NUTRITIVE VALUE OF COMMON REED (*Phragmites australis*) LEAVES FOR RABBITS

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ABSTRACT

The nutritive value and potential use of sun-dried common reed (*Phragmites australis*) leaves "CRL", for the growing rabbit was studied by comparing 3 diets (regression method) containing an increasing incorporation of CRL: 0% (control, CRL0), 15 % (CRL15) and 30% (CRL30) in substitution to the control diet (356 g NDF and 197 g CP/ kg). Three groups of 37 rabbits (individually caged) were fed *ad libitum* the three diets from weaning (35 d, mean weight: 722 ± 142 g) to 77 d of age. The faecal digestibility of the diets was measured between 42 and 46 days of age on 10 rabbits per group. Common reed leaves can be considered as a roughage since it contained 64% of NDF (38% of ADF) and 10.2% of crude protein. The digestible energy (DE) content of CRL calculated by regression was null (-1.8±0.29 MJ/kg as fed) that classed this roughage as a source of ballast, probably active for transit stimulation. The digestibility of crude protein reached 28.5%, corresponding to a digestible crude protein concentration of 29.0±5.6 g/kg as fed basis. Health status was not affected by the CRL incorporation rate. However, incorporation of CRL in feeds impaired the growth less than 10% (34.2 for CRL0 *vs* 31.4 g/d for CRL15 and CRL30, from 35 to 77d old) and feed conversion 16%.

Key words: Growing rabbit, digestion, Reed leaves (*Phragmites australis*), growth performance, nutritive value.

INTRODUCTION

In Algeria and other maghrebian countries (Morocco, Tunisia), the dehydrated alfalfa (*Medicago sativa*) and the wheat by-products are the main fibre sources for rabbit feeds formulation. Alfalfa is imported and become very expensive. Therefore, alternatives are required to produce balanced pelleted feeds using local raw materials, available at lower price.

Phragmites australis (Poaceae) is a large perennial grass called common reed with a large geographical distribution in the world. In the growing season, common Reed is high-quality forage for horses and cattle (Baran *et al.*, 2002).

Reed leaves are already used as forage in some traditional rabbitries in Algeria (Kadi *et al.*, unpublished data), and could be a potential source of fibre and protein for rabbits since the crude protein content reached 12.7% (De La Cruz, 1983). Thus we aimed to determine the nutritive value for the growing rabbit of common reed leaves incorporated at increasing levels in 3 pelleted feeds.

MATERIALS AND METHODS

Experimental design and feeds

A total of 111 rabbits of Algerian white local population were used to assess the nutritive value of common reed leaves "CRL" for growing rabbits, in the rabbitry (15 to 23°C, 7:00–19:00 lighting schedule) of the centre of vocational training (CFPA) of Mechtras located near Tizi-Ouzou (Algeria). Chemical analyses were conducted at INRA of Toulouse (UMR 1289 Tandem, France).

The common Reed were harvested after flowering stage at the end of autumn, when their colour begin to change from initially fully green to bright yellow, in the CFPA of Mechtras in Tizi-Ouzou area. Then, the leaves were manually separated from stems and sun dried. Samples of dried CRL were collected in the feed mill factory after grinding (sieves with a diameter of 3 mm) in order to determine its chemical composition (Table 1). A basal mixture was formulated to fit with nutritional requirement of the growing rabbit (De Blas and Mateos, 2010). Three experimental diets containing an increasing incorporation rate of CRL were prepared by substituting the basal diet, without minerals and premix, with 0, 15 or 30 % of dried CRL (CRL0, CRL15 or CRL30, Table 1). Mineral and premix were added to all diets at a fixed amount of 2%. The mixture was then pelleted (4 mm diameter, 9 mm length).

Animals and measurements

Rabbits were weaned at 35 d old (mean weight: 722 ± 142g), allotted in three groups (37 per diet), according to weaning weight and litter origin. They were placed in wire mesh individual cages in flat deck disposition till 77 d old. During the 6 weeks of the experiment, rabbits were fed *ad libitum* one of the 3 diets, with a weekly control of live weight, feed intake and a daily control of mortality (Fernandez-Carmona *et al.,* 2005). Fresh water was always available. After a 7-d adaptation period (42 d old), faecal collections were achieved during 4 days for 10 rabbits per group following the European reference method for digestibility in rabbits described by Perez *et al.* (1995).

Chemical analyses

The following analyses were performed at INRA (UMR 1289 TANDEM) on feeds, CRL and faeces according to EGRAN harmonised procedures (EGRAN, 2001): humidity, crude ash, crude protein (N x 6.25, Dumas method, Leco apparatus), energy (adiabatic calorimeter Parr), and fibres (NDF, ADF and ADL) according to the sequential procedure of Van Soest.

Statistical analyses

Data were analyzed as a completely randomized design (diet effect) by using the GLM procedure of SAS software. Means comparison were done by using the test of Scheffe. The linear effect of CRL incorporation was analysed with the REG procedure of SAS. The nutritive value of CRL has been calculated using the regression method according to Villamide *et al.* (2001).

