CHEMICAL COMPOSITION OF SELECTED FORAGES AND THEIR ACCEPTABILITY FOR RABBIT PRODUCTION

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ABSTRACT

Rabbits, if properly harnessed, could address the animal protein shortage in Africa throμgh the use of forage resources, which are richly available and abundant in the tropics. However, information on the potential use of these forages for rabbit production is scanty. Hence, this study examined the chemical composition of some selected forages and their suitability for rabbit production. 10 forages (*Griffonia simplicifolia, Albizia odoratissima, Ficus thonningii, Leucaena leucocephala, Mangifera indica, Moringa oleifera, Gliricidia sepium, Terminalia catappa, Pentaclethara macrophylla, and Dacryodes edulis*) were selected. The forages were subjected to proximate, mineral, and fiber fraction analyses and were screened for phytochemicals. The rabbits were fed using the cafeteria feeding technique, in which forages were presented to 72 rabbits for a period of 10 days to assess the coefficient of preference (CoP). Results showed that *Leucaena leucocephala* had higher ($P<0.05$) crude protein (26.15 %), and *Pentaclethara macrophylla* had higher ($P<0.05$) crude fiber (28.20 %), while *Moringa oleifera* (10.45 %) and *Ficus thonningii* (10.70 %) had higher ash values than other forages. *Albizia odoratissima* had higher ($P<0.05$) calcium level (4.56 cmol/kg) and iron (846.00 μg/dL), *Gliricidia sepium* had higher ($P<0.05$) magnesium (0.84 cmol/kg) and phosphorus (0.50 mg/kg) concentrations, while *Leucaena* had higher ($P<0.05$) zinc (96.20 μg/dL) and manganese (0.08 mg/kg) concentrations than others. Fibre fractions showed that *Griffonia simplicifolia* had higher neutral detergent fibre (58.77 %) and acid detergent fibre (43.18 %) values, while the highest ($P<0.05$) acid detergent lignin value was obtained in *Leucaena leucocephala* (14.39%). Values for phytochemicals (mg/100g) ranged from 0.01 - 0.09 for tannin, 0 - 1.90 for saponin, 1.00 - 2.36 for oxalate, and phytate from 2.01 - 3.33. The average value of CoP obtained for the feeding period showed that *Leucaena leucocephala* (2.12) was the most preferred. It could be concluded that all the forages are potential resources for rabbit production, though *Leucaena leucocephala* was the most preferred by the rabbits.

Keywords: ***Chemical composition; coefficient of preference, Forages, phytonutrients, rabbit production***

INTRODUCTION

Deficiency in animal protein remains a continuous occurrence in the developing countries of Africa (Schonfeldt and Hall, 2012). Several attempts have been made, however, to address this issue. One such attempt is the diversification of efforts from commonly reared species like poultry and ruminants that are more expensive to alternative protein sources (Upton, 2004) like rabbits that are cheaper to produce. Rabbits are a ready alternative source of protein since they are prolific, have a short gestation period, and possess good meat quality (Cullere and Dalle Zotte, 2018). However, there still remain some peculiar challenges that limit rabbit production, especially in Nigeria, one of which is nutrition.

Unlike poultry, the nutrition of the rabbit is a peculiar one as rabbits cannot survive solely on the available high-grain cereals and energy-dense finished feeds in the market; rather, they require a diet rich in crude fibre because of the nature of their digestive

system. These levels of fibre can only be sourced from forages. The rabbit's ability to turn forages into high quality protein is an unequal advantage over other monogastric animals (Abu and Turner, 2017). Of course, the rabbit is an excellent converter of forages, and diverse forage resources are abundant all over the country. There is a need to investigate the potential of available and abundant local forage resources peculiar to our locality for rabbit production. Also, there have been reported cases of selective feeding in rabbits (McNitt *et al.*, 1996; De Blas and Wiseman, 2010; Safwat *et al.*, 2014), thus indicating that all forages may not be acceptable. Therefore, this study was designed to assess the chemical constituents of some commonly available forages and their acceptability by Chinchilla weaner grower rabbits.

MATERIALS AND METHODS

Experimental Sites

The study was carried out at the Central Laboratory, Department of Animal Science, University of Ibadan, Ibadan, Nigeria. The University is located in Ibadan in the tropical rain forest zone within a latitude of 7o 26` north and longitude of 3o 54` east, with a mean altitude of 277 meters above sea level (Ogunwole and Adedeji, 2014).

