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Relative palatability and preference of sorghum silage, moringa or sesbania leaf meals by red Maasai sheep

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Abstract
Intake, palatability, and preference of Sorghum silage, Moringa (*Moringa oleifera*) and Sesbania (*Sesbania sesban*) were assessed. Five (5) mature Red Maasai sheep (three females and two males) were used in a Complete Randomized Design. The sheep were kept in separate enclosures measuring 1.5 by 2.5 meters, each featuring a feeding trough separated into three portions. Using the cafeteria feeding strategy, the sheep were offered 500g of sorghum silage and 200g of Moringa or Sesbania leaf meals daily at 8:00 a.m. for a duration of sixty minutes. Feed intake differed significantly (p<0.05). Sorghum silage had the highest feed intake of 271.69 g Kg-1 DM. In terms of preference, Sesbania was the most preferred feed with the highest palatability index of 74.87%. The order of the sheep's relative palatability index, according to the results was Sesbania>Moringa>Silage.

Keywords: Dry matter intake, sheep, silage, legumes, preference, palatability

1. Introduction
Smallholder farmers in Kenya's arid and semi-arid regions (ASALs) experience feed constraints such as inadequate feed quality and quantityIn the dry season, when natural pastures are fully grown and very fibrous, there is less feed available [19]. And are of low nutritive value [14]. Animal performance is low during dry season [5]. The two nutrients most lacking during the dry season are protein and energy, with protein frequently being the most restricting [4, 16]. Thus, it is necessary to search for additional protein sources to augment the poor-quality pasture and crop residues that can be accessible during the dry season. Research has indicated that multifunctional trees, often referred to as leguminous fodder trees, can be utilized as inexpensive protein supplements to enhance the performance of animals fed subpar basal diets [7, 8]. Studies have shown that the leaves of multipurpose trees such as Sesbania and Moringa have high the crude protein (CP) content leaves ranging from 24.0 - 31.9% [13] and 23.0%-30.3% [21] respectively and can be used as cheap protein supplements which can improve the performance of animals fed low quality basal feeds [7, 15].
The quantity of feed consumed in less than 30 minutes is referred to as palatability, whilst the amount of feed consumed more than 24 hours later is referred to as preference. Palatability is influenced by a wide range of animal traits, including overall health, appetite, and the preferences of different forage species [8] as well as environmental influences [6, 2]. Additionally, elements affecting plants' palatability include their level of maturity, stage of growth, chemical composition, morphology, and seasonal availability [3]. The two main indicators for palatability are potential intake rate and relative preference. Level of tenderness affects potential intake rate, while chemical components determine relative preference [20]. This study aimed to assess the choice and palatability of ensiled sorghum, moringa, and sesbania leaf meals in Red Maasai lambs.

2. Materials and Methods
2.1 Study Site
The research was carried out at KALRO Dairy Research Institute Naivasha in Nakuru County. The station is located at latitude 0° N 18° S and longitude 36°W 09°E, 1920m Above Sea Level (ASL).

The area has bimodal rainfall pattern with long rains being experienced from the month of March to June and short rains in the months of October, November and December. Annual rainfall is often below 800mm and unreliable both in quantity and distribution. Temperatures range between 8 to 30 ^{o}C. Soils are deep sandy loam with good water holding capacity with pH range of 5.5 to 6.5.

2.2 Animals, housing and feeding

Five (5) mature Red Maasai sheep (3 females and two males) were used in a Complete Randomized Design. They were kept in separate enclosures measuring 1.5 by 2.5 meters, each with a feeding trough that was partitioned into distinct parts to hold the various test diets. There was an adaptation period of 14 days and data collection period of 14 days. The cafeteria feeding method used for the palatability trial was reported by [11] using Moringa and Sesbania leaf meals. Sorghum silage was used as the basal diet. Each pen was provided with a water container and a wooden feed trough designed in a way that each was partitioned into three compartments to accommodate each of the test legume supplements and silage. Each day at 8:00 am, the sheep were given 200g of Moringa or Sesbania leaf meals and 500g of sorghum silage, with a 60-minute feeding window. To minimize bias resulting from goats' innate preference for one side or habit reflex, the studied native browse species were physically rearranged in the feed troughs every day. Mineral lick and water were provided *ad libitum* throughout the experimental period the rejections were gathered, weighed, and the difference between them was used to calculate intake. Ad libitum supplies of mineral supplement, water, and sorghum silage were provided.

