ENERGY, PROTEIN AND FIBRE DIGESTIBILITY OF PAPRIKA MEAL 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 paprika meal. The nutritive value was determined by the substitution method using a basal diet formulated for a high energy content (11.4 MJ DE kg^{-1}) to balance the low nutritive value of the paprika meal. This feedstuff was substituted at a 24.4% in the basal diet. Energy, protein and NDF digestibilities (%) of paprika meal calculated by difference were 38.2(±2.55), 63.1(±4.42) and 30.7(±6.06), respectively, and its digestible energy value was 7.34(±0.49) MJ kg^{-1} DM. Standard errors of these estimations were similar respect to those obtained with other fibrous by-products studied previously

RESUME : Digestibilité de l'énergie, des protéines et des fibres de la farine de paprika chez le lapin.
Afin de déterminer la digestibilité de l'énergie, des protéines et des fibres de la farine de paprika, on a utilisé 20 lapins croisés NZW x CAL en croissance, âgés de 46 à 51 jours. La valeur nutritive a été déterminée par la méthode de substitution en utilisant un aliment de base riche en énergie (11,4 MJ ED kg^{-1}) pour compenser la faible valeur nutritive de la farine de paprika. 24,4% du régime de base ont été remplacés par le paprika. La digestibilité de l'énergie, des protéines et des fibres de la farine de paprika, calculées par différence, ont été de 38,2 ± 2,55 ; 63,1 ± 4,42 et 30,7 ± 6,06 respectivement, pour un taux d'énergie digestible de 7,34 ± 0,49 MJ kg^{-1} MS. Les valeurs de l'erreur standard liées à ces estimations sont analogues à celles trouvées antérieurement pour d'autre sous-produits fibreux.

INTRODUCTION

Paprika meal is the residue of the chemical extraction with solvents of colourings (oleoresin) from red paprika. It is not regularly used in animal nutrition due to its small and localised production and its variable availability in the market. There is few information of the chemical composition of this feedstuff. According to GARCÍA *et al.* (1996a) and GARCÍA (1997), paprika meal is characterised by a relatively high content of crude protein (19%) which is mainly soluble (60%), with only a 13% linked to the NDF residue. It also contains a significant amount of soluble sugars (19%). Its fibrous fraction accounts for one third of its dry matter content. Their proportions of lignin and cutin (20 and 30%, respectively) are relatively high. Uronic acid content is not high (5%), although only one tenth is retained in the NDF fraction.

From this chemical composition a low extent of microbial degradation of its NDF fraction would be expected. However, GARCÍA *et al.* (1996a) determined a NDF digestibility of 35.1%, associated to a fermentation time of 43.2 h (GARCÍA *et al.*, 1997a). Furthermore, an *in situ* fermentation study (ESCALONA *et al.*, 1995) showed an NDF disappearance of 35.0 and 37.2% after 16 and 72 h of incubation, respectively.

Paprika meal is characterised by a very small particle size (93% of particles shorter than 0,315 mm; GARCÍA *et al.*, 1996a), because it is finely ground and pelleted before extraction. This small particle size explains the long fermentation time of this feedstuff.

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

MATERIAL AND METHODS

Digestibility Trial

A basal diet 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, obtained after substitution of 24.4% of the basal diet with paprika meal, was evaluated. Ingredients and chemical composition of both diets and paprika meal are shown in Table 1.

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 allotted 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 analysed for DM, NDF, CP and energy to determine diet digestibility. The nutritive value of paprika meal 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 (temperatures ranged between 14 and 22°C), under a 12–12h light-dark schedule.

Statistical Analysis

Statistical analyses were performed using the ANOVA procedures of SAS (1985). The standard error of the nutritive

Table 1 : Ingredients (%) and chemical composition (% DM) of experimental diets and paprika meal.

	Basal diet	24% Paprika	Paprika meal
Paprika meal	---	24.0	---
Barley	39.9	30.1	---
Sunflower meal	28.2	21.3	---
Wheat bran	15.2	11.5	---
Wheat straw	14.7	11.1	---
Sodium chloride	0.5	0.5	---
Dicalcium phosphate	0.5	0.5	---
Calcium carbonate	0.5	0.5	---
Mineral–vitamin premix[1]	0.5	0.5	---
Chemical composition			
Dry Matter	91.2	90.7	90.0
Ash	10.7	11.0	11.8
Ether Extract	4.2	3.2	1.1
Crude Protein	19.7	19.6	19.0
Crude Fibre	13.2	17.1	25.0
NDF	31.3	33.5	35.5
ADF	20.4	23.7	30.0
ADL	6.9	7.9	15.5
CP–NDF	-	-	3.1
CP–ADF	-	-	1.5
Gross Energy, MJ kg^{-1}DM	17.2	18.1	19.2

[1] 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, 940,000 IU kg^{-1}

value of paprika meal estimated by difference were calculated according to the following formula:

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

where V(PMD) and V(BD) are the variances of the diet with 24.4% of paprika meal and of the basal diet, respectively and n_{PMD} and n_{BD} the number of animals used for each diet.

