NUTRITIVE VALUE OF DEHYDRATED CHICORY PULP FOR FATTENING RABBITS

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ABSTRACT

The aim of the study was to determine the nutritive value of chicory pulp for fattening rabbits. Sixteen individually caged 8-week-old rabbits were used to determine the digestibility and preliminary effects on feed intake and weight gain. Dehydrated chicory pulp was incorporated at 30% inclusion level in a basal diet at the expense of all basal ingredients. Basal and experimental diet were fed *ad libitum* to 8 rabbits during the four days balance trial. A moderate protein digestibility 59.2% was determined corresponding to a digestible protein concentration of 5.3% DM. A quite high energy digestibility of 73% and a DE content of 12.1 MJ/kg DM was found while all fibre fractions had a remarkable high digestibility: CF, NDF and ADF: 65.5; 56.0 and 83.1%, respectively. It may be concluded that chicory pulp can be effectively considered as an energy-rich feedstuff and a good source of fermentable fiber.

Key words: Fattening rabbit, Chicory pulp, Digestibility, Nutritive value.

INTRODUCTION

The use of by-products and non conventional feedstuffs are of great importance in rabbit nutrition. However, the knowledge of their nutritive value is fundamental for their inclusion in balanced rabbit diets. Especially by-products with a high fibre content are interesting, taking into account the quite high dietary requirements of different fiber fractions (Gidenne *et al.*, 2015).
In rabbit diets, the main used sources of digestible or soluble fibres are beet pulp, apple or citrus pulp. An alternative source could be chicory pulp (*Cichorium intibus* L.) known for its high content of inulin and pectin (minimum 7% and 27%, respectively according to Socode, 2013).
Chicory pulp is the dried and ground product obtained after partial extraction of inulin by diffusion of the chicory root shreds. Maertens *et al*. (2004), Volek and Marounek (2011) and Volek *et al*. (2016) evaluated the effects of chicory roots and inulin in fattening rabbit diets. They concluded that chicory root can serve as a natural source of inulin type-fructans in rabbit feed. Diet supplementation with 10% dried chicory root beneficially affected the caecal fermentative activity in the rabbits and no adverse effects on growth rate, feed intake or slaughter yield were observed.
The objective of this study was to determine the nutritive value of dried chicory pulp, which is very scarcely documented in the literature, in fattening rabbits.

MATERIALS AND METHODS

Experimental design and feeds

A total of 16 rabbits (8/diet) of 8-9 weeks old were used to determine the nutritive value of dried chicory pulp. They were placed in digestibility cages measuring 30 x 45 x 35 cm (width x depth x height). They were individually housed and the cages allowed an accurate collection of the faeces separately from the urine. After one week of adaptation to the experimental diets and to the cages, the digestibility trial was done (duration: 4 days) following the European reference method (Perez *et al*., 1995). The trial was conducted at the ILVO institute (Melle, Belgium). The rabbit house was windowless and a lighting

program of 10 hours light and 14 hours dark was used during the whole trial period. The trial was executed during the period of April-May. The temperature varied between 22°C during the day and 14°C at the night.

A basal diet (Table 1) was formulated to fit with nutritional requirement of growing rabbits (De Blas and Mateos, 2010). The experimental diet was obtained by replacing 30% of the basal diet by the dehydrated chicory pulp. The basal and control diets were pelleted (1 cm length and 3 mm diameter).

Table 1: Basal diet used for the digestibility trial.

Ingredient	%
Alfalfa meal 16	30.1
Wheat	9.50
Wheat middlings	17.5
Beet pulp	11.0
Sunflower meal 28	15.0
Full fat soybeans	2.00
Flax chaff	7.00
Soybean oil	1.00
Vitamin and mineral premix	2.50
Molasses	4.00
NaCl	0.13
L-Lysine HCl	0.125
DL-methionine	0.120
Clinacox	0.02

Animals and measurements

Hycole hybrids, the progeny of the cross between the female and heavy male line, were used. Young rabbits were weaned at 35 days of age. At about 8 weeks of age 16 healthy rabbits were ad random selected for the digestibility trial. They were allotted (8/diet), according to their weight (1959 ± 98 g) to one of the 2 diets. They were housed individually and fed *ad libitum*, with a weekly control of live weight, feed intake and a daily control of mortality and morbidity. No medicinal treatment has been used during the test.

Chemical analyses and digestibility

The following chemical analyses were executed: dry matter (DM) (SCD 71/393/EEC), Ash (5 h at 550°C), Nitrogen (ISO 5983-2), gross energy (Adiabatic calorimeter), crude fiber, NDF, ADF and ADL (AOAC 2000, procedure 973.187, Van Soest et al., 1991) and lipids (ISO 6492). Analyses were performed at ILVO according to EGRAN harmonized procedures (EGRAN, 2001).