Experimental Materials

Ten selected forages were sourced from the National Centre for Genetic Resources and Biotechnology (NAGRAB) in Apata, Ibadan, Oyo State, Nigeria. The forages include *Griffonia simplicifolia, Albizia odoratissima, Ficus thonningii, Leucaena leucocephala, Mangifera indica, Moringa oleifera, Gliricidia sepium, Terminalia catappa, Pentaclethara macrophylla, and Dacryodes edulis.*

Proximate, mineral compositions and fibre fractions of selected forages

Proximate, mineral compositions and fibre fractions were carried out according to the protocols of AOAC (2010). The dry matter (DM) of the various samples was determined by weighing 1g each of the ground samples and then oven drying them until constant weights were attained, while moisture content (MC) was calculated as the difference between the initial weight and the final weight. Crude protein was determined according to the Kjedahl method. Crude fat was determined using the soxhlet method, while the ash content was determined by introducing 1g of the samples into the muffle furnace for eight hours at 550°C, and the resultant weight loss was obtained as the ash. Fibre fractions (NDF, ADL, and ADF) were determined according to Van Soest *et al.*, 1991.

Phytochemical analyses of forage samples

The level of oxalates in the samples was determined using the aluminum chloride colorimetric method described by Chang and Minga (2002). Phenols and tannic acids were determined using the Folin-ciocalteu spectrophotometric method (Makkar *et al.* 1993), while saponin and alkaloids were determined using the gravimetric method described by Harbone (2008).

Acceptability of Selected Forages by Growing Rabbits

The 10 forage samples were allocated to 6 groups of 12 rabbits per group and housed in individual compartments on the deep litter for a period of 10 days in a cafeteria feeding method described by Babayemi (2007). Preference for the forages was used to determine the Coefficient of Preference (CoP). The CoP was calculated using the following formula;

$$CoP = \frac{\text{Consumption of individual forages}}{\text{Average consumption of total forages}} \times 100$$

Statistical Analysis

Data were subjected to one-way analysis of variance SAS (2006), and mean differences were separated using Duncan's Multiple Range Test of the same software.

RESULTS

The proximate composition of selected forages for rabbit production is shown in Table 1. The different forages had significantly different (P<0.05) dry matter (DM) values. *Mangifera indica* had the highest (P<0.05) DM value (89.87 %), while *Griffonia simplicifolia* (67.70 %) and *Pentaclethara macrophylla* (68.02 %) had the lowest DM values. *Leucaena leucocephala* had the highest (P<0.05) crude protein (CP) of 26.15 %, while *Griffonia simplicifolia* (9.72 %), *Mangifera indica* (9.70 %), and *Albizia odoratissima* (10.36 %) had similar CP values that were lower (P<0.05) compared to other forages.

A higher (P<0.05) crude protein (22.32 %) was observed for *Moringa oleifera* compared to *Ficus thonningii* (13.10 %), *Gliricidia sepium* (20.12 %), *Terminalia catappa* (12.29 %), *Pentaclethara macrophylla* (11.82 %), and *Dacryodes edulis* (15.59 %). *Pentaclethara macrophylla* had higher (P<0.05) crude fiber (28.20 %) than others, while *Moringa oleifera* had the lowest (P>0.05) crude fiber (5.00 %). The crude fibre of *Mangifera indica* (26.95 %) and *Ficus thonningii* (26.80 %) were comparable (P > 0.05). *Moringa oleifera* (10.45 %) and *Ficus thonningii* (10.70 %) had higher ash values (P<0.05) than other selected forages, while *Griffonia simplicifolia* (4.90 %) had the lowest ash value. The ash values of *Mangifera indica* (7.35 %) and *Gliricidia sepium* (7.65 %) were comparable (P>0.05). When compared to other selected forages, *Terminalia catappa* had the highest crude fat (1.79 %) content (P <0.05), while *Albizia odoratissima* had the lowest (1.37 %) ether extract value.

