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NUTRITIONAL VALUE AND *IN SITU* DEGRADABILITY OF SELECTED FORAGES, BROWSE TREES AND AGRO INDUSTRIAL BY-PRODUCTS

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ABSTRACT: The *in situ* dry matter and crude protein degradability of grasses, legumes, browse trees and agro industrial by products were evaluated by three fistulated bulls (Boran × Holstein-Friesian with mean body weight 580 kg and age= 29±3 months). The lower (P<0.05) crude protein content was reported in Bracharia grass than the other grasses. The higher (P<0.05) washing loss rapidly soluble nutrients (a) in Bracharia and Rhodes grasses and the greater (P<0.05) potential and effective degradability for dry matter (DM) and crude protein (CP) were observed in desho grass compared with the other grasses. The content of crude protein, relative feed value, washing loss or rapidly soluble nutrients (a) and potential DM degradability were higher (P<0.05) in Sesbania than Pigeon pea and tree lucerne browse trees. *Acacia nilotica* and Wanza (*Cordia African*) had the greater (P<0.05) washes loss (a), potential and effective degradability for dry matter and crude protein than the other browse trees. Cactus (*Cleistocactus sextoianus*) and Shola *(Ficus sure)* had the highest (P<0.05) undegradable protein than *Acacia nilotica* and Wanza (*Cordia african*). The energy source feed (maize bran) had the greater (P<0.05) potential and effective dry matter and crude protein degradability parameters than the other by products. The rumen undegradable protein was higher (P<0.05) in vetch than lablab. The rumen undegradable protein was higher (P<0.05) in Rhodes grass than the other forage grasses. Brewery spent grain and cotton seed cake have the higher (P<0.05) rumen undegradable protein than Noug seed *(Guizotia abyssinica)* cake, wheat and maize bran. The *in situ* dry matter and crude protein degradability values obtained in this study can be useful to identifying the best materials used for ruminant feeds.

Keywords: By-products, Dry matter, Forage, Rumen degradability, Bulls.

INTRODUCTION

The majority of ruminant animals in tropical Africa are raised on natural pastures which drop rapidly in quality (Smith et al., 1991; Amole et al., 2021). Many systems have been developed to predict the quality of forages fed to ruminants (Moore, 1994; Tedeschi et al., 2019; da Cruz et al., 2021). To parameterize the relative feed value system, the National Forage Testing Association selected equations that relate forage neutral detergent fiber and acid detergent fiber to dry matter intake and digestible dry matter with a base daily dry matter intake (DDMI) of 1.29% of daily body weight (Linn and Martin, 1989). Fluctuations in nutritional values result in very irregular growth and marked fluctuations in seasonal weights (Wilson, 1987). From understanding, and to a lesser amount from the extension of research results, small-scale farmers are increasingly relying on browse and by-products to supplement roadside grazing during the dry season (Odunlami, 1988; Duguma, 2020). Others animal feeds had poor degradability so that they may require some improvement before they can contribute to animal feed (Smith et al., 1988; Salami et al., 2019). This study was considered to evaluate the potential nutritive value of different animal feeds including forage, browse trees, and by-products commonly fed by ruminant animals.

MATERIALS AND METHODS

Study site and feed samples

The study was conducted at Holetta agricultural research center in animal nutrition research laboratory. The feeds including grass, legumes, browse trees, and agro industrial by products (protein and energy source concentrate feeds) were used for this study. The browse and agro industrial by-products animal feed samples were collected during the low rainy season while grasses and legumes forage feed samples were harvested and collected during the rainy season.

Chemical analysis

The green and fresh samples including grass and legume forages, browse trees and brewery spent grain were dried at 60 °C for 72 h and ground to pass through 1mm sieve size. The feed samples and residues after *In situ* dry matter degradability were analyzed through a standard procedure of AOAC (2005), this was used for dry matter, crude protein and ash content determination. The fiber fractions (neutral detergent fiber, acid detergent fiber and lignin) were analyzed by using the standard procedures (Van Soest and Robertson, 1985). Two-stage technique (Tilley and Terry, 1963) was employed to analyze *in vitro* digestibility dry matter the feed.

