimental diets.

Animals were housed in metabolism wire cages that allowed separation of faeces and urine. The rabbits were kept in a closed building with partial environmental control, under a 12-12h light-dark schedule.

Analytical Procedures

Chemical analyses were conducted according to AOAC (1984) for DM, ash, CP, crude fibre (CF) and ether extract, Van Soest *et al.* (1991) for NDF and Goering and Van Soest (1970) for ADF and ADL. N-NDF and N-ADF were performed following Licitra *et al.* (1996). Gross energy was determined by adiabatic calorimetry.

Statistical Analysis

Statistical analyses were performed using the ANOVA procedures of SAS (1985). The standard error of the nutritive value of soya bean hulls estimated by difference were calculated according to the following formula:

$$SE = 1/0.244 \sqrt{(SHD)/n_{SHD} + (1-0.24)^2 V(BD)/n_{BD}]}$$

where V(SHD) and V(BD) are the variances of the diet with 24% of soya bean hulls and of the basal diet, respectively and n_{SHD} and n_{BD} the number of animals used for each diet.

Energy, protein and NDF digestibility and digestible energy of soya bean hulls (Table 3) has been calculated from the nutritive value of the experimental diets corrected by 0.98.

RESULTS

Dry matter intake during the digestibility period was 122.3 ± 11.7 and 132.1 ± 15.9 g d^{-1} for the basal and 24% soya bean hulls (24 SBH) diets, respectively. Average daily gain was slightly higher (40.6 *vs* 38.9 g d^{-1} s.e.= 2.7) for the basal diet than for the 24 SBH diet, although differences did not reach significant levels (P= 0.669).

Digestibility coefficients of the experimental diets are shown in Table 2. Dry matter, energy and protein digestibilities decreased significantly (by 13.5, 13.9 and 10.5%, respectively; P<0.001) with the substitution of soya bean hulls for basal diet. However, NDF digestibility was not affected (P= 0.726) by soya bean hulls inclusion and was 27.9% as average.

The nutritive value of soya bean hulls was calculated by difference from the digestibility values of the experimental diets (Table 3). Crude protein and NDF digestibilities were around 30%, whereas energy digestibility was 35% and digestible energy 6.18 MJ kg^{-1} DM. The precision of the estimation was higher for energy (coefficient of variation, CV = 10%) than for CP and NDF digestibilities (CV = 15%). These variations are similar to those obtained previously for other fibrous ingredients using the difference method (DE BLAS *et al.*, 1989; VILLAMIDE *et al.*, 1989; FERNANDEZ *et al.*, 1996).

DISCUSSION

The results from this work indicate that, despite its low degree of lignification, NDF digestibility of soya bean hulls in rabbits is not high (around 30%). This value is close to that obtained by GARCIA *et al* (1996) using a semisynthetic diet (28.2%), in which most of its fibre content was supplied by this feedstuff. It also agrees with the low crude fibre digestibility (6%) obtained by MAERTENS and DE GROOTE (1984). These values are higher than those obtained previously for alfalfa hays by GARCIA *et al* (1995) and similar to those obtained also with dehydrated alfalfa by PEREZ (1994), but much

Table 3: Energy, protein and NDF digestibility (%) and digestible energy (MJ kg^{-1}DM) of soya bean hulls determined by difference.

	Mean	SEM[1]
Gross Energy digestibility	34.5	3.28
Crude Protein digestibility	30.0	4.28
NDF digestibility	30.6	4.71
Digestible Energy	6.17	0.60

[1] n= 10

lower than those determined for another low-lignified fibrous sources, as beet pulp (GIDENNE, 1987).

The relatively low fibre digestibility of soya bean hulls might be related to its slow degradation rate through microbial fermentation, combined with its low proportion of fine particles (46.9% of particles shorter than 0.315 mm; GARCIA *et al*, 1996) and then with a shorter caecal fermentation time (14.1 h; GARCIA *et al*, 1997) than beet pulp. By interpolating this fermentation time, a NDF degradation of 42% can be estimated for soya bean hulls from data obtained in an *in situ* fermentation study (ESCALONA *et al*, 1995). It must be taken into account that this type of experiments overestimate NDF digestibility in rabbits, as rumen microorganisms can ferment the whole sample of the ingredient, whereas rabbits are able to ferment only the shorter sized fraction of fibre.

Crude protein digestibility was also relatively low (30%), as occurs in other species, including ruminants. Part of these results might be related to the high proportion of protein linked to fibre (43% of N-NDF on total N). Other factors, as an increase of nitrogen of microbial or endogenous origin in the hard faeces might also be involved. Other authors, as MAERTENS and DE GROOTE (1984) and INRA (1989) also assign to this ingredient values (54 and 42%, respectively) lower than, for instance, those assigned to alfalfa hay.

The energy digestibility obtained in this experiment (34.5%) is slightly higher than that observed for the NDF and nitrogen fraction. Soya bean hulls contains about 8% both of pectins and sugars (FEDNA, 1997), i.e. carbohydrates which are not included in the NDF residue. These components are presumably better digested than NDF and can account for that difference. The digestible energy content determined in this work (6.18 MJ kg^{-1} DM) is lower than that obtained (8.14 MJ kg^{-1} DM) by MAERTENS and DE GROOTE (1984) and those assigned (8.27 MJ kg^{-1} DM) by INRA (1989) and MAERTENS *et al* (1990) (7.16 and 8.62 MJ kg^{-1} DM, respectively). A part of this difference could be due to the lower gross energy value of soybean hulls used in the current study (17.88 MJ kg^{-1} DM).

