NUTRITIVE VALUE OF HOLM OAK (*Quercus ilex*) ACORN FOR GROWING RABBITS

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ABSTRACT

The aim of our work was to assess nutritive value of acorn of the holm oak (*Quercus ilex: "*QI*"*). The acorn was incorporated at increasing rates in three diets (0, 10 and 20%) as a substitute for a basal diet. Three groups of 7 rabbits, individually caged, received *ad libitum* one of the three diets. The faecal digestibility of the feed was measured between 46 and 49 days of age. The holm oak acorn (QI) has high starch content: 31% DM but a low protein concentration: 5.6% DM. The digestible energy (DE) concentration of the holm oak acorn estimated by regression was 17.9 ± 1.6 MJ DE/kg DM, corresponding to an energy digestibility of 89.4%. The digestible protein content was 52.4 ± 6.4 g/kg DM corresponding to a crude protein digestibility of 93.9%. The holm oak acorn can be considered as a good source of energy for growing rabbits.

Key words: Digestibility, Growing rabbit, Nutritive value, *Quercus ilex*, Acorn

INTRODUCTION

In Algeria, rabbit feed formulation is currently based essentially on imported raw materials. Since the feed represents up to 70% of rabbit farming costs, the incorporation of these imported raw materials in the formulation of rabbit diets leads to an increase in the price of the feed and consequently the cost price of rabbit meat. Overcoming this constraint, it would be wise to develop the use of locally available raw materials.

Among local ingredients, the acorn of holm oak (*Quercus ilex*: "QI") is available in large quantities, although it is little valued in conventional livestock farming. Nevertheless, several authors have reported its interest in animal feed, both in ruminants (Keddam *et al*., 2010), chicken (Bouderoua *et al*., 2009) and rabbits (Kadi *et al.*, 2016). The acorn can be used as an energy source, since according to Kadi *et al.* (2016), acorns (QI) have a high crude energy content of 17.9MJ/kg.
Introducing acorn (QI) into a feed formulation matrix requires knowledge of its chemical profile and nutritive value. The aim of our study was therefore to assess the nutritional value of the holm oak (*Quercus ilex*) acorn for growing rabbits.

MATERIALS AND METHODS

Animals and experimental design

The trial was carried out at the educational farm of the ITMAS of Boukhalfa (Tizi-Ouzou, Algeria). The full holm oak acorns used (hull and endocarp) came from the market of Tizi-Ouzou and were harvested in 2016. A basal diet containing dehydrated alfalfa, soybean meal, wheat bran and barley as main ingredients was formulated to meet the nutritional needs of the growing rabbit according to the recommendations of De Blas and Mateos (2010). Three experimental diets with an increasing incorporation rate of holm oak acorns were prepared by substituting the basal diet without minerals or premix with 0, 10 or 20% of holm oak acorns (QI-0, QI-10 and QI-20). The minerals and premix were

added to the 3 diets at a fixed rate of 2%. The resulting mixture was then pelleted. Dietary ingredients and chemical composition are shown in Table 1.

Twenty-one local population rabbits of 46 days of age (weaned at 35days old) and homogeneous live weight (1331 ± 261g) were allotted into three groups (7 per diet) according to their live weight. They were placed in individual wire mesh cages (56x38x28cm). The cages were equipped with wire net under the floor to collect the hard faeces individually and totally. Each group received one of the three experimental diets. Throughout the experimental period, the animals had free access to feed and water. After an adaptation period of 7 days, the faeces were collected from 46 to 49 days, according to the European Reference Method described by Perez *et al.* (1995), and stored daily in polyethylene bags at -20ºC until chemical analysis. At the end of the experimental period, faeces excreted by each rabbit during the 4 days of collection are regrouped, dried and stored for later chemical analyses.

Chemical Analyses

The chemical analyses were conducted at INRAE (Occitanie, GenPhySe,) for diets, faeces (7 per group) and on the holm oak acorn according to EGRAN (2001): humidity, crude ash, crude protein (N x 6.25, Dumas method, Leco apparatus), crude energy (adiabatic calorimeter Parr), and Van Soest fibre (NDF, ADF and ADL).

Table 1: Ingredients and chemical composition of experimental diets, and of holm oak acorn (QI)

	QI-0	QI-10	QI-20	QI[1]
Ingredients (% as fed):				
Holm oak acorn	-	10.0	20.0	-
Alfalfa dehydrated	37.2	33.4	29.6	-
Barley	8.8	7.9	7.0	-
Soybean meal	9.8	8.8	7.8	-
Wheat bran	42.1	37.8	33.5	-
Premix[2]	2.0	2.0	2.0	-
Chemical composition, g/kg DM				
Dry matter (DM)	885	891	885	721
Crude ash	94	97	83	24
Crude protein	174	159	147	56
Crude fibre	-	-	-	112
Ether extract	-	-	-	85
Starch	-	-	-	310
Neutral detergent fibre	286	314	307	274
Acid detergent fibre	144	157	152	207
Acid detergent lignin	35	43	40	104
Gross energy (MJ/kg)	16.62	18.34	18.45	19,97

[1]Holm oak acorn (*Quercus ilex*); [2]Provided by Bouhzila S.A. (Sétif, Algeria). Mineral and vitamin composition (g/kg premix): Se: 0.025, Mg: 5, Mn: 7.5, Zn: 7.5, I: 0.12, Fe: 3.6, Cu: 2.25, Co: 0.04, thiamine: 0.1, riboflavin: 0.45, calcium pantothenate:0.6, pyridoxine: 0.15, biotin: 0.0015, nicotinic acid: 2, choline chloride: 35,folicacid: 0.4, vitamin K_3: 0.2, dl-α-tocopherolacetate: 1.35, cyanocobalamin: 0.0006, vitamin A: 850000 IU, vitamin D3: 170000 IU.