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In situ dry matter and crude protein degradability

The rumen degradability of the feeds was evaluated through (Orskov, 1982) procedure. All fee samples were ground to pass through 2mm sieve size. Duplicated feed samples were weighted (3 g) in a 6.5 × 14 cm nylon bag (50 μm pore size) and incubated in the rumens of three fistulated Boran × Holstein-Friesian bulls. The average body weight and age of experimental bulls were 580 kg and 29±3 months, respectively. The bulls were fed natural pasture hay (5.6% CP) *ad libitum* and about 2 kg concentrate feed (19.86% CP) bull^{-1} day^{-1} on dry mater basis. The bulls were offered the concentrate feed at every morning of 8 A.M. The bulls were housed in individual pens and provided water *ad libitum.* The bags with feed samples were incubated for 6, 12, 24, 48, 72, and 96 h. After removing the bag from rumen, it was washed in running water. Washing losses were determined in duplicate by weighing nylon bags with 3 g feed and then soaked in a tap water for about 30 minutes. The nylon bags were dried in oven at 60°c for 72h and then weighed to determine the dry weight of the residues. Based on the following formula dry matter degradability was determined.

Dry matter degradability was calculated by $= \frac{((BW+S1)-(BW+RW))}{S1*DM} * 100$

Where: BW = Bag weight, RW = Residue weight, S1 = Sample weight, DM = Absolute dry matter of the original sample

Degradability (Y) of DM/CP was calculated by using the following equation

$Y = P = a + b\ (1 - e^{-ct})$, where:

a = soluble fraction

b = insoluble but potentially degradable fraction

c = degradation rate constant of the b fraction

t = degradation time (0, 6, 12, 24, 48, 72, and 96 h) and e = base for natural logarithm

Statistical analysis

The degradability parameters (a, b, and c) were estimated by using the general linear model procedures of statistical analysis, version 9.3 (Guide, 2010). Mean separation test was made using least significant differences analysis at $P \leq 0.05$. The linear model used was: $Y_{ij} = \mu + F_i + e_{ij}$

where: Y_{ij} = response variable, μ = Overall mean, F_i = ith feed effect and e_{ij} = residual error.

Potential degradability (PD) for DM and CP was determined by the equation: PD = a + b,

Effective degradability (ED) for DM and CP was calculated through, ED = a + bc/k + c where: a = soluble fraction b = insoluble but potentially degradable fraction c = degradation rate constant of the b fraction k = rumen outflow rate (assumed to be 0.03/h). The effective degradability crude protein is similar to rumen degradable protein (RDP). The rumen undegradable protein (RUP) of each the sample was calculated as: RUP = 100 - RDP

RESULT AND DISCUSSION

Nutrient content and Relative feed value

The mean nutrient content of different animal feeds is presented Table (1). The higher ($P<0.05$) relative feed value and net energy content were obtained in Bracharia and Rhodes grasses compared with the other grasses. The lower ($P<0.05$) crude protein content was recorded in Bracharia grass than the other grass. Sesbania had the greater ($P < 0.05$) crude protein, relative feed value and net energy than the pigeon pea and tree lucerne browse forages. Vetch had a better ($P<0.05$) nutritional value than lablab. As compared with the other browse species, the higher ($P<0.05$) crude protein content and the better ($P<0.05$) relative feed value were observed in Wanza (*Cordia africana)* and cactus (*Cleistocactus sextoianus)*, respectively. Agam (*Carissa spinarum* L.) had the higher (*P*<0.05) net energy than Wanza (*Cordia africana)* and cactus (*Cleistocactus sextoianus*, but non-significantly different (*P* >0.05) with *Acacia nilotica*. Among concentrate feeds, Noug seed cake had the greater ($p < 0.05$) crude protein content and relative feed value than the other concentrate feeds.

