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# Apparent digestibility of mixed feed with increasing levels of chia (*Salvia hispanica* L.) seeds in rabbit diets

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**ABSTRACT** - Thirty crossbred rabbits were randomly allocated to three groups with ten animals each (five male and five female rabbits each), and kept individually in separate cages. Three isocaloric and isonitrogenous diets were formulated with increasing levels of chia (*Salvia hispanica* L.) seeds (SHS) (0, 10, and 15%). The digestibility coefficients of the dry matter (DM), organic matter (OM), crude protein (CP), crude fibre (CF), neutral detergent fibre (NDF), acid detergent fibre (ADF) and gross energy (GE) were calculated according to standard procedures following the indirect digestibility method, using acid insoluble ash as an internal marker. The results showed that the DM, OM and GE digestibilities of 10% and 15% SHS diets were higher than those of the control diet, while the ADF digestibility of the 15% SHS diet was lower than that of the 10% SHS diet.

**Key words:** Rabbit, *Salvia hispanica* L., Apparent digestibility, Acid insoluble ash.

**INTRODUCTION** - Rabbits have proved to be able to utilise various oleaginous-seeds, such as cotton, linseed, soybean and safflower (Johnston and Berrio, 1985), false flax (Peiretti *et al.*, 2007a) and sunflower (Balogun and Etukude, 1991) seeds. The revival of interest in chia (*Salvia hispanica* L.) seed (SHS) is due to its oil content, which ranges from 25 to 39% (Ayerza, 1995) and to its richness in essential fatty acids (FA; Ting, 1990). Recent research has shown that it is possible to use chia seed and its by-products for animal nutrition (Ayerza *et al.*, 2002; Ayerza and Coates, 2002). The aim of this work was to study the effect of SHS inclusion in rabbit diets on apparent digestibility according to standard procedures following the indirect digestibility method, using acid insoluble ash as an internal marker.

**MATERIAL AND METHODS** - The study was carried out at the experimental rabbitry of the University of Turin according to the guidelines for applied nutrition experiments in rabbits (Fernández-Carmona *et al.*, 2005). Thirty weaned crossbred rabbits aged 60 days and weighing on average 1433±156g were randomly assigned to three groups of 10 (five male and five female rabbits each) with equal initial weight variability. The animals were housed individually under standard conditions at a temperature of 22±2°C in wire cages at a height of 90cm from the concrete floor. The animals were assigned three isocaloric and isonitrogenous dietary treatments containing 0, 10 and 15% SHS. All the diets were pelleted. Feed and water was available *ad libitum* to the animals. The ingredients and chemical composition of the diets are presented in Tables 1 and 2, respectively. The SHS raw material showed high percentages of linoleic acid (C18:2n-6; 18.8% of total FA) and linolenic acid (C18:3n-3; 64.1% of total FA). After 14 days of adaptation, the faeces were collected over a period of 4 days and the collection was performed at approximately 09:00h each morning before the next daily ration was provided. The faeces were collected using a nylon net placed under the cages of each trial, to avoid urine contamination. Each pooled fecal sample was taken and placed in a two-layer plastic bag to prevent the loss of moisture. The frozen samples were individually mixed thoroughly and pooled, ground in a homogenizer (Tecator, Herndon, VA, USA) and the representative samples were then weighed on an aluminium foil pan, dried in a draft oven at 80°C to constant weight and stored for chemical analysis. The diet and faeces samples were analysed according to the AOAC method (1990) to determine: dry matter (DM), total N content, ash by ignition to 550°C, ether extract (EE) using the Soxhlet method, crude fibre according to the Weende method, neutral detergent fibre (NDF), acid detergent fibre (ADF) and lignin (ADL) as described by Van Soest *et al.* (1991), and gross energy (GE) by means of an adiabatic calorimeter bomb (IKA

C7000, Staufen, Germany). The digestibility coefficients were calculated through standard procedures following the indirect digestibility method (Crampton and Harris, 1969), using an inert marker such as acid insoluble ash (AIA) determined according to Van Keulen and Young (1977). The analysis of variance was used to evaluate the effects of different concentrations of SHS on the digestibility of rabbits and the difference was tested using the Duncan test (SPSS Inc., 2002).

