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INFLUENCE OF POST-HARVEST PROCESSING METHODS ON CHEMICAL COMPOSITION, DRY MATTER AND ORGANIC MATTER DEGRADABILITY OF ACACIA (*Acacia hockii*) LEAF MEAL

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ABSTRACT

Three fistulated rams with average live weight of 20kg were used as replicates in a completely randomized design (CRD) to study the influence of post-harvest processing methods on chemical composition, I*n Sacco* dry matter degradability (DMD) and organic matter degradability (OMD) of three differently processed *Acacia hockii* leaf meal. The processed leaf meals (ensiled, T1; sundried, T2 and fresh, T3) were incubated in the rumen of the three rams (3, 6, 12, 24 and 48h incubation time). The processing significantly ($p<0.05$) reduced the tannin and saponin levels. The highest levels were observed in the fresh leaf meal. There was significant ($p<0.05$) different in CP contents between the treatments, with T1 having the highest CP content of 15.06%. The CF contents also differed significantly ($p<0.05$) between the treatments. T3 had the highest CF content (9.23%). T1 had significantly ($p<0.05$) higher DMD and OMD than T2 and T3. The differences in effective dry matter degradations (EDMD) and effective organic matter degradations (EOMD) were also significant ($p<0.05$) between the three treatments. It is concluded that the processing methods (ensiling and drying) had positive effect on the chemical composition, DMD and OMD of Acacia (*Acacia hockii*) leaf meal. It is recommended that ruminant animal farmers, who practice zero grazing, should process *Acacia hockii* leaf meal before feeding it to their animals for better nutrients availability and utilization.

Keywords: Degradability, Processing methods, Ram, Rumen and Acacia hockii.

INTRODUCTION

Ruminant production in most part of the world is faced by inadequate nutrition in terms of quality and quantity due to seasonal fluctuations in availability of forage. Natural vegetation in arid, semi-arid and coastal areas constitutes the main feed resources for the indigenous herbivores (Forbey *et al.*, 2009). The native pastures and crop residues are the major feed sources available in these areas for the ruminants (Osuga *et al.*, 2005). Browse plants are widely used as fodder for livestock in the tropics and subtropics of the world and few Acacia genus are extensively cultivated for fodder (Bekele-Tesemma, 2007). During the prolonged season of about 8 months in a year, Acacia species serve as source of much needed nutrients to domestic herbivores. Several species of Acacia are recognized by grazers for their feeding value during drought (Canbolat, 2012). Forbey *et al*., (2009) indicated that seed pods of some Acacia species such as *A.tortilis* and *A. albida* as well as leaves of *A. brevispica* when offered as supplements to poor-quality roughages, gave live weight gains comparable with those of livestock fed oilseed cakes and lucern (*Medicago sativa*)

Acacia is a genus of indigenous woody legumes that occupies a dominant position in plant communities in semi-arid and arid areas of tropical and subtropical countries (Siegler and Ebinger, 2010). Acacia has the ability to rapidly absorb nutrients, particularly nitrogen, and incorporate them into biomass after fire, enabling it to act as a pioneer species. Although the nutrient contents indicate a high potential for using the foliage of some Acacia species as a feedstuff, other constituents also need to be considered. Acacia could be good feed resources utilized for livestock production during feed gaps and drought season (Neba, 2009).

The inclusion of browse plants in concentrate supplementary feeds for ruminants provides feed at reduced cost. The utilization of browse is limited by the high lignin content and the presence of plant secondary metabolites (PSMs). The PSMs are substances that when present in animal feed reduce the availability of one or more nutrients. They interfere with the intake, availability, or metabolism of nutrients in the animals (Attia-Ismail, 2005; Katie and Thorington, 2006; Hoste *et al*., 2006). They are produced in plants for protection and adaptation to environmental stresses. Some of them are deleterious and some are beneficial, some of which may be nutritionally valuable but many have no nutritional value or nutritionally detrimental (Bento *et al.,* 2005). Their effects can also range from a mild reduction in animal performance to death, even at relatively small intakes. Harmful effects of plant secondary metabolites cause great economic losses to livestock producers (Forbey *et al.,* 2009).