Digestibility and fiber component

The average fiber fractions, digestibility and dry matter intake of grass and legume forages, browse species and agro industrial by product feed is presented in Table 2. The elephant grasses had the greater ($P<0.05$) acid detergent fiber (ADF), Acid detergent lignin (ADL) and Neutral detergent fiber (NDF) content than the other grasses. The *in vitro* dry matter digestibility, the calculated total digestible nutrient and dry matter intake were better ($P< 0.05$) in Bracharia and Rhodes grasses than elephant and desho grasses. Moreover, Rhodes grass had the higher ($P< 0.05$) dryb matter intake than desho grass. Sesbania had the lower ($P<0.05$) fiber fractions (ADF and NDF) compared with Pigeon pea and Tree lucerne browse legumes. Vetch had a better ($P<0.05$) *in vitro* dry matter digestibility and dry matter intake than lablab As compared with the other browse species, the least ($P<0.05$) fiber components in cactus (*Cleistocactus sextoianus* and the greater ($P<0.05$) total digestible nutrient in *Acacia nilotica* and Agam (*Carissa spinarum* L.) were reported in this finding. The higher ($P<0.05$) neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) content were reported in brewery spent grain and cotton seed cake than the other agro industrial by products. Noug (*Guizotia abyssinica*) seed cake and wheat bran have the greater ($P<0.05$) *in vitro* dry matter digestibility, calculated total digestible nutrient and dry matter intake compared with the other agro industrial by products.

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Table 1 - Nutrient content and relative feed value of grass and legume forages, browse species and by product feeds

Feeds		Nutrient Parameters (%, DM basis)				
		DM	Ash	CP	RFV	NE1 (Mcal Kg^{-1})
Forage Grasses	Bracharia grass	92.92^{a}	8.92^{b}	7.35^{b}	90.19^{a}	1.45^{a}
	Desho grass	90.82^{d}	13.06^{a}	9.85^{a}	81.62^{b}	1.30^{b}
	Elephant grass	91.53^{b}	11.74^{a}	8.78^{a}	74.36^{c}	1.24^{c}
	Rhodes grass	91.16^{c}	12.66^{a}	9.96^{a}	92.37^{a}	1.45^{a}
	SE	0.09	0.51	0.35	1.07	0.01
	CV	0.19	8.80	8.01	2.54	1.94
	LSD	0.28	1.63	1.12	3.44	0.04
Browse Legumes	Pigeon pea	92.58	13.39^{a}	20.55^{c}	108.01^{b}	1.33^{b}
	Sesbania	91.96	10.14^{b}	30.81^{a}	224.02^{a}	1.67^{a}
	Tree lucerne	91.20	5.56^{c}	25.55^{b}	100.19^{b}	1.40^{b}
	SE	0.21	1.13	0.53	17.74	0.05
	CV	0.43	7.91	3.92	24.16	5.90
	LSD	0.51	0.67	0.45	3.24	0.01
Forage Legumes	Vetch	93.16^{a}	14.57	28.35^{a}	116.52^{b}	1.41
	Lablab	91.10^{b}	14.28	22.55^{b}	120.58^{a}	1.40
	SE	0.21	1.13	0.53	17.74	0.05
	CV	0.43	7.91	3.92	24.16	5.90
	LSD	0.51	0.67	0.45	3.24	0.01
Browse Trees	*Acacia nilotica*	90.63^{bc}	2.25^{e}	14.78^{b}	188.03^{b}	1.89^{ab}
	Agam (*Carissa spinarum* L.)	90.20^{c}	8.75^{d}	8.34^{c}	167.53^{bc}	1.90^{a}
	Cactus (*Cleistocactus sextoianus*)	91.00^{b}	19.72^{a}	8.92^{c}	359.46^{a}	1.86^{b}
	Wanza (*Cordia african*)	93.23^{a}	11.84^{b}	22.83^{a}	191.70^{b}	1.64^{c}
	Shola (*Ficus sure*)	93.37^{a}	10.15^{c}	15.85^{b}	142.33^{c}	1.63^{c}
	SE	0.16	0.30	0.45	9.54	0.01
	CV	0.31	4.87	5.45	7.88	1.07
	LSD	0.53	0.97	0.59	31.12	0.4
By products	Brewery grain	23.17^{b}	4.23^{c}	25.43^{c}	96.77^{d}	1.57^{c}
	Cotton seed cake	90.55^{a}	4.99^{b}	29.51^{b}	117.82^{c}	1.34^{d}
	Maize Bran	91.31^{a}	5.39^{b}	11.06^{e}	192.05^{b}	1.99^{a}
	Noug seed cake	91.31^{a}	8.04^{a}	34.08^{a}	280.71^{a}	1.87^{b}
	Wheat bran	90.6^{a}	4.00^{c}	16.60^{d}	206.66^{b}	2.01^{a}
	SE	0.77	0.16	0.44	4.96	0.03
	CV	1.73	5.26	3.18	4.81	2.51
	LSD	2.52	0.53	1.45	16.18	0.08