Table 1. Ingredients of the diets (%).

Ingredient	SHS0	SHS10	SHS15
Corn	15	18	21
Barley	19	24	20
Dehydrated alfalfa meal	46	33	30
Soybean seed meal	12	11	10
Palm oil	4	0	0
Chia seed	0	10	15
Vitamin-mineral premix <sup>1</sup>	2	2	2
Lignosulphite	2	2	2

<sup>1</sup> per kg diet: Vit. A 200 UI;  $\alpha$ -tocopheryl acetate 1 mg; Niacine 72mg; Vit. B<sub>6</sub> 16mg; Choline 0.48mg; DL-methionine 600mg; Ca 500 mg; P 920mg; K 500mg; Na 1g; Mg 60mg; Mn 1.7mg; Cu 0.6mg.

**RESULTS AND CONCLUSIONS** - The SHS raw material has a CP level markedly greater than other nutritional grains. The two diets with SHS were lower in CF and fibrous fractions content than control diet (Table 2). Similar trends were observed in a digestibility trial with rabbits fed increasing levels of false flax seeds (Peiretti *et al.*, 2007<sup>b</sup>). The results reported in the present investigation (Table 3) showed that the DM, OM, and GE digestibilities of both diets with SHS were higher than those of the control diet, while the ADF digestibility of the SHS10 diet was higher than that of the SHS15 diet.

The GE digestibilities determined in vivo using the AIA method for the experimental diets were similar to those calculated with the following equation:  $dGE = 86.3 - 1.23 ADF$ , proposed by De Blas *et al.* (1992).

In conclusion it could be possible to formulate rabbit diets containing from 100 to 150 g of SHS/kg of the diet with a better digestibility of DM, OM, GE than the control diet.

Table 2. Chemical composition (% on DM basis) of the diets and the chia seed (SHS).

	SHS0	SHS10	SHS15	SHS
Dry matter (% as fed)	92.3	91.1	91.3	94.9
Organic matter	93.4	94.4	94.7	95.2
Crude protein	15.9	15.6	15.7	23.5
Crude fibre	13.6	11.5	11.9	32.9
Ether extract	4.9	6.1	5.0	31.1
Ash	6.6	5.6	5.3	4.8
Nitrogen free extract	59.0	61.2	62.1	7.8
Neutral detergent fibre	27.2	24.0	22.7	n.a. <sup>1</sup>
Acid detergent fibre	16.1	14.2	14.1	34.5
Acid detergent lignin	5.5	4.6	5.2	12.6
Acid insoluble ash	0.95	0.92	0.80	n.a.1
Gross energy (MJ/kg DM)	15.9	15.6	15.9	26.1

<sup>1</sup> Not available

Table 3. Apparent digestibility (%) of the three experimental diets (mean  $\pm$  SE), obtained using AIA (acid insoluble ash) as the internal marker.

	SHS0	SHS10	SHS15
Dy matter	68.7 $\pm$ 0.76a	72.4 $\pm$ 0.33b	72.2 $\pm$ 0.19b
Organic matter	69.1 $\pm$ 0.73a	73.4 $\pm$ 0.62b	73.0 $\pm$ 0.18b
Crude protein	71.2 $\pm$ 1.35	72.7 $\pm$ 0.49	73.6 $\pm$ 0.45
Crude fibre	22.4 $\pm$ 1.25	22.6 $\pm$ 0.33	24.0 $\pm$ 0.90
Neutral detergent fibre	32.2 $\pm$ 1.74	30.4 $\pm$ 1.28	28.8 $\pm$ 0.55
Acid detergent fibre	23.3 $\pm$ 1.58ab	24.5 $\pm$ 0.81b	19.0 $\pm$ 1.60a
Gross energy	65.5 $\pm$ 1.12a	69.4 $\pm$ 0.38b	69.7 $\pm$ 0.34b

Differences among groups within the same row;  $P > 0.05$ .

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