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TANNIN CONTENT AND CHEMICAL COMPOSITION OF UNCONVENTIONAL AND CONVENTIONAL FEED FOR RUMINANTS

SUMMARY

An interesting challenge for animal nutrition scientists is introduce alternative feedstuffs that would help them overcome the issues of environmental harshness and the forages high production costs in tropical, subtropical and arid areas. The objective of this study was to contribute to the characterization of nutritional potential of unconventional and conventional feed with special attention to the profiles of phenolic compounds and condensed tannin, which could cause effects on meat and milk composition, when consumed in large quantities by animals. The species were: *Opuntia ficus-indica, Agave Americano, Arundo donax*, used for farmers to feed animals from wild populations and *Triticum spp, Avena spp, Hordeum spp* and *Pisum spp*, species natives cultivated as forages for animals, from seeds of species conserved by farmers in the Canary Islands (Spain). Nutrient content and the profiles in secondary compounds would differ between species and that their quantity and qualitative interactions would influence nutritive value. Crude protein (CP) was: 4.2% (*Opuntia ficus-indica*), 6.7% (*Agave Americano*), 10.7% (*Arundo donax*), 11.2% (*Hordeum spp*), 12.6 % (*Triticum spp*), 13.9% (*Avena spp)* and 18.4%, *Pisum spp*). Condensed tannins ranged from 0.0% (Opuntia ficus-indica) to 2% (*Pisum spp*), and total phenols from 0.6% (*Hordeum spp)* to 9.2% (*Pisum spp*). Organic matter digestibility (OMD) ranged from 46% (*Triticum spp*) to 88.6% (*Agave Americano*). Based on IVOMD, digestible energy of the different species was estimated to range from 6.5 to 11.8 MJ DE/kg DM. Current results support the thesis that, some alternative local feedstuffs have potential to be used in ruminant feeding strategies.

Keywords: Opuntia, Agave, Pisum, Hordeum, Arundo

INTRODUCTION

Herbaceous and legume plants have been largely reported to be used for small ruminant feeding as feed resources, but in tropics, subtropics, arid and dry regions, during dry seasons this feedstuff is normally scare and limited. Good

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economic alternative for livestock feeding is to produce good quality forage with native well adapted species and use as well spontaneous species which grow easily without too much care. Some of them are known to be tolerant to drought having the ability to accumulate green fodder over several seasons, controlling erosion, providing fodder reserves for times of dearth and contributing, as legumes plants, for positive impacts on soil fertility with organisms which fix atmospheric nitrogen (Le Houérou, 2000). Nevertheless, their use has been limited by scant research on their nutritional and chemical properties, in particular on anti-nutritional factors. The presence of tannins in browsing legumes plants is normally associated with limiting factor to the utilization as feedstuffs (Mangan, 1988; Kumar and Vaithiyanathan, 1990); but may be advantageous by protecting dietary protein from digestion in the rumen and thus increasing total supply of protein for absorption (D, Mello, 1992).

In Canary Islands there are some native species (*Triticum spp., Avena spp., Hordeum spp.* and *Pisum spp.*) traditionally cultivated for feeding animals and other which grow spontaneously (*Opuntia ficus-indica, Agave americano, Arundo donax*) which have been used by local goat and sheep keepers to feed animals as forage resources. *Agave spp* and *Opuntia ficus-indica* are usually thrived in semiarid regions such as Mexico, Australia, and Africa used as supplements in small ruminant diets, without compromising animal performance (Vasta *et al., 2008)*. In the case of *Arundo donax* is usually considered a noxious weed, most efforts are dedicated to controlling it and there are few trials dedicated to its management as forage. It is a highly productive species, yielding from 30-40 t/ha/year biomasses in low yield areas such as Greece or Spain, to 171 t/ha/year in the USA (CIPC, 2011). Grazing of the young shoots and leaves, which are the only parts palatable to livestock, may help to control its development during the dry season (USDA, 2012).

However, there is still scarce literature about their particular characteristics and nutritive value which had lead to a poor promotion at local and regional level, even in some species with a risk of losing native seeds and germoplasm of it.

The objective of this study was to assess the nutritive value of some unconventional and conventional feed, species used to feeding animals, specially taking into account their profiles on phenolic compounds and condensed tannins for select properly the species and the variety of the legumes shrubs for animal nutrition.