Mean values in the columns without common superscripts are significantly different at (P<0.05), DM= dry matter, CP = Crude protein, RFV =Relative feed value, NE = Net energy, SE= standard error, CV= coefficient variation and LSD =least significance differences

Table 2 - Means of fiber fraction, digestibility (%, DM basis) and dry matter intake (g Kg^{-1} of body weight) of forages browse and by product feeds

Feeds		Fiber fractions and other components (%, DM basis)					
		ADF	ADL	NDF	IVDMD	TDN	DMI
Forage Grasses	Bracharia grass	32.34^{c}	3.88^{c}	65.71^{bc}	62.26^{a}	59.61^{a}	18.3^{ab}
	Desho grass	38.39^{b}	4.76^{b}	67.26^{b}	63.08^{a}	51.79^{b}	17.8^{b}
	Elephant grass	40.72^{a}	5.17^{a}	71.54^{a}	46.72^{c}	48.79^{c}	16.8^{c}
	Rhodes grass	32.59^{c}	4.11^{c}	63.96^{c}	51.35^{b}	59.29^{a}	18.8^{a}
	SE	0.50	0.13	0.66	1.17	0.64	1.23
	CV	2.76	5.69	1.98	4.22	2.34	1.99
	LSD	1.59	0.41	2.12	3.77	2.05	0.5
Browse Legumes	Pigeon pea	36.96^{a}	8.32	51.77^{a}	55.28^{c}	53.63^{b}	23.2^{b}
	Sesbania	24.11^{b}	7.16	31.32^{b}	66.27^{a}	70.23^{a}	40.7^{a}
	Tree lucerne	34.37^{a}	8.01	57.70^{a}	61.64^{b}	56.97^{b}	20.8^{b}
	SE	1.64	0.37	2.87	1.10	2.13	2.62
	CV	9.23	10.44	11.45	3.53	7.06	18.59
	LSD	1.45	0.32	1.23	2.14	4.67	5.67
Forage Legumes	Vetch	34.09	6.78	49.90^{a}	58.06^{b}	57.34	24.1
	Lablab	34.54	7.07	47.86^{b}	61.40^{a}	56.76	25.1
	SE	1.64	0.37	2.87	1.10	2.13	2.62
	CV	9.23	10.44	11.45	3.53	7.06	18.59
	LSD	1.45	0.32	1.23	2.14	4.67	5.67
Browse Trees	*Acacia nilotica*	17.30^{bc}	9.69^{a}	37.32^{c}	58.20^{a}	79.02^{ab}	32.1^{bc}
	Agam (*Carissa spinarum* L.)	16.57^{c}	10.67^{a}	42.20^{b}	50.75^{c}	79.96^{a}	28.5^{cd}
	Cactus (*Cleistocactus sextoianus*)	18.43^{b}	4.02^{d}	26.40^{e}	53.13^{bc}	77.56^{b}	62.2^{a}
	Wanza (*Cordia african*)	26.71^{a}	8.45^{b}	33.03^{d}	55.59^{b}	66.86^{c}	36.4^{b}
	Shola (*Ficus sure*)	26.72^{a}	6.93^{c}	44.49^{a}	58.43^{a}	66.86^{c}	26.9^{d}
	SE	0.37	0.34	0.60	0.78	0.48	1.44
	CV	3.05	7.33	2.93	2.45	1.12	6.68
	LSD	1.21	0.34	1.45	1.11	1.57	4.68
By products	Brewery grain	27.93^{b}	6.43^{a}	64.63^{a}	63.10^{c}	65.29^{c}	18.57^{d}
	Cotton seed cake	36.72^{a}	6.05^{a}	47.65^{b}	51.35^{d}	53.94^{d}	25.20^{c}
	Maize Bran	12.12^{d}	3.16^{b}	38.50^{c}	76.19^{b}	85.73^{a}	31.17^{b}
	Noug seed cake	16.38^{c}	4.14^{b}	25.26^{d}	79.46^{a}	80.20^{b}	47.57^{a}
	Wheat bran	10.97^{d}	3.16^{b}	36.17^{c}	82.01^{a}	87.18^{a}	33.17^{b}
	SE	1.00	0.33	0.92	0.90	1.29	0.7
	CV	8.33	12.66	3.73	2.20	3.01	3.93
	LSD	3.01	1.10	2.98	2.92	2.52	18.28