Calculation of digestibility was done according to the recommendations of Villamide *et al.* (2001). It is assumed that additivity exists between the basal diet and the test ingredient. A correction for the difference in DM between the basal mash and chicory pulp was executed to determine the exact inclusion level.

Statistical analysis

Digestibility data of diets and performance data were submitted to a one way ANOVA (StatSoft, 2012). Differences between means were tested by the least significant difference test. Data are presented as means and standard deviation.

RESULTS AND DISCUSSION

The weight of the rabbits was on average 1959 ± 98 g at the beginning of the trial adaptation period and 2519 ± 105 g at the end of the balance trial. This means that the average daily weight gain, during the adaptation and balance trial period, amounted to 50.1 g or in the normal range of hybrid rabbits of that age. No cases of mortality or morbidity have been reported during the test.

The chicory pulp batch tested contained on average 7.9% CP and 2.1% fat (Table 2) which is in line with the values of CP mentioned by Socode (2013) and Maertens *et al*. (2014): 8.8% and 8.54%, respectively. The chicory pulp had a high crude fibre content of 19.4% but with a low lignification: 1.4% ADL. NDF, ADF and ADL values were also in line with those reported by Socode (2013).

Except for the protein fraction, all fractions of the chicory pulp diet were higher than the basal data (Table 3). A good energy and fat digestibility were determined for the chicory pulp diet. The CP digestibility (70.0%) was somewhat lower than the values determined for other by-products as brewer's grain and maize silage diets, 75.0 and 75.3%, respectively (Guermah *et al*., 2016).

Table 2: Analysed composition of the test ingredient and diets (% as fed)

	Chicory pulp	Basal diet	Diet 30% chicory pulp
Dry matter	88.4	91.7	91.8
Ash	5.26	8.16	7.22
Crude fat	2.14	4.35	3.84
Crude protein	7.89	16.9	14.6
Crude fibre	19.4	15.6	17.1
Neutral detergent fibre	27.5	29.9	29.7
Acid detergent fibre	24.9	17.4	20.7
Acid detergent lignin	1.38	4.05	3.61
Gross energy, (MJ/kg)	15.4	17.1	16.8

Table 3: Digestibility (%) of the diets

	Basal	30% Chicory pulp	Proba.
Dry matter	59.0 ± 1.3	61.8 ± 1.1	< 0.01
Crude protein	74.5 ± 1.8	70.0 ± 2.3	< 0.01
Crude Fat	77.7 ± 1.6	79.1 ± 1.8	< 0.12
Crude fibre	24.4 ± 2.9	36.4 ± 2.3	< 0.01
Neutral detergent fibre	34.8 ± 2.2	41.0 ± 3.3	< 0.01
Acid detergent fibre	22.6 ± 4.9	40.3 ± 2.8	< 0.01
Gross energy	64.4 ± 1.3	66.8 ± 1.3	< 0.15

The digestibility of chicory pulp is presented in Table 4. Chicory pulp showed a moderate protein digestibility (59.2%) while all fibre fractions had a very high digestibility (e.g. CF: 65.5%). This resulted in a quite high energy digestibility (72.9%) or a DE content of 2902 kcal/kg DM or 2565 kcal/kg product. Volek and Marounek (2011) also mentioned a quite low digestibility of CP in rabbits fed chicory root diets. A moderate CP digestibility (50%) is also mentioned for beet pulp in the EGRAN tables (Maertens *et al.*, 2002).

The energy value determined for chicory pulp (12.1 MJ/kg DM / 2902 kcal/kg) or 2565 kcal/kg product is higher than the beet pulp value, mentioned in the EGRAN tables: 10.4 MJ/kg DM (Maertens *et al.*, 2002) but quite in line with the INRA tables (Sauvant *et al*., 2004) and Gidenne *et al*. (2007). For a quite similar byproduct as citrus pulp a DE content of 11.3 MJ/kg is assumed (Maertens *et al*. (2002).

Table 4: Digestibility (%) of chicory pulp

	Chicory pulp
Dry matter	68.4
Crude protein	59.2
Crude fat	82.6
Crude fibre	65.5
Neutral detergent fibre	56.0
Acid detergent fibre	83.1
Gross energy	72.9
Digestible energy (MJ/kg DM)	12.14
Digestible protein (%/DM)	5.29

The high digestibility of all fibre fractions of chicory pulp can be explained by its soluble fibres (SF) content. The same for other raw materials containing high levels of soluble fibres fractions, such high digestibiltity is also mentioned (Gidenne *et al*., 2010; Trocino *et al*., 2013)).

Growth performance and feed intake were not significantly affected by chicory pulp at 30% incorporation level, thus confirming the results obtained by Volek and Marounek (2011) who used levels of 5 and 10% chicory root in replacement of oats in their diets. The feed conversion ratio was significantly ($P<0.01$) lower, confirming the result of Maertens *et al.* (2014) with the highest level of chicory pulp (20%). The quite high digestible energy content of this by-product favours the feed conversion rate, a tendency also observed by Volek and Marounek (2011).