Table 1: Proximate composition of selected forages available for rabbit production

Parameters (%)	MC	DM	CP	CF	Ash	EE
Grif	32.30a	67.70g	9.72g	22.60c	4.90f	1.53cd
Mang	10.14g	89.87a	9.70g	26.95b	7.35c	1.41ef
Mor	12.75bc	87.24ef	22.32b	15.00g	10.45a	1.41ef
Leu	11.95d	88.04d	26.15a	12.40h	8.35b	1.73b
Ficus	12.46c	87.54e	13.10e	26.80b	10.70a	1.60c
Glir	12.85b	87.14f	20.12c	16.00f	7.65c	1.76ab
Termi	10.88e	89.12c	12.29ef	22.40c	5.55ed	1.79a
Alb	10.37fg	89.62ab	10.36g	21.15d	5.45de	1.37f
Macro	31.99a	68.02g	11.82f	28.20a	5.25e	1.48d

Parameters (%)	MC	DM	CP	CF	Ash	EE
Dacry	10.55ef	89.45b	15.59d	20.20e	6.05d	1.52cd
SEM	0.11	0.11	0.27	0.09	0.18	0.03
P value	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001

abcdefg- Means of treatments along a row with different superscripts differed significantly (P<0.05). Griff- *Griffonia simplicifolia*, Alb- *Albizia odoratissims*, Ficus- *Ficus thonningii*, Leu- *Leucaena leucocephala*, Mang- *Mangifera indica*, Mor- *Moringa oleifera*, Glir- *Gliricidia sepium*, Termi- *Terminalia catappa*, Macro- *Pentaclethara macrophylla*, Dacry- *Dacryodes edulis*, MC-Moisture content, DM- Dry matter, CP-Crude protein, CF-crude fibre, EE- Ether extract, SEM- Standard error of means, P value- Probability

Mineral Composition of Selected Forages Available for Rabbit Nutrition

Table 2 shows the mineral composition of some selected forages for rabbits. Leaves of *Albizia odoratissima* had significantly higher (P<0.05) calcium levels (4.56 cmol/kg) compared with other forages, while the lowest (P<0.05) calcium level (1.28 cmol/kg) was observed in *Ficus thonningii*. However, the calcium values of *Mangifera indica* (2.69 cmol/kg) and *Leucaena leucocephala* (2.63) were comparable (P>0.05). Also, the calcium values of *Moringa oleifera* (2.24 cmol/kg) and *Gliricidia sepium* (2.25 cmol/kg) were similar (P>0.05).

Gliricidia sepium had a higher (P<0.05) magnesium concentration (0.84 cmol/kg) than the others, while *Moringa oleifera* had the lowest. When compared with other selected forages, *Albizia odoratissima* had the highest (P<0.05) iron concentration (846.00 µg/dL), while *Dacryodes edulis* had the lowest (P<0.05) value of 189.00 µg/dL. However, the iron concentrations of *Mangifera indica* (514.80 µg/dL), *Leucaena leucocephala* (504.25 µg/dL), and *Ficus thonningii* (515.50 µg/dL) were all comparable (P>0.05). However, Leucaena had more (P<0.05) zinc concentration (96.20 µg/dL), while *Ficus thonningii* had the lowest. *Gliricidia sepium* had a significantly (P<0.05) higher phosphorus (0.50 mg/kg) value than the other selected forages. However, the lowest phosphorus concentration was found in *Ficus thonningii* (0.08). The highest manganese concentration (92.00 mg/kg) was found in *Leucaena leucocephala*, while the lowest concentration (31.90 mg/kg) was found in *Ficus thonningii*. The manganese content of the leaves of *Mangifera indica* (40.70 mg/kg) and *Moringa oleifera* (41.70 mg/kg) is similar (P>0.05).

Table 2: Mineral composition of selected forages for rabbit production

Parameters	Calcium (cmol/kg)	Magnesium (cmol/kg)	Iron (µg/dL)	Zinc (µg/dL)	Phosphorus (mg/kg)	Manganese (mg/kg)
Griff	3.00d	0.48f	494.00g	55.60c	0.11f	67.80c
Mang	2.69e	0.52e	514.80e	41.88e	0.33b	40.70f
Moringa	2.24f	0.38h	632.50d	16.95h	0.12f	41.70f
Leu	2.63e	0.66b	504.25e	96.20a	0.19e	92.00a
Ficus	1.28g	0.15i	515.50e	15.55i	0.08g	31.90h
Gliri	2.25f	0.84a	826.50b	37.30f	0.50a	84.70b
Termi	3.32b	0.62c	802.00c	54.87c	0.29c	56.70e