Mean values in the columns without common letters are significantly different at (P<0.05), NDF= Neutral detergent fiber, ADF= Acid detergent fiber, ADL= Acid detergent lignin, IVDMD=Invitro dry matter digestibility, TDN= Total digestible nutrient, DMI= dry matter intake, SE= standard error, CV= coefficient variation and LSD =least significance differences.

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Dry matter degradability

The mean dry matter degradability of different grass, legume, browse species and agro industrial by product feeds is presented in Table 3. The washing loss (a) was higher (P<0.05) in Bracharia and Rhodes grasses than the other grasses but the higher (P<0.05) potential and effective DM degradability was observed in desho grass compared to other grasses. As compared with the other browse legumes, the lower (P<0.05) washing loss and the higher potential and effective DM degradability (P<0.05) were recorded in Pigeon pea and tree lucerne, respectively. Sesbania had the higher potential DM degradability while Pigeon pea and tree lucerne had the lowest values, meaning that the amount of dissolved material in Sesbania was the highest. *Acacia nilotica* and Wanza (*Cordia africana*) browses have the higher (P<0.05) washes loss, potential and effective degradability than the other browse species. Among concentrate feeds, maize bran and wheat bran had he superior (P<0.05) water wash fraction, potential and effective dry matter degradability than the other concentrate feeds.