RESULTS AND DISCUSSION

According to their chemical composition (Table 1), CRL can be classified as a very fibrous feedstuffs. Indeed, at so deep maturity stage (post-flowering), NDF concentration reached 64.2 %, with other fibre fractions comparable to the most fibrous feedstuffs as wheat straw or grape pomace (Maertens *et al.*, 2002). Common reed leaves contained a moderate amount of crude protein (10.2%) close to that reported by De la Cruz (1983) (12.7%) but higher than that reported for some fibrous feedstuffs usually used in rabbit feed formulation as beet pulp, grape seed meal or wheat straw. In return, CRL presented a relatively high level of ash (12.1%), higher than that reported for the same raw material by De la Cruz (1983) (8.6%), but comparable to the Sulla hay (12.5%) reported by Kadi *et al.* (2011).
As expected, the dietary incorporation of common reed leaves increased the NDF level from 35 (CRL0) to 43% (CRL30), while the crude protein level decreased from 19.7 to 16.4%.

As expected, the dry matter digestibility decreased linearly from CRL0 to CRL30, according to the CRL dietary incorporation (Table 2). Classically, when the dietary fibre level increases the diet digestibility is reduced, because of the lower digestion of fibrous components. As expected, a close relationship was observed between the digestibility of DM, organic matter and that of energy. The energy digestibility was very negatively influenced by CRL level, since it decreased by 20 points from CRL0 to CRL30 ($p<0.001$). This agrees with the findings of Gidenne *et al.* (2010) who confirmed that the fibre content is the main factor affecting energy digestibility. The fibre digestion was linearly impaired with CRL dietary inclusion. Indeed, the NDF and ADF digestibility was divided by three from CRL0 to CRL30, probably due to the latest stage of maturity of CRL which increased the content in cellulose (perhaps with a high cristallinity for the cellulose molecule).

Table 1. Ingredient and chemical composition of experimental diets and of sun-dried Common Reed Leaves (CRL)

Ingredient, % as fed	CRL0	CRL15	CRL30	CRL
Common reed leaves sun-dried	-	15.00	30.00	
Dehydrated Alfalfa	30.00	25.41	20.81	
Wheat bran	17.00	14.40	11.80	
Soybean meal	20.00	16.94	13.88	
Corn grain	25.00	21.17	17.35	
Crude olive cake	6.00	5.08	4.16	
Sodium chloride	1.00	1.00	1.00	
Vitamin/mineral premix	1.00	1.00	1.00	
Chemical composition, g/kg, raw basis				
Dry matter	890	899	894	932
Crude ash	94	102	106	121
Crude protein (Nx6.25)	197	181	164	102
NDF	356	388	431	642
ADF	170	199	228	380
ADL	53	64	71	107
Gross energy, MJ/kg	16.95	17.01	16.68	17.3

[1] analytical value of a sample from the material incorporated in the pelleted feeds (CRL0, CRL15, and CRL30)

Using the digestibility coefficient for energy and protein obtained on the three feeds, we obtained equations to predict by the regression method the digestible energy of CRL (DE (MJ/kg) = 9.081 – 0.1088 CRL (%); R^2= 0.97; P = 0.001) and protein (DP (g/kg) = 117.91 – 0.89 CRL (%); R^2= 0.87; P = 0.0001). Accordingly and using the calculation procedure proposed by Villamide *et al.* (2001), the digestible energy obtained for sun dried CRL was not different from zero (-1.8 ±0.29 MJ/kg raw basis) and showed a relatively high standard error (16.1%). In rabbit nutrition there was few studies that dealt with highly fibrous raw material, such forages or by products. For instance, Garcia *et al.* (1996) reported a negative value (-4.6 MJ/kg DM), for DE for Sunflower Hulls, and even at a low substitution level (6 %). Besides, the DE value of CRL seemed to be similar to DE of a straw as reported by Lebas and Djago (2001) who estimated a DE level not significantly different from zero.

Table 2. Effect of CRL dietary incorporation level on faecal digestibility, and nutritive value of experimental diets in growing rabbits (42 and 46 d of age).

	Experimental diets			*SEM*[1]	*P*
	CRL0	CRL15	CRL30		
Digestibility coefficients (%)					
Dry matter[µ]	57.1[a]	44.8[b]	38.3[c]	0.25	<0.001
Organic matter[µ]	57.2[a]	44.5[b]	38.2[c]	0.26	<0.001
Energy[µ]	56.8[a]	44.1[b]	36.8[c]	0.26	<0.001
Crude protein	63[a]	58.6[b]	58.5[b]	0.74	0.001
Neutral detergent fibre[µ]	33.9[a]	25.1[b]	11.1[c]	1.51	<0.001
Acid detergent fibre[µ]	22.6[a]	17.7[ab]	11.4[b]	1.58	0.002
Dietary nutritive value					
DP (g/kg raw basis)[µ2]	119[a]	102[b]	92[c]	1.28	<0.001
DE (MJ/kg raw basis)[3]	9.20[a]	7.18[b]	5.88[c]	0.04	<0.001
Ratio DP/DE (g/, raw basis)[µ]	12.94[a]	14.22[b]	15.65[c]	0.20	<0.001

[1] n = 10. , [2] DP: digestible crude protein. , [3] DE: digestible energy. [µ] : Significant linear effect (P<0.05)
Mean values in the same raw with a different superscript differ, P < 0.05.