The most important PSM is tannin, which is shown to decrease the digestibility in browse fodders. Tannins are a group of polyphenol substances with the ability to bind protein in aqueous solution (Katie and Thorington, 2006). Other

secondary compounds found in browse plants species include: cyanide, nitrate, fluoroacetate, cyanogenic, glucosides, saponins, oxalates, mimosine and various sterols (Leng, 1997).
Beauchemin *et al.,* (2008) reported that, the saponins, tannins and anthraquinones are toxic for microorganisms and suppress methane production in animal nutrition. Anti-helminthic properties have been reported in many plants that are browsed (Hammond *et al.,* 1997), thereby improving the nutritional status of the animals and increase their ability to resist the harmful effects of parasites (Hoste *et al*., 2006).
Trees provide fodder and shade for livestock, improve soil fertility through nitrogen fixation and the production of leaf litter and stabilize soils. Acacia species provide edible fruits and seeds, gum arabic and timber for fuel, construction and fencing (Lock, 1989).
Acacia hockii is a shrub that grows all the year round thereby reducing the effects of feed scarcity on ruminant animals, more especially during the dry season. Acacia species, like other browse plants, contain secondary metabolites that hinder its effective utilization by the ruminant animals. However, there are several methods of reducing the effects of these anti-nutritional factors, which include different post-harvest processing techniques. There is paucity of information on the effects of post-harvest processing techniques on the ruminal degradability of *Acacia hockii.* Therefore, this research focused on studying the effects of post-harvest processing techniques on ruminal degradability of *Acacia hockii* leaf meal.

MATERIALS AND METHODS

Location of the experiment

This experiment was conducted at the Federal University Dutsin-Ma Livestock Teaching and Research Farm located at the outskirt of Dutsin-Ma local government area of Katsina State. It lies within latitude 11 9’ 45” N and longitude 7^{O} 38’ 8” E, at an altitude of 610m above sea level (Ovimaps, 2012). The area has a flat topography with the vast tropical grasslands of the Sudan savannah characterized by luxuriant vegetation suitable for ruminant grazing. The rainfall ranges between 700mm to 800mm occurring annually with distinct wet season between May-September and dry seasons between October-April (Ovimaps, 2012).

Sample preparation

Acacia hockii leaves were collected from Dutsin-Ma town and subjected to one of the following treatments:

1. **Fresh leaves:** Fresh leaves were used in their fresh form.
2. **Sun-drying:** The leaves were air-dried under a shade at a temperature of 30˚C for five days until the leaves became crisp, they were then stored in airtight plastic bags until when needed.
3. **Ensiling:** Samples were collected and ensiled in an air-tight polyethylene bags for seven days.

Animals and their management

Three rams with average live weight of 20kg were fistulated and used as replicates in a completely randomized design (CRD) to determine *in Sacco* DM degradability of the differently processed *Acacia hockii* leaf meal. The rams were housed in individual pens and fed with basal diet consisting of groundnut haulms, maize offal and cowpea husk a*d libitum.* Water and mineral block were available at all times. The diet was offered at 08:00h daily. The animals were adapted to the basal diet for a period of 14 days prior to the suspension of the bags in the rumen.

Ruminal degradability study

Rumen degradability was measured according to the techniques described by Ørskov (2000). Three grams of each sample was weighed into labeled nylon bags with the size of 70mm × 40mm and a pore space of 0.2mm. The bags were tied firmly using nylon strings and anchored with about 25cm nylon thread in the rumen of each ram for each sample and incubation time. The incubation times were 3, 6, 12, 24 and 48h. The bags containing undigested residues were sequentially removed from the rumen after each incubation time and thoroughly washed under running tap water until the washing water became clear. The 0h incubation samples were soaked in warm water for 2hrs and washed in similar condition as in the other samples. They were then dried in an oven at the temperature of 60˚C for 48hrs and the weights of residues were recorded. The degradation rate constant (C) was calculated using the following exponential equation:

$P = a + b\,(1- e^{-ct})$, described by Ørskov (2000).

Where:

P = dry-matter degradation (%)
a = dry-matter solubility (%)
b = potentially degradable fraction (%)
t = time of maximum rate of dry matter degradation (hours)
c = degradation rate constant

Effective degradability (ED) of the samples was calculated using the outflow rates of 0.02, 0.03, 0.04 and 0.05/hr, according to Ørskov *et al.* (1980) model:

$ED = a + (bc/c + k)$

ED is effective degradability; ‘a’, ‘b’ and ‘c’ are the constants described earlier in the exponential equation (Ørskov, 2000).
‘k’ the rumen fractional outflow rate constant.