Table 3 - Ruminal dry matter degradation kinetics of different animal feeds

Feeds		Parameters (%, DM basis)				
		a	b	c	PD	ED
Forage Grasses	Bracharia grass	10.41^{a}	45.55^{b}	0.030^{bc}	55.96^{b}	33.38^{b}
	Desho grass	7.73^{b}	56.83^{a}	0.037^{ba}	64.56^{a}	38.97^{a}
	Elephant grass	7.22^{b}	44.25^{b}	0.038^{a}	51.47^{c}	32.03^{b}
	Rhodes grass	9.64^{a}	40.77^{c}	0.028^{c}	50.42^{c}	29.45^{c}
Browse Legumes	Pigeon pea	8.20^{c}	31.46^{c}	0.06^{b}	39.66^{b}	28.91^{b}
	Sesbania	21.19^{a}	46.58^{b}	0.07^{b}	67.77^{a}	52.62^{b}
	Tree lucerne	10.39^{b}	56.06^{a}	0.10^{a}	66.45^{a}	53.48^{a}
Forage Legumes	Vetch	25.07^{a}	35.79^{b}	0.08^{b}	60.86^{b}	51.13^{b}
	Lablab	21.41^{b}	52.53^{a}	0.13^{a}	73.93^{a}	63.87^{a}
Browse Trees	*Acacia nilotica*	9.15^{a}	75.70^{a}	0.05^{b}	84.85^{a}	57.00^{a}
	Agam (*Carissa spinarum* L.)	9.69^{b}	53.16^{cd}	0.07^{a}	62.84^{c}	46.40^{b}
	Cactus (*Cleistocactus sextoianus)*	8.82^{b}	50.52^{d}	0.05^{b}	59.35^{d}	41.39^{c}
	Wanza (*Cordia africana*)	11.96^{a}	61.16^{b}	0.04^{c}	73.12^{b}	47.44^{b}
	Shola (*Ficus sure)*	8.58^{b}	55.54^{c}	0.04^{c}	64.12^{c}	41.43^{c}
By products	Brewery grain	8.82^{e}	60.05^{c}	0.07^{b}	67.87^{d}	42.96^{e}
	Noug seed cake	9.27^{d}	64.18^{b}	0.24^{a}	73.45^{bc}	66.10^{c}
	Cotton seed cake	14.94^{c}	56.55^{c}	0.03^{b}	71.49^{c}	43.57^{d}
	Wheat bran	21.05^{b}	54.11^{c}	0.27^{a}	75.16^{b}	69.60^{b}
	Maize bran	26.64^{a}	70.66^{a}	0.07^{b}	97.30^{a}	75.02^{a}

Mean values in the columns without common superscripts are different at (P<0.05): a = soluble fraction, b = insoluble but potentially degradable fraction c = degradation rate constant of the b fraction, PD= Potential degradability and ED= Effective degradability (at 0.02)

Crude protein degradability

The average crude protein degradability of grass and legume forages, browse species and by product feeds was significantly affected by type and is presented in Table 4. The washing loss fraction (a) of crude protein was higher (P<0.05) in Bracharia and Rhodes grasses than the other grasses but the upper (P<0.05) potential and effective degradability of crude protein was observed in desho and Bracharia grasses. The desho and elephant grass have a smaller soluble CP fraction than Bracharia and Rhodes grasses. The rumen undegradable protein was better (P<0.05) in vetch (30.4%) than lablab (24.98%) forage. The rumen undegradable protein of Pigeon pea and Sesbania was increased by 23-26% than the rumen undegradable protein of tree lucerne. *Acacia nilotica* and Wanza (*Cordia africana*) browse species had the higher (P<0.05) crude protein potential and effective degradability than the other browse species. The maize bran and wheat bran had the greater (P<0.05) soluble nutrient fraction, potential and effective crude protein degradability than the other concentrate feeds.

In line with earlier finding by Hadjipanayiotou and Economides (2001) vetch had the highest CP content (28.35% DM basis) whereas the CP content of lablab relatively closes (22.55% DM basis). The low digestibility and dry matter intake of the feed could be attributed by the higher fiber components which might be limited a microbial access to digest feed and fiber content. The small amount of soluble DM fraction in desho and elephant grass is supported with the previous result of Kabi et al. (2005). The Sesbania browse have the greater potential dry matter degradability value while Pigeon pea and tree lucerne had the lowest values, meaning that the amount of dissolved material and the degradable components in Sesbania was the highest but this value is relatively lower as compared with the other report (Rahmat and Permana, 2021), the potential and effective dry matter degradability of vetch in this study is comparable with the previous study (Hadjipanayiotou and Economides, 2001). The potential and effective degradability of DM and CP in *Acacia nilotica* and Wanza (*Cordia africana*) browse species in this study in agreement with the previous report (Rahmat and Permana, 2021). In this study desho and elephant grass have a smaller soluble CP fraction than Bracharia and Rhodes grasses,

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which is comparable with the other finding (Kabi et al., 2005). Comparable potential and effective crude protein degradability in the vetch has been reported in earlier (Hadjipanayiotou and Economides, 2001).