2.3 Data Collection and Measurement

Every day, the difference between the feed served and leftovers were calculated in order to estimate feed intake, which in turn helped forecast palatability. The volume of feed consumed within 30 minutes of the supply and the amount of time the animals spent consuming it were taken into account for determining palatability. Preference was assessed considering the feed intake after 24 hours. For every diet, the amount consumed was divided by the highest number to create a relative palatability index (RPI), which was then multiplied by 100 [1].

$$\text{Relative palatability index} = \frac{\text{Daily feed intake}}{\text{Highest feed intake}} \text{x} 100$$

2.4 Statistical Analysis

Data collected was submitted to the General linear model procedure of the statistical analysis system (SAS, 2002) version 9.0 for analysis of variance (ANOVA) in a completely randomized design (CRD). Least Significant Difference (LSD at $p<0.05$) was used to distinguish treatment means. For statistical analysis, the model that follows was employed:

$$Y_{ijk} = \mu + T_i + \varepsilon_{ijk}$$

where:

Y_{ijk} = dependent variable; μ = overall mean; T_i = i^{th} treatment {T1, T2. T7};

ε_{ijk}= random error term.

Using the Least Significant Difference (LSD) at $p<0.05$, treatment means were separated.

3. Results and Discussion

3.1 Chemical composition

Proximate composition of Sorghum silage, Moringa and Sesbania is presented in Table 1.

The Crude protein (CP) content ranged from 93.76 g Kg^{-1} DM in Sorghum Silage to 288.2 g Kg^{-1} DM in Moringa leaf meal. Crude Fibre (CF) ranged from 100.17 g Kg^{-1} DM in Sesbania leaf meal to 270.8 g Kg-^{1} DM in Sorghum Silage. Nitrogen Free Extract ranged from 283.2 g Kg^{-1} DM in Sorghum Silage to 475.0 g Kg^{-1} DM for Sesbania leaf meal. Ether extract (EE) content was 49.6 g Kg^{-1} DM in SLM, 59.6 g Kg^{-1} DM for Sorghum Silage. Moringa meal had the highest EE of 325.67 g Kg^{-1} DM. Neutral Detergent fibre (NDF) ranged from 148.07 g Kg^{-1} DM in Sesbania meal to 570.3 g Kg^{-1} DM in Sorghum silage. Acid detergent Fibre (ADF) ranged from 99.2 g Kg^{-1} DM to 212.3 g Kg^{-1} DM in Sorghum Silage. Acid detergent lignin ranged from 57.07 g Kg^{-1} DM in Moringa to 245.6 g Kg^{-1} DM in Sorghum Silage. Fibre content was the highest in Sorghum Silage than in the leaf meals. Sesbania leaf meal had the highest amounts of amino acids, Lysine and Methionine than Moringa leaf meal.

Table 1: Chemical composition of Moringa, Sesbania leaf meal and Sorghum silage (g Kg^{-1} DM)

Sample	DM	ASH	CP	EE	CF	NFE	NDF	ADF	ADL	TEPH	TET	CT	Meth	Lys
Moringa meal	907.2a	107.95b	288.2b	325.67a	102.7b	420.7ab	190.7b	99.2b	57.07b	3.628b	2.714b	0.239b	10.89b	10.677b
Sesbania meal	910.0b	908.5c	281.57a	49.6b	100.17b	475.0a	148.07b	101.97b	68.53b	4.241a	3.546a	0.448a	24.07a	21.735a
Sorghum Silage	928.0a	577.7a	93.76b	59.6b	270.8a	283.2b	570.3a	212.3a	245.6a	1.656c	1.158c	0.166c	N/A	N/A
SEM	0.244	1.098	1.403	1.098	0.961	1.048	3.069	3.069	0.994	0.020	0.020	0.0023	0.211	0.174
P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0.0011	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

DM; Dry matter; CP; Crude Protein; EE; Ether Extracts; CF; Crude Fiber; NFE; Nitrogen Free Extract; NDF; Neutral Detergent Fiber; ADF; Acid Detergent Fiber; ADL; Acid Detergent Lignin; TEPH; Total Extractable Phenolic; TET; Total Extractable Tannins, CT; Condensed Tannins. Meth; Methionine; Lys; Lysine; SEM; Standard Error of Mean; abc means values without common superscript differ at $p<0.05$; * 0.05 Significance levels; a, b, c, d, Column means with the different superscript are significantly different ($p<0.05$).