Statistical analysis

Analysis of variance was carried out to determine the effects of processing methods on chemical composition, dry matter and organic matter degradability of Acacia (*Acacia hockii*) Leaf Meal using the Proc GLM procedure of SAS (SAS 2001).The model equation:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Where

Y_{ij} = Record of the Jth value belonging to the ith sample
μ = Overall mean
T_i = Effect of the ith incubation period (0 – 48h)

e_{ij} = Error term

Significant treatment means were separated using Duncan Multiple Range Test (Duncan, 1995).

RESULTS AND DISCUSSION

RESULTS

Chemical composition of differently Processed *Acacia hockii* leaf meal.

The chemical composition of the Acacia leaf meal is presented in Table 1. There was significant (p<0.05) difference in dry matter of the ensiled, dried and fresh leaf meal. Significant (p<0.05) difference was observed in the CP, CF, Ash, oil, tannin and saponin contents of the three treatments. There was significant (p<0.05) difference in CP contents between the treatments. T3 (fresh leaves) had CP content of (12.95%) and T2 (sun dried) and T1 (ensiled) had 14.65% 15.06% respectively. There was also a significant (p<0.05) difference in CF between the treatments, with T3 (fresh leaves) having the highest CF content of (9.23%). The tannin content was significantly (p<0.05) higher in T3 (0.06%) than in T2 (0.04%) and T1 (0.04%). The saponin content also followed the same trend.

Table 1: Effects of processing on chemical composition of *Acacia hockii* leaf meal (%).

PARAMETERS	ENSILED	DRIED	FRESH	SEM
Dry matter	75.00^{a}	89.70^{b}	63.33^{c}	1.896
Crude protein	15.06^{a}	14.65^{a}	12.95^{b}	0.474
Crude fiber	5.61^{a}	5.71^{a}	9.23^{b}	0.091
Ash	1.29^{a}	1.47^{a}	2.35^{b}	0.053
NFE	75.89	76.28	73.47	0.957
Oil	2.15	1.89	2.00	0.099
Tannin	0.04^{a}	0.04^{a}	0.06^{b}	0.006
Saponin	9.00^{a}	10.00^{a}	16.00^{b}	0.577

^{a,b,c} means with different superscript within the same row differ significantly (p<0.05) SEM = standard error of the means.

***In sacco* Dry Matter Degradationof Differently Processed *Acacia hockii* Leaf Meal.**

Table 2 shows the dry matter degradability (DMD) of the Acacia leaf meal. T1 had the highest DM degradability (43.37 to 87.78%) following the incubation in the rumen from 3 to 48h.

The dry matter solubility (a) value (7.10%) obtained in T2, for DMD was significantly (p<0.05) lower than those obtained in T1 and T3 (21.05 and 21.41%, respectively) which were not significantly (p>0.05) different from each other. For potentially degradable fraction (b) values, there was significant (p<0.05) difference among the treatments for DMD. T1 had the highest value (87.78%) and T3 had the least (73.33%). The asymptote (a+b) values were also significantly (p<0.05) different between all the treatments. T1 had the highest value of asymptote (108.83%) for the DMD while T2 had the least (91.00%). The rate of DM degradation was significantly (p<0.05) affected by processing methods with the highest value of c for T1 ($0.087h^{-1}$) and lowest for T3 ($0.037h^{-1}$).

Table 2: Effects of processing on degradation characteristics and disappearance of DM in *Acacia hockii* leaf meal.

	Incubation time (h)								
Treatments	3	6	12	24	48	A	b	a+b	C
T1(Ensiled)	43.37^{a}	63.16^{a}	52.63	82.46^{a}	87.78^{a}	21.05^{a}	87.78^{a}	108.83^{a}	0.087^{a}
T2(Dried)	23.20^{b}	34.35^{b}	50.45	64.08^{b}	83.90^{a}	7.10^{b}	83.90^{b}	91.00^{b}	0.079^{b}
T3(Fresh)	27.41^{b}	33.33^{b}	42.22	52.59^{c}	73.33^{b}	21.41^{a}	73.33^{c}	94.73^{c}	0.037^{c}
SEM	4.433	2.581	3.456	9.462	2.856	2.478	2.856	2.595	0.010

^{a,b,c} means with different superscript within the same column differ significantly (p<0.05); SEM = standard error of the means.
a = soluble fraction; b =insoluble fraction; a+b = sum of soluble and insoluble fraction; c = degradation rate constant.