MATERIAL AND METHODS

The species used in this study were *Opuntia ficus-indica, Agave americano, Arundo donax*, used to feed animals sporadically for farmers from wild populations from different localities in Gran Canary (Latitude 27º 55´ 45´´; Longitude 15º 23´ 20´´). The original plants were randomly selected from spontaneous populations which have been developed without irrigation or fertilization. The other native's species from Canary used were *Triticum spp.*,

Avena spp, Hordeum spp. and *Pisum spp.* which were specifically cultivated on the Cabildo's Experimental Farm in Gran Canary. Fresh samples were weighed, cut and dried at 60 ◦C to about 90 g/kg dry matter (DM). They were then ground to pass a 1mm screen prior to duplicate chemical analyses. Dry matter, ash and crude protein (CP) were determined according to standard methods as described in AOAC (2000) (methods 930.15, 942.05, and 976.05, respectively). Ash-free neutral detergent fibre (NDFom) was determined using sodium sulphite in the ND according to Van Soest et al. (1991). The acid detergent fibre (ADF) and acid detergent lignin (ADL) were determined following the procedure of Van Soest *et al.* (1991).Condensed tannin (TC) analysis and total phenolic content (PC) were performed by the vanillin-HCL method of Burns (1963) and the technique of Makkar, H. and Al. (1993) respectively; *In vitro* dry matter digestibility (DMD) and organic matter digestibility (OMD) was determined according to the two stage pepsin-cellulase method (Pepcel) (Aufrere, 1982). Based on digestible OM, digestible energy (DE, MJ/kg DM) content of the species was estimated as 0.0185 × digestible OM (NRC, 1988). To assess the content of nutrients according to the type of plant, an analysis model of variance with a factor of variation (ANOVA-1) was used (SAS, 2000).

RESULTS AND DISCUSSION

In Mediterranean countries, livestock nutrition is based on the natural grazing and supplementary feeding consisting mainly of fodder, by-products and concentrates. The feed used is usually cereals, hay, consisting mainly of annual legumes and seeded small grains, such as oats and vetch. But in arid and semi-arid areas are characterized by limited food resources and the production of green fodder is scare, which is reflected in weight loss, poor reproductive performance and low overall production. The future of arid and semiarid regions depends on the development of sustainable agricultural systems and on the cultivation of appropriate crops. Such crops must successfully withstand water shortage, high temperature, and poor soil fertility (Nefzaoui, and Ben Salem. 2002).

Table 1. Chemical composition on conventional and unconventional feed (g/kg DM)

Species	DM	OM	CP	NDF	ADF	ADL	ASH	PT	TC
Triticum	295	757	126	62	367	35	121	0.8	1.0
Avena	206	714	139	559	326	11	144	0.9	1.3
Hordeum	250	792	112	419	210	12	95	0.6	1.3
Pisum	156	750	185	282	218	38	111	9.2	1.4
Opuntia	91	558	42	317	77	10	330	1.5	0.0
Agave	120	722	67	200	152	40	125	2.0	0.1
Arundo	298	751	107	568	313	40	193	1.1	0.1

(Dm) dry matter; (om) organic matter; (cp) crude protein ;(ndf) neutral detergent fibre; (adf) acid detergent fibre; (adl) acid detergent lignin; (ash) ash in g/kgdm. (pt) total phenols (% of tannins as tannic acid equivalent), (tc)condensed tannins content (%of tannins as catechin equivalent),

However, there are resources, unconventional feed, that can be produced in this semi-arid conditions, which provides the necessary nutrients to improve the nutritional status of the animals, some of them have been selected and analyzed in this study to compare nutritive value among them; the chemical composition, are seen in table 1.

The DM content of the species was 91–298 g/kg fresh forage, and OM content of the different species analyzed was 558–792 g/kg DM (Table 1). Both DM and OM content were lower (P<0.05) in the *Opuntia ficus* specie and *Agave americano,* with differences significantly among the other species, high water content could affect nutritive value of this species.