Table 4 - Ruminal crude protein degradation kinetics of different feeds

Feeds		Parameters (%, DM basis)					
		a	b	c	PD	ED	RUP
Forage Grasses	Bracharia grass	5.14^{a}	45.15^{b}	0.031^{b}	50.29^{b}	27.86^{b}	72.14^{b}
	Desho grass	1.04^{b}	56.43^{a}	0.037^{a}	57.47^{a}	32.24^{a}	67.76^{c}
	Elephant grass	1.72^{b}	44.25^{b}	0.038^{a}	45.97^{c}	26.53^{b}	73.47^{b}
	Rhodes grass	4.14^{a}	40.77^{c}	0.028^{b}	44.92^{c}	23.95^{c}	76.05^{a}
Browse Legumes	Pigeon pea	0.82^{c}	58.05^{b}	0.07^{b}	58.87^{c}	40.96^{c}	59.04^{a}
	Sesbania	14.94^{a}	56.55^{b}	0.03^{b}	71.49^{b}	43.57^{b}	56.43^{a}
	Tree lucerne	9.27^{b}	64.18^{a}	0.24^{a}	73.45^{a}	66.10^{a}	33.90^{b}
Forage Legumes	Vetch	21.05^{b}	54.11^{b}	0.27^{a}	75.16^{b}	69.60^{b}	30.40^{a}
	Lablab	26.64^{a}	70.66^{a}	0.07^{b}	97.30^{a}	75.02^{a}	24.98^{b}
Browse Trees	*Acacia nilotica*	7.23^{b}	75.46^{a}	0.05^{b}	82.69^{a}	54.82^{a}	45.18^{c}
	Agam (*Carissa spinarum* L.)	7.49^{b}	53.16^{cd}	0.07^{a}	60.64^{c}	44.20^{a}	55.80^{b}
	Cactus (*Cleistocactus sextoianus)*	6.62^{b}	50.52^{d}	0.05^{b}	57.15^{d}	39.19^{c}	60.81^{a}
	Wanza (*Cordia africana*)	9.76^{a}	61.16^{b}	0.04^{c}	70.92^{b}	45.24^{b}	54.76^{b}
	Shola (*Ficus sure)*	6.52^{b}	55.46^{c}	0.04^{c}	61.98^{c}	39.32^{c}	60.68^{a}
By products	Brewery grain	7.38^{d}	41.68^{c}	0.04^{b}	48.08^{e}	29.73^{d}	70.27^{a}
	Noug seed cake	5.33^{c}	58.28^{b}	0.22^{a}	63.60^{c}	56.40^{c}	43.60^{b}
	Cotton seed cake	1.95^{d}	56.08^{b}	0.02^{b}	57.03^{d}	24.20^{d}	75.80^{a}
	Wheat bran	21.06^{b}	52.79^{b}	0.26^{a}	73.85^{b}	68.33^{b}	31.67^{c}
	Maize bran	25.64^{a}	70.66^{a}	0.07^{b}	96.30^{a}	74.02^{a}	25.98^{c}

Mean values in the columns without common superscripts are different at ($P<0.05$: a = soluble fraction, b = insoluble but potentially degradable fraction, c = degradation rate constant of the b fraction, PD= Potential degradability, ED= Effective degradability (at 0.02) and RUP=Rumen undegradable protein

CONCLUSION

In the result of the current study the different grass and legume forages, browse legumes and trees as well as agro industrial by-products have good nutritional value. The *in situ* dry matter degradability and rumen undegradable protein of the studied feeds can be useful to predict the highest materials used for ruminant feeds. Among the studied forage feeds Rhodes grass, Pigeon pea, Sesbania, vetch, cactus (*Cleistocactus sextoianus)* and brewery by products had the higher rumen undegradable protein than the other animal feeds and recommended for ruminant feeds.

DECLARATIONS

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Data availability

The data used to support the findings of this study are available from the corresponding author on reasonable request.

Authors' contributions

Conceptualization, investigation methodology, and writing - original draft was done by G. Terefe; data cleaning and data analysis by SAS software was done by M. Faji; formal analysis and writing, review and editing of the paper was done by G. Mengistu.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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