***In sacco* Organic Matter Degradability of Differently Processed *Acacia hockii* Leaf Meal**

The organic matter (OM) degradability of the Acacia leaf meal is presented in Table 3. T1 had the highest OM degradability (48.79 to 90.78%) after suspension in the rumen from 3 to 48h.

The organic matter solubility (a) value obtained for T2 (8.16%) was significantly (p<0.05) lower than those obtained for T1 and T3 (21.77 and 23.62%) which were not significantly (p>0.05) different from each other. For potentially degradable fraction (b) values, there was significant (p<0.05) difference among the treatments for OMD. T1 (90.78%) had the highest for OMD and T3 (75.79%) had the least. The asymptote (a+b) values were significantly (p<0.05) different between all the treatments. T1 had the highest values (112.55%) for OM and T2 had the least value (94.02%). The rate of DM degradation was also significantly ($p<0.05$) affected by processing methods with the highest value of c for T1 ($0.091h^{-1}$) and lowest for T3 ($0.028h^{-1}$).

Table 3: Effects of processing on degradation characteristics and disappearance of OM in *Acacia hockii* leaf meal.

	Incubation time (h)								
Treatments	**3**	**6**	**12**	**24**	**48**	**A**	**b**	**a+b**	**C**
T1(Ensiled)	48.79[a]	64.84[a]	54.99[a]	86.95[a]	90.78[a]	21.77[a]	90.78[a]	112.55[a]	0.091[a]
T2(Dried)	25.20[b]	36.28[b]	52.49[a]	65.51[b]	85.90[b]	8.16[b]	85.87[b]	94.02[b]	0.080[b]
T3(Fresh)	29.84[b]	35.40[b]	45.26[b]	54.45[c]	75.88[c]	23.62[a]	75.79[c]	99.41[c]	0.028[c]
SEM	4.485	2.325	2.811	9.189	2.337	2.497	2.861	2.738	0.017

[a,b,c] means with different superscript within the same column differ significantly ($p<0.05$) SEM = standard error of the means.
a = soluble fraction, b =insoluble fraction, a+b = sum of soluble and insoluble fraction, c = degradation rate constant.

Effective Dry Matter Degradability of Differently Processed *Acacia hockii* Leaf Meal

Table 4 shows the processing methods on different passage rates of DM in *Acacia hockii* leaf meal. There was significant ($p<0.05$) difference in EDMD among the three treatments. The EDMD decreased with increase in outflow rates from 2% to 5%. It ranges from 92.38% (K = 0.02) for T1, to 51.84% (K = 0.05) for T3.

Table 4: Effect of processing methods on different passage rates of DM in *Acacia hockii* leaf

	Passage rate/h			
Treatments	**0.02**	**0.03**	**0.04**	**0.05**
T1(Ensiled)	92.38[a]	86.28[a]	81.14[a]	76.75[a]
T2(Dried)	74.03[b]	67.71[b]	62.52[b]	58.18[b]
T3(Fresh)	67.66[c]	60.76[c]	55.72[c]	51.84[c]
SEM	4.133	4.204	4.151	4.052

[a,b,c] means with different superscript within the same column differ significantly ($p<0.05$) SEM = standard error of the means.

Effective Organic Matter Degradability of Differently Processed *Acacia hockii* Leaf Meal.

Table 5 shows the effective organic matter degradability (EOMD) of Acacia leaf meal. There was also a significant ($p<0.05$) difference in EOMD between the three treatments. The EOMD followed similar trend with EDMD. It decreased with increase in outflow rates from 2% to 5%. It ranges from 92.28% (K = 0.02) for T1, to 50.06% (K = 0.05) for T3.