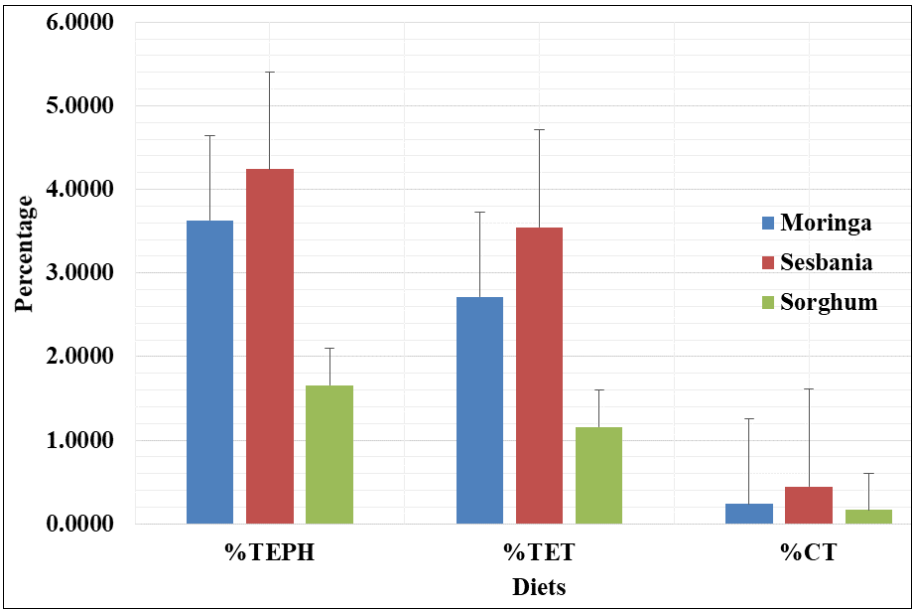

Fig 1: Total extractable phenolic (TEPH), Total Extractable tannins and condensed tannins (CT) contents of Moringa, Sesbania leaf meal and Sorghum silage

Total extractable phenolic (TEPH), Total Extractable tannins and condensed tannins (CT) contents of Moringa, Sesbania leaf meal and Sorghum silage are illustrated in Figure 1

The crude protein (CP) content of Moringa (288.2 g Kg^{-1}) was slightly higher than values got by Muremera *et al*., 2022 (268.0 g Kg^{-1}) but in agreement by studies carried out by [12] who got a CP value of 280 g Kg^{-1}. The crude protein of Sesbania showed a higher value of (281.57 g Kg^{-1}) compared to 236.5 g Kg^{-1} by [10]. According to the study, NDF values for Moringa and Sesbania were 190.7 g Kg^{-1} and 148.07 g Kg^{-1}, respectively. The current study's results for Moringa are close to those from [17], with a value of 55.83, but slightly higher than the results from [10], which had values of 45.27. In this study, sorghum silage had a CP content of 93.76 g Kg^{-1} was higher that results got by [18]. The National Research Council (NRC) states that a CP of greater than 70 g Kg^{-1} DM is the minimum requirement for rumen function, and this value was met by the nutritional qualities of the meals and silage.

Feed Intake

Table 2 shows the feeds' dry matter (DM) consumption, preference, and palatability index during observation. Figure 2 illustrates the feed intake and relative palatability index

Table 2: Feed Intake, Palatability Index and Preference ranking of the three treatments.

Treatment	Feed Intake (gms)	Relative palatability index (%)	Preference ranking
Moringa	147.46^{b}	73.73^{b}	2
Sesbania	149.74^{b}	74.87^{b}	1
Silage	271.69^{a}	54.34^{a}	3
SEM	8.90	2.67	
P	<0.0001	<0.001	

ab A column's means that have different superscripts are substantially different at $p<0.05$.