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REFERENCES

AOAC, 1984. Official Methods of Analysis (14 th Ed). *Association of Official Analytical Chemists (Ed)*, Arlington, VA.

ESCALONA B., ROCHA R., GARCIA J., CARABAÑO R., DE BLAS C., 1995. Efecto del tipo de fibra sobre la extensión y velocidad de digestión de la fibra neutro detergente. *ITEA, 16, 45-47.*

DE BLAS J.C., VILLAMIDE M.J., CARABAÑO R. 1989. Nutritive value of cereal by-products for rabbits 1. Wheat straw. *J. Appl. Rabbit Res., 12, 148-151.*

DE SMET J.L., BOEVER J.L., BRABANDER D.L., VANACKER J.M., BOUCQUE C.V., 1995. Investigation of dry matter degradation and acidotic effect of some feedstuffs by means of in sacco and in vitro incubations. *Anim. Feed Sci. Technol., 51, 297-315.*

FEDNA, 1997. Normas para la formulación de piensos compuestos. *Fundación Española para el Desarrollo de la Nutrición Animal (Ed), Madrid.*

FERNANDEZ-CARMONA J., CERVERA C., BLAS E. 1996. Prediction of the energy value of rabbit feeds varying widely in fibre content. *Anim. Feed Sci. Technol., 64, 61-75.*

GARCIA J., PEREZ-ALBA L., ALVAREZ C., ROCHA R., RAMOS R., DE BLAS C., 1995. Prediction of the nutritive value of lucerne hay in diets for growing rabbits. *Anim. Feed Sci. Technol., 54, 33-44.*

GARCIA J., CARABAÑO R., PEREZ L., DE BLAS C., 1996. Effect of type of fibre on neutral detergent fibre digestion and caecal traits in rabbits. *In: Proc. 6th World Rabbit Congress. INRA, Toulouse, vol. 1, 175-180.*

GARCIA J., MATEOS J., PIQUER J., CARABAÑO R., DE BLAS C., 1997. Efecto de la fuente de fibra sobre el tiempo medio de retención total y el tiempo de fermentación en conejos. *ITEA, 18, 187-189..*

GIDENNE T., 1987. Effet de l'addition d'un concentré riche en fibres dans une ration à base de foin, distribuée a deux niveaux alimentaires chez la lapine adulte. 2. Mesures de digestibilité. *Reprod. Nutr. Dévelop., 27, 801-810.*

GOERING H.K., VAN SOEST P.J., 1970. Forage Fiber Analysis *USDA. Agricultural Handbook 379, USDA, Washington, DC.*

GRENET E., BARRY P., 1987. Etude microscopique de la digestion des parois végétales des téguments de soja et de colza dans le rumen *Reprod. Nutr. Dévelop., 27, 246-248.*

INRA, 1989. L'alimentation des animaux monogastriques: porc, lapin, volailles. (2e éd.). *Institut National de la Recherche Agronomique. Paris.*

LICITRA G., HERNANDEZ T.M., VAN SOEST P.J., 1996. Standarization of procedures for nitrogen fractionation of ruminant feeds. *Anim. Feed Sci. Technol., 57, 347-358.*

MAERTENS L., DE GROOTE G., 1984. Digestibility and digestible energy content of a number of feedstuffs for rabbits. *In : Proc. II World Rabbit Congress, Rome, Vol.I, 244-251.*

MAERTENS L., JANSSEN W.M.N., STEENLAND E., WOLTERS D.F., BRANJE H.E.B., JAGER F., 1990. Tables de composition, de digestibilité et de valeur energetique des matières premières pour lapins. *5émes Journées de la Recherche Cunicole. Communication no 57, ITAVI. Paris.*

PEREZ J.M., 1994. Digestibilité et valeur energetique des luzernes deshydratées pour le lapin: influence de leur composition chimique et de leur technologie de preparation. *VIèmes Journées de la Recherche Cunicole. La Rochelle, 355-364.*

PEREZ J.M., LEBAS F., GIDENNE T., MAERTENS L., XICCATO G., PARIGI-BINI R., DALLE-ZOTE A., COSSU M.E., CARAZZOLO A., VILLAMIDE M.J., CARABAÑO R., FRAGA M.J., RAMOS M.A., CERVERA C., BLAS E., FERNANDEZ J., FALCAO E CUNHA L., BENGALA FREIRE J., 1995. European reference method for in vivo determination of diet digestibility in rabbits. *World Rabbit Science, 3, 41-43.*

STATISTICAL ANALYSIS SYSTEMS INSTITUTE, 1985. SAS User's guide: Statistics. *SAS Institute, Cary, NC.*

VAN SOEST P.J., ROBERTSON J.B., LEWIS B.A., 1991. Symposium: carbohydrate methodology, metabolism, and nutritional implications in dairy cattle. Methods for dietary fiber, neutral detergent fiber and non starch polysaccharides in relation to animal nutrition. *J. Dairy Sci., 74, 3583-3597.*

VILLAMIDE M.J., DE BLAS J.C., CARABAÑO, R. 1989. Nutritive value of cereal by-products for rabbits 2. Wheat bran, corn gluten feed and dried distillers granis and solubles. *J. Appl. Rabbit Res., 12, 152-155.*