Energy, protein and NDF digestibilities and digestible energy of paprika meal (Table 3) have 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 136.2 ± 18.9 g d^{-1} for the basal and 24.4% paprika meal (24 PM) diets, respectively. Average daily gain was slightly higher (40.6 *vs* 36.8 g d^{-1}; SE = 1.2) for the basal diet than for the paprika meal diet, although the difference did not reach a significant level (P= 0.268).

Digestibility coefficients of the experimental diets are shown in Table 2. Dry matter, energy and protein digestibilities decreased significantly (by 8.2, 13.1 and 11.6%, respectively; P<0.001) with the substitution of paprika meal for the basal diet. However, NDF digestibility was not affected (P= 0.518) by paprika meal inclusion and was 27.1% as average.

The nutritive value of paprika meal was calculated by difference from the nutrient digestible content of the experimental diets (Table 3). Average crude protein and NDF digestibilities were 63.1 and 30.7%, respectively, whereas energy digestibility was 38.2% and digestible energy 7.34 MJ kg^{-1} DM. The precision of the estimation was higher for energy and CP (coefficient of variation, CV = 7%) than for NDF digestibility (CV = 20%). These variations are similar to those obtained previously for other fibrous ingredients using the difference method (DE BLAS *et al.*, 1989; FERNÁNDEZ-CARMONA *et al.*, 1996; GARCÍA *et al.*, 1996b; GARCÍA *et al.*, 1997b).

DISCUSSION

The results from this work indicate that NDF digestibility of paprika meal (30.7%) is relatively high considering its high degree of lignification. This value is close to that obtained by GARCÍA *et al.* (1996a) using a semisynthetic diet (35.1%), in which most of its fibre content was supplied by this feedstuff. FERNÁNDEZ-CARMONA *et al.* (1996) observed a very low crude fibre digestibility (2.8%) of paprika residue that could be related with a higher lignin concentration in its crude fibre residue.

The relatively high fibre digestibility of paprika meal seems to be more related to its fast degradation rate through microbial fermentation than with its low particle size and long fermentation time. In this way, ESCALONA *et al.* (1995) in an *in situ* fermentation study, observed that 95% of the total degraded fibre was reached after 16 h of incubation, so that the long fermentation time of this feedstuff in the caecum of rabbit (43.2 h; GARCÍA *et al.*, 1997a) does not improve its fibre digestibility. Although ADL fraction accounts for 50% of NDF it is mainly compound by cutin. Cutin acts as a barrier to micro-organisms but its negative effect on digestibility of other cell wall polysaccharides is lower than that of lignin (VAN SOEST, 1982). In the case of paprika meal the whole cutin content is concentrated in the seed and therefore could not affect the digestibility of others parts of the fruit.

Fibre digestibility observed in this study is similar to those obtained with dehydrated alfalfa by PEREZ (1994), higher than those obtained for alfalfa hays by GARCÍA *et al.* (1995) and slightly higher than those determined for another high-lignified fibrous sources as sunflower hulls or olive leaves (GARCÍA *et al.*, 1996a; GARCÍA *et al.*, 1996b).

Table 2: Digestibility coefficients of the experimental diets (%)

Digestibility Coefficient	Basal diet	24% Paprika meal diet	SEM[1]	P
Dry Matter	63.1	57.9	0.47	0.001
Gross Energy	66.2	57.5	0.50	0.001
Crude Protein	78.5	69.4	0.70	0.001
NDF	27.2	26.9	1.21	0.518

[1] n = 10

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

	Mean	SEM[1]
Gross Energy digestibility	38.2	2.55
Crude Protein digestibility	63.1	4.42
NDF digestibility	30.7	6.06
Digestible Energy	7.34	0.49

[1] n= 10

Crude protein digestibility was relatively high (63.1%). This result agrees with its high concentration of soluble protein (60%) and its low proportion of protein linked to NDF (16%) (GARCÍA, 1997). This protein digestibility value is lower than those obtained previously for paprika residue by FERNÁNDEZ–CARMONA *et al.* (1996) and for alfalfa hays by GARCÍA *et al.* (1995), but again similar to those obtained also with dehydrated alfalfa by PEREZ (1994).

Energy digestibility and digestible energy content of paprika meal were 38.2% and 7.34 kJ g^{-1}DM. The latter value is lower than that obtained by FERNÁNDEZ–CARMONA *et al.* (1996) (9.5 kJ g^{-1}DM), although in this case the ether extract content was higher (5.2 vs 1.1% DM) and could explain 60% of the difference. The other 40% could be due to the different methodology used or to differences in paprika processing in the industry. The DE content obtained in this study is similar to that obtained for alfalfa hays of medium quality (GARCÍA *et al.*, 1995) and lower than that determined by PEREZ (1994) for dehydrated alfalfa.

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