The digestible protein content of the CRL was relatively low: 29.0±5.6g DCP/kg raw basis, which corresponded to a crude protein digestibility of 28.5%. This value is close to that of Cacao hulls (25 %), but much higher than that of sunflower hulls (15 %) and carob meal (20 %) of which the contents in fibre is much lower (Maertens *et al.*, 2002). The DCP of CRL was more than twice as high in pre-flowering green oat forage (12.4 g/kg) found by Deshmukh *at al.*(1990). Besides, the standard error for the predicted value of digestible protein content was relatively high (19 %). Although, the CP digestibility variation is only slightly explained by the chemical composition (16 % according to Villamide *et al.*, 2010), this digestible protein content should to be related to the fibre concentration in CRL as for the majority of fibrous feedstuffs in EGRAN tables reported by Maertens *et al.* (2002).

The level of the growth performances and intake are significantly impaired by CRL incorporation, although the global growth rate exceeds 30 g/d (Table 3). Throughout the experiment, the health status of rabbits was good, since only 2 rabbits died in the groups CRL0 and 4 in CRL15, but none in the group CRL30.

Table 3. Effect of CRL dietary incorporation on feed intake and growth of rabbits

	Experimental diets			*SEM*	*P*
	CRL0	CRL15	CRL30		
n[1]	35	33	37		
Period 35-56 d					
Live weight at 35 d, g	720	729	716	45.4	0.98
Live weight at 56 d, g	1512	1508	1419	56.7	0.42
Weight gain, g/d	38.9 ^{a}	38.4 ^{a}	33.9 ^{b}	0.82	<0.001
Daily intake, g/d	106.0	118.8	107.0	4.0	0.048
Feed conversion, g/g	2.89	3.18	3.15	0.11	0.129
Period 56-77 d					
Live weight at 77 d, g	2130	2050	2020	55.7	0.35
Weight gain, g/d	29.5 ^{a}	26.5 ^{b}	28.6 ^{ab}	0.80	0.04
Daily intake, g/d	127.3 ^{b}	115.8 ^{c}	137.8 ^{a}	3.02	<0.001
Feed conversion, g/g	4.38	4.40	4.81	0.12	0.035
Period 35-77 d					
Weight gain, g/d	34.2 ^{a}	31.8 ^{b}	31.1 ^{b}	0.62	0.002
Daily intake, g/d	119.9 ^{ab}	114.4 ^{b}	129.5 ^{a}	2.85	0.001
Feed conversion, g/g	3.59 ^{b}	3.64 ^{b}	4.16 ^{a}	0.09	<0.001

[1]n: number of rabbits at the end of experimental period.
Mean values in the same raw with a different superscript differ, P < 0.05

According to Garcia *et al.* (2002) dietary inclusion of fibrous feedstuffs at levels of 100-150 g/kg has little effect on rabbit performance, when the rabbit is able to regulate its DE intake and thus to adjust its growth. For instance, from 35 to 77d old, impairment of growth performances originated both in a lower digestible energy intake (1.1 MJ/day in CRL0 *vs* 0.82 and 0.76 MJ/day respectively in CRL15 and CRL30) and protein intake (14.26 g/day in CRL0 *vs* 11.66 and 11.91 respectively in CRL15 and CRL30). It is well known that the rabbit regulates its energy intake from a dietary digestible energy concentration of 9.0 MJ/kg whereas does not exceed 7.1 and 5.8 respectively in CRL 15 and CRL 30. However, growth results are better than that expected according to digestibility assay. This can be explained by an underestimation of CRL nutritive value as suggested by De Blas *et al.* (1989) for high fibre raw material at high level of substitution of basal diet, or by higher efficiency of utilization of DE for fibrous diets. In perspective, we should consider an earlier collection of the CRL, before the maturity stage, and expecting a lower mineral content and a higher protein concentration.

CONCLUSION

Sun dried Reed leaves is a high fibre source for rabbit, with a moderate level in crude protein at maturity stage. However, its nutritive value for the growing rabbit harvested at maturity stage appear relatively poor, either respect to its digestible energy (around zero) or to its digestible protein level (29 g DP/kg as fed basis). It should be considered as high fibre feedstuffs with a potential role of "ballast" and transit stimulation when incorporated at highest level. However, the substantial growth rate obtained suggests an adaptation of rabbits to CRL and motivate for further investigations on those leaves at earlier vegetative stages.

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