Table 5: Effect of processing methods on different passage rates of OM in A. hockii leaf

	Passage rate/h			
Treatments	**0.02**	**0.03**	**0.04**	**0.05**
T1(Ensiled)	92.28[a]	85.95[a]	80.70[a]	76.27[a]
T2(Dried)	76.40[b]	70.10[b]	64.90[b]	60.51[b]
T3(Fresh)	66.40[c]	59.03[c]	53.88[c]	50.06[c]
SEM	3.541	3.651	3.669	3.632

[a,b,c] means with different superscript within the same column differ significantly ($p<0.05$); SEM = standard error of the means.

DISCUSSION

Chemical composition of the differently Processed Acacia hockii leaf meal.

The variability observed between the treatments was expected because they were subjected to different processing methods. The CP contents was within the range of 12% to 30% reported for tropical tree legumes by Norton (1994), and similar to the mean of 12.5% CP and 17% CP found by Le Houerou (1980) for West African browse plants and legume species, respectively. The CP content of browse plants has been shown generally to be above the minimum level (8% CP) required for microbial activities in the rumen (Norton, 1994). Therefore, the CP content of the processed Acacia leaf meal was sufficient for the growth and activities of microorganisms in the rumen. The crude fibers of the processed leaf meals were lower than that of the fresh. This agrees with the finding of Abdu *et al*. (2010), who reported low CF for ensiled Ziziphus leaf meal and attributed it to effect of the processing method.

The level of tannin and saponin contents of the processed feed material were lower than the fresh feed material due to processing techniques as reported by Reddy (2001) thatphysical methods like soaking, drying and ensiling before feeding of forage may reduce the toxic level of tannin (Nuttaporn and Naiyatat 2009). Attia-Ismail (2005) also reported that drying and ensiling reduce the tannin content of the forages.

In sacco dry matter degradation of differently Processed Acacia hockii leaf meal.

The significant difference observed in the DM degradation following the different processing techniques might be due to differences in their chemical composition and the processing methods. The Dry matter digestibility, (DMD) of foliage is one of the measures used to describe the nutritive value of foliage (Ternouth and McDonald, 1979). The difference in solubility might be due to difference in fibre content of the feeds. Moore and Jung (2001) reported a negative correlation between lignin concentration and cell wall digestibility by its action as a physical barrier to microbial enzymes. Negative correlations between tannin and protein or DM digestibility had also been studied (Balogun *etal.*, 1998).

In sacco organic matter degradation of differently Processed Acacia hockii leaf meal.

The variations noticed in OM degradability between the treatments might also be due to differences in their chemical composition and the processing methods. A similar observation was made by Abdu *et al*., 2010, who reported the higher levels of OM degradability in ensiled and sun-dried ziziphus leaf meals as a result of reduced tannin level by ensiling and sun-drying. Attia-Ismail (2005) had reported that ensiling and sun-drying reduce the level of tannin in browse plants. The difference in solubility might be due to differences in fibre content of the feeds. The rate of degradation (c) is an important factor in the assessment of the fermentation in the rumen (Preston, 1986).The low c value implies that the rate of breakdown of indigestible particles to sizes small enough to transverse the reticulo-omasal would be slow (Ørskov, 1980).

Effective dry matter degradability of differently Processed _Acacia hockii_ leaf meal.

There was decrease in the effective dry matter degradability with the increase in the outflow rates. Effective degradability is a measure of the proportion of plant DM that can be fermented in the rumen before it passes to the lower digestive tract for post ruminal digestion (McDonald *et al*., 2002). High tannin and saponin level causes a decrease in degradability of forage because tannins cause precipitation of microbes and enzymes, which hydrolyze molecules into smaller particles (Makkar, 2003). The higher tannins may therefore have a beneficial effect (increasing bypass protein or decreasing ammonia loss) or detrimental effect (depressing palatability, decreasing number of ammonia, decreasing post-nominal protein absorption) on protein availability (Abia *et al*., 2006).

Effective organic matter degradability of differently Processed _Acacia hockii_ leaf meal.

The observed decrease in the effective organic matter degradability with the increase in the outflow rates corresponds with the findings of Mupangwa *et al*. (1997) that DM and OM effective degradability decreases as the outflow rate increases.

CONCLUSION

It is concluded that the processing techniques; ensiling and drying have positive effect on reducing the level of anti-nutritional factors and increasing the crude protein level of the *Acacia hockii* leaf meal. It is recommended that ruminant animal farmers, who practice zero grazing, should process *Acacia hockii* leaf meal before feeding it to their animals for better nutrients availability and utilization.

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