Statistical Analysis

Data were analysed as a completely randomised design with type of diet as the main source of variation using the GLM procedure of SAS software (OnlineDoc®, SAS Inst., Cary, NC). Mean comparisons were performed by Scheffe test. The nutritive value of holm oak acorn was calculated according to the regression method described by Villamide *et al.* (2001).

RESULTS AND DISCUSSION

Chemical composition of acorn

The chemical composition of the acorn can be affected by several factors including the species, variety, geographical origin and soil nature, storage conditions as well as the harvesting stage and consequently, the maturation degree of the acorns. The results obtained here (Table 1) showed that holm oak acorn was poor in fibre and protein, but high in energy. The composition of QI was close to previous studies as it is shown in Table 2.

Table 2: Chemical composition of the holm oak acorn compared to bibliography

	QI[1]	Kadi *et al.* (2016)	Keddam (2001)[2]	Ait Saada *et al.* (2017).	Galván (2012)µ	Rodríguez-Estévez *et al.* (2008)£
Crude ash	2.4	2.0	2.0	2.01	2.13	1.8
Crude protein	5.6	6.3	6.0	7.9	4.6	5.0
Fat	8.5	-	5.9	8.04	11.3	7.2
Starch	31	-	46.7	71.3	-	-
Crude fibre	11.2	-	3.6	2.4	-	4.9
NDF	27.4	29.5	-	-	-	-
ADF	20.7	19.2	-	-	-	-
ADL	10.4	11.2	-	-	-	-

[1]Our results; [2]acorn harvested in mid-November; µ: value of measured on samples taken from 13 different stations, £: compilation of results of 10 studies on holm oak acorns.

Nutritive value of holm oak acorn

Digestible energy

Energy digestibility increases linearly and significantly with the incorporation of the holm oak acorn (P<0.001), from 0.64 for the control diet to 0.70 for the QI diet 20 (Table 3).The digestible energy (DE) of the holm oak acorn, calculated by the regression method (Villamide *et al.*, 2001) was 17.9 MJ DE/kg DM with an estimation error of 1.61 (12.5%). The DE prediction equation obtained by regression was: DE (MJ/kg DM) = 0.063 QI (%) + 10.65; R^2 = 0.77 with QI (%) = incorporation rate of the *Quercus ilex* acorn .

Digestible protein

Increasing the incorporation rate of the holm oak acorn in the basal diet has a beneficial effect on the proteins digestibility. In fact, the digestive utilization coefficient of proteins increased slightly in parallel with the incorporation rate of the holm oak acorn (from 0.74 to 0.76; Table 3). The prediction equation for digestible protein obtained by regression was: DP (g/kg) = -1.605 QI (%) + 125.7; R^2=0.96 with QI (%)= incorporation rate of *Quercus ilex* acorn.The predicted digestible protein content of the holm oak acorn was 52.4 g/kg DM corresponding to a crude protein digestibility of 93.9% with an estimation error of 6.4g (3.0%).

To our knowledge, there is no scientific literature dealing with the determination of the nutritive value of the holm oak acorn in growing rabbits. In addition, the digestible energy content obtained for the holm oak acorn (17.9 MJ/kg DM) is much higher than those reported by Maertens *et al*. (2002) for raw materials commonly used as energy source in rabbit feed such as barley, maize and oats characterized by digestible energy contents of 14.7 MJ/kg DM, 14.9 MJ/kg DM and 12.4 MJ/kg DM, respectively.

Table 3: Effect of dietary level of inclusion *Quercus ilex* acorn on faecal digestibility coefficients and nutritive value of experimental diets in growing rabbits between 46 and 49 d of age.

	Experimental diets				
	QI-0	QI-10	QI-20	P-value	SEM[1]
Digestibility coefficients					
Dry matter	0.694[a]	0.719[b]	0.722[b]	0.001	0.18
Organic matter	0.685[a]	0.714[b]	0.715[b]	<0.001	0.19
Energy[µ]	0.642[a]	0.702[b]	0.705[b]	<0.001	0.20
Crude protein[µ]	0.746[a]	0.763[b]	0.762[b]	0.017	0.38
Neutral detergent fibre[µ]	0.196[a]	0.308[b]	0.314[b]	<0.001	0.44
Acid detergent fibre[µ]	0.100[a]	0.183[b]	0.215[b]	<0.001	0.54
Dietary nutritive value					
DP (g/kg)	127[a]	109[b]	100[c]	<0.001	0.58
DEµ (MJ/kg)	10.9[a]	11.1[ab]	11.3[b]	0.009	0.03

[1]MSE: mean square error (n=7); DP: digestible protein; DE: digestible energy; µ: linear effect (P<0.05). Mean values in the same raw with different superscript differ at P<0.05.

CONCLUSIONS

Holm oak acorn can be considered as a good source of digestible energy for growing rabbits. Further experiments are needed to study the impact of QI incorporation on health and growth of the rabbit. The optimum inclusion rate of QI in growing rabbits feeding should also be determined, using iso-nutritive diets and a high number of rabbits.

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