CP content ranged from 42 to 185 g/kg DM, and it was lower (P<0.05) in the *Opuntia ficus* specie and higher (P<0.05) in the *Pisum* specie. These values obtained in the *Opuntia* on DM, OM, CP and Digestibility is similar to results described by Flachowsky *et al*., 1985. Bouaziz *et al., (*2014) found lower CP content (3.5%) on *Agave Americano* collected on Tunisia.NDFom content of varieties ranged from 200 to 620 g/kg DM, and it was lower (P<0.05) in the *Agave Americano* and higher (P<0.05) in the *Triticum* specie.

Condensed tannins contents ranged from 0.0% in the *Opuntia ficus* to 2 % of tannins as catechin equivalent, in the *Pisum* specie, and total phenols contents ranged from 0.6% in the *Hordeum* specie to 9% of tannins as tannic acid equivalent in the *Pisum* specie.

Both TC and PC contents were higher in the *Pisum* specie, similar results found in legume shrub called *Tagasaste by Ventura et al.,* (2002). Moreover no differences occurred for cereal species and in the *Agave americano* and *Arundo donax* in the condensed tannins contents. Nevertheless just in case of concentrations greater than 50 g/kg DM, tannins can decrease food intake (Barry and Forss, 1983) and this should limits the use of feedstuffs even though they may have high protein content.

Table 2. Dry matter digestibility (DMD),organic matter digestibility (DMD), digestible organic matter (DOM) in g/kg DM and estimate digestible energy (DE) in MJ/kg DM

	DMD	OMD	DOM	DE
Triticum	0.47	0.46	351	6.5
Avena	0.60	0.58	415	7.7
Hordeum	0.68	0.69	540	10.0
Pisum	0.82	0.80	605	11.2
Opuntia	0.73	0.80	448	8.2
Agave	0.89	0.88	639	11.8
Arundo	0.45	0.47	359	6.6

The *In vitro* organic matter digestibility (IVOMD) (Table 2) ranged from 0.464 in the *Triticum* specie to 0.886 in the *Agave Americano*, were it was the higher (P<0.05) value. Moreover IVOMD was quite high and similar than in the *Pisum specie* and in the *Opuntia ficus*. Digestibility is similar to results described by Flachowsky *et al*., 1985 in the *Opuntia spp*. Digestible OM content of the

species was 351–639 g/kg DM, with differences among species. Finally, based on IVOMD, digestible energy of the different species was estimated to range from 6.5 to 11.8 MJ DE/kg DM. It was lower in the *Arundo donax* and in the *Triticum* specie and higher ($P<0.05$) in the *Agave Americano, Pisum specie* and *Opuntia ficus.* ED was similar among *Pisum specie* and *Agave americano,* due to the higher IVOMD on both of them. An exception in the *Arundo donax* and in the *Triticum* specie, estimated DE of the species analyzed was similar and higher to *Medicago arborea* and to other forage legumes shrubs such as *Bituminaria* varieties or tagasaste reported by Ventura et al. (2002; 2004; 2009). Similar results of Chemical composition and digestibility were described by Ahmed et al., (2009) for *Arundo donax.*

Moreover DE content of all species analyzed was higher and in the range (6.9-9.2 MJ DE/kg DM) estimated by INRA (1988) for cereals, legumes straws and medium quality alfalfa hay.Current results support the thesis that, some alternative local feedstuffs have potential to be used in ruminant feeding systems strategies.

CONCLUSIONS

The value of forages as supplements is mainly depending on their capacity to provide essential nutrients to the rumen microbial population and/or critical nutrients (anti-nutritive factors) to meet the host animal requirements, thus increasing or reducing the efficiency of feed utilization (Elliot and McMenimen, 1987). In this study we can see that there are many differences in chemical composition, in the condensed tannins and in the total phenols contents within the different species analyzed. Condensed tannins and total phenols contents were low in the different species analyzed a exception of total phenols contents in the Pisum specie were it was quite high. Although, more research should be done on the relation between the quantity of total phenols and tannins and the possible toxic effects on animals or the reduction on voluntary dry matter intake and palatability. Based on CP, IVOMD and digestible energy results, all the species analyzed are within the range estimated by INRA (1988) for cereals, legumes straws and medium quality alfalfa hay. Current results support the thesis that, these alternative local feedstuffs have potential to be used in ruminant feeding systems strategies, although more research is needed to see productive responses on animals feeding these plants.

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