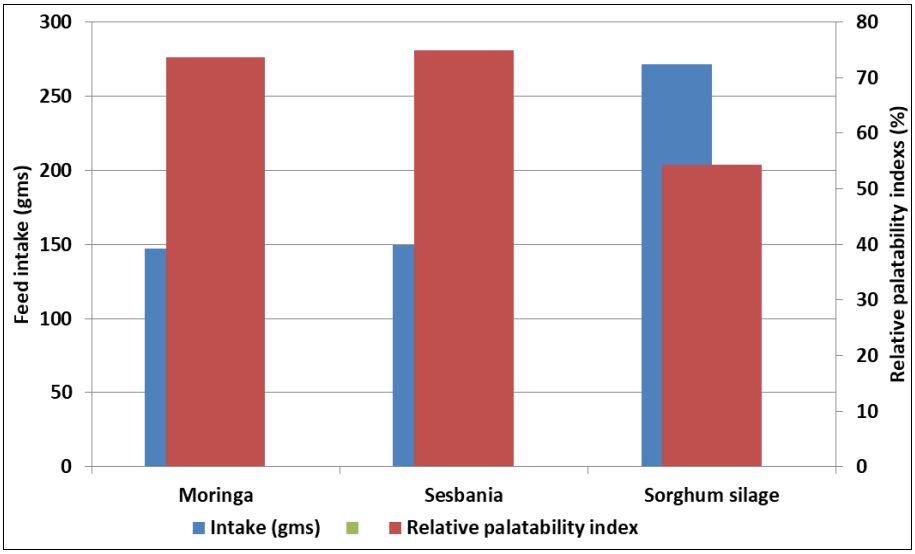

Fig 2: The relative palatability index (RPI) and average daily DM intake (DMI) of the experimental meals

Table 3: Comparison of feed intake between Male and Female sheep

Sex	Feed intake (gms)	Std	Min feed intake (gms)	Max feed (gms)
Male	266.66[a]	97.21	0	500
Female	140.28[b]	135.54	0	500
SEM	8.90			
P	<0.0001			

Note: [ab] at p-value<0.05, means in a column with distinct superscripts differ from one another.

Table 3 indicates the mean of total feed intake by sex of the sheep. Male sheep had a higher feed intake mean as compared to female sheep. There was no difference in the minimum and maximum feed intake between male and female sheep. Table 5 represent the effect of the three feeding pattern on the total feed intake of the three treatments.

Table 4: Feeding Pattern, Intake and Preference Ranking of the Feeding Pattern

Feeding pattern	Feed Intake (gms)	Std	Preference ranking
Mor-Ses-Sil	367.00[a]	96.16	1
Ses-Mor-Sil	294.48[a]	167.81	2
Ses-Sil-Mor	108.00[b]	90.27	3
SEM	32.85		
P	<0.0001		

ab Means with different subscripts in a column differ at (p<0.05). Mor-Ses-Sil, Moringa-Sesbania-Silage; Ses-Mor-Sil, Sesbania-Moringa-Silage; Se-Si-Mor,Sesbania-Silage-Moringa.

In this study, sheep were initially more accustomed to the basal diet than they were to Moringa and Sesbania. According to a study by [8], ruminants' sample unfamiliar feeds cautiously and prefer familiar feeds over new or unexpected ones. This study provided an explanation for this pattern of consumption. In terms of feed intake, preference and palatability, there were marked differences in consumption and it was statistically significant at (p<0.05) that the sheep consumed different quantities of the three feeds offered to them (Table 3). The species that are most palatable are rated first, followed by the least pleasant, based on the relative palatability index and daily intake of DM. Despite having less total extractable phenolics and condensed tannins than Sesbania sesban, Moringa oleifera proved less palatable. This could be due to the high NDF level in Moringa (190.7 g Kg^{-1} DM) compared to Sesbania (148.07 g Kg^{-1} DM). Tannins may affect ruminant feed quality in both favorable and unfavorable ways. They attach to protein (astringency), which lowers the amount of dietary protein that can be digested in the rumen; however, if protein is released after rumination, the effect can be beneficial. Sesbania was ranked the highest in terms of preference followed by Moringa and silage respectively. This could be due to the low NDF value of Sesbania compared to Moringa and silage. In this study, the relative palatability index showed a similar pattern, with Sesbania having a better palatability index than Silage and Moringa due to its low NDF level. This could be explained by the fact that Moringa has a greater NDF concentration than Sesbania. The high NDF level could have lowered the acceptability.

The effect of total feed intake by the sheep based on the feeding pattern used was statistically significant at (p<0.05). This is evident as *Moringa-Sesbania-Silage* feeding pattern had a higher mean of total feed intake consumed by the sheep having a slight difference with *Sesbania-Moringa-Silage* pattern as indicated in the Table 5. *Sesbania-Silage-Moringa* pattern follows respectively having the lowest mean of total feed intake among the three treatments. This may be explained by the fact that Moringa has a higher crude protein content than Sesbania and sorghum silage.

4. Conclusion

At first, sheep ate more of the basal diet since it was more accustomed to it than Moringa and Sesbania. The relative palatability index for the sheep, according to the results, was Sesbania>Moringa>Silage. Sesbania was ranked the highest in terms of preference followed by Moringa and silage respectively.

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6. Conflict of Interest: Not available

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