Table 5: Overall feed intake and weight gain on the 2 diets*

	Basal diet	Diet 30% chicory pulp	Probability
Feed intake (g/d):	176 ±16.6	158 ± 7.9	0.124
Daily weight gain (g/d)	47.9 ± 5.4	52.4 ± 4.5	0.308
Feed conversion ratio	3.70 ± 0.31	3.03 ± 0.24	0.005

*n=8 and a fattening period of 18 days (50 – 68 days of age)

CONCLUSIONS

It may be concluded that dried chicory pulp can be considered as an energy-rich feedstuff (12.14 MJ/kg DM) and a good source of well digestible fibre for growing rabbits. Even at a dietary inclusion level of 30%, no adverse effects on DWG or FCR were observed.

REFERENCES

De Blas C., Mateos, G.G. 2010. Feed formulation. In: *De Blas C., Wiseman J.* (Eds.), *Nutrition of the rabbit, CABI*, 222-232.

EGRAN 2001. Technical note: Attempts to harmonise chemical analyses of feeds and faeces, for rabbit feed evaluation. *World Rabbit Sci., 9: 57-64.*

Gidenne T. 2015. Dietary fibres in the nutrition of the growing rabbit and recommendations to preserve digestive health: a review, *Animal, 9: 227-242.*

Gidenne T., Aymard P., Bannelier C., Coulmier D., Lapanouse A. 2007. Valeur nutritive de la pulpe de betterave déshydratée chez le lapin en croissance. Proc. 12èmes *Journ. Recherche Cunicole*, 27-28 November, 2007, Le Mans, France. 105-108.

Gidenne T., García J., Lebas F., Licois D. 2010. Nutrition and Feeding Strategy: Interactions with Pathology. *In: De Blas, C., Wiseman, J. (Eds.), Nutrition of the rabbit, CABI, 179-199.*

Guermah H., Maertens L., Berchiche M. 2016. Nutritive value of brewers' grain and maize silage for fattening rabbits. *World Rabbit Sci. 2016, 24: 183-189.*

Maertens L., Perez J.M., Villamide M., Cervera C., Gidenne T., Xiccato G. 2002. Nutritive value of raw materials for rabbits*:* EGRAN tables 2002. *World Rabbit Sci., 10: 157-166.*

Maertens L., Aerts J.M., De Boever J. 2004. Degradation of dietary oligofructose and inulin in the gastro-intestinal tract of the rabbit and the effects on caecal pH and volatile fatty acids. *World Rabbit Sci.* 12: 235-246.

Maertens L., Guermah H., Trocino A. 2014. Dehydrated chicory pulp as an alternative soluble fibre source in diets for growing rabbits. *World Rabbit Sci. 22: 97-104*.

Perez J.M., Lebas F., Gidenne T., Maertens L., Xiccato G., Parigi-Bini R., Dalle Zotte A., Cossu M.E., Carazzolo A., Villamide M.J., Carabaño R., Fraga M.J., Ramos M.A., Cervera C., Blas E., Fernàndez-Carmona J., Falcao E Cunha L., Bengala Freire J. 1995. European reference method for in-vivo determination of diet digestibility in rabbits. *World Rabbit Sci., 3: 41-43.*

Sauvant D., Perez J.M., Tran G., 2004. Tables de composition et de valeur nutritive des matières premières destinées aux animaux d'élevage: porc, volailles, bovins, ovins, caprins, lapins, chevaux, poissons. *2ème Edition revue et corrigée. INRA Editions, Paris, 301p.*

Socode. 2013. Ground and dehydrated chicory pulp. Available at: http://www.socode-warcoing.be/en/fibres_pulpe.htm Accessed: April 2013.

StatSoft. 2012. Statistica 11 release. *StatSoft, Inc. Tulsa, OK, USA*

Trocino A., García J., Carabaño R., Xiccato G. 2013. A metaanalysis on the role of soluble fibre in diets for growing rabbits. *World Rabbit Sci*., 21: 1-15.

Van Soest P.J., Robertson J.B., Lewis B.A.1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. *J. Dairy Sci*., 74: 3583-3597.

Villamide M.J., Maertens L., Cervera C., Perez J.M., Xiccato G. 2001. A critical approach of the calculation procedures to be used in digestibility determination of feed ingredientsfor rabbits. *World Rabbit Sci., 9: 19-2*

Volek Z., Marounek M. 2011. Dried chicory root (*cichorium intybus l.*) as a natural fructan source in rabbit diet: effects on growth performance, digestion and caecal and carcass traits. *World Rabbit Sci., 19:143-150.*

Volek Z., Uhlířová L., Marounek M., Tůmová E., Zita L. 2016. The effect of dried chicory root added to the restrictive feed ration of rabbits on health status, performance and caecal and carcass traits. *11thWorld Rabbit Congress-June 15-18,2016-Qingdao-China.*