Parameters	Calcium (cmol/kg)	Magnesium (cmol/kg)	Iron (µg/dL)	Zinc (µg/dL)	Phosphorus (mg/kg)	Manganese (mg/kg)
Alb	4.56a	0.47f	846.00a	51.70d	0.26cd	83.75b
Macro	3.09cd	0.41g	337.00h	23.45g	0.14f	35.30g
Dacry	3.16c	0.60d	189.00i	69.67b	0.23ed	63.80d
SEM	0.04	2.74	1.72	0.24	0.01	0.40
P value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

abcdefg- Means of treatments along a row with different superscripts differed significantly (P<0.05). Griff- *Griffonia simplicifolia*, Alb- *Albizia odoratissims*, Ficus- *Ficus thonningii*, Leu- *Leucaena leucocephala*, Mang- *Mangifera indica*, Mor- *Moringa oleifera*, Glir- *Gliricidia sepium*, Termi- *Terminalia catappa*, Macro- *Pentaclethara macrophylla*, Dacry- *Dacryodes edulis*, SEM- Standard error of means, P value- Probability.

Fibre Fractions of Selected Forages

The fibre fractions of selected forages for rabbit production are shown in Table 3. *Griffonia simplicifolia* had a significantly higher NDF (58.77 %) compared to other selected forages, whereas *Dacryodes edulis* had the lowest (47.19 %). *Gliricidia sepium*, *Terminalia catappa*, and *Albizia odoratissims* had comparable (P>0.05) NDF of 53.88 %, 53.26 %, and 52.80 %, respectively. The ADF value of *Griffonia simplicifolia* (43.18 %) was higher (P<0.05) than values for other forages. *Dacryodes edulis*, had the lowest ADF value (27.89 %) while the ADF values of *Mangifera indica* (35.69 %) and *Moringa oleifera (36.04 %) were found to be comparable* (P>0.05), likewise the ADF values of *Leucaena leucocephala* (38.32 %) and *Ficus thonningii* (37.91 %). The highest (P<0.05) ADL value was obtained in *Leucaena leucocephala* (14.39), though it was not different (P>0.05) from *Griffonia simplicifolia* (14.12 %), *Mangifera indica* (12.91 %), *Moringa oleifera* (13.38 %), *Ficus thonningii* (13.97 %), *Gliricidia sepium* (11.66 %) and *Terminalia catappa* (11.68 %). *Pentaclethara macrophylla* and *Dacryodes edulis* had the lowest ADL values of 7.89 % and 7.17 %, respectively.

Table 3: Fibre fractions of selected forages available for rabbit production

Parameters (%)	NDF	ADF	ADL
Grif	58.77a	43.18a	14.12ab
Mang	57.84ab	35.69c	12.91ab
Mor	57.66b	36.04c	13.38ab
Leu	55.81c	38.32b	14.39a
Ficus	54.78cd	37.91b	13.97ab
Glir	53.88de	32.47d	11.66ab
Termi	53.26e	32.18de	11.68ab
Alb	52.80e	31.73e	11.34b
Macro	48.57f	29.19f	7.89c
Dacry	47.19g	27.89g	7.17c
SEM	0.34	0.21	0.82

Parameters (%)	NDF	ADF	ADL
P value	<0.0001	<0.0001	0.0008

abcdefg Means with similar superscripts along a row are significantly the same (P<0.05). Griff- *Griffonia simplicifolia*, Alb- *Albizia odoratissims*, Ficus- *Ficus thonningii*, Leu- *Leucaena leucocephala*, Mang- *Mangifera indica*, Mor- *Moringa oleifera*, Glir- *Gliricidia sepium*, Termi- *Terminalia catappa*, Macro- *Pentaclethara macrophylla*, Dacry- *Dacryodes edulis*, SEM- Standard error of means, P value- Probability

Phytochemicals Present in Selected Forages

Table 4 shows the phytochemical composition of selected forages. Values for phytochemicals ranged from 0.013 to 0.099 mg/100g for tannin, 0.00 to 1.90 mg/100g for saponin, 1.00 to 2.36 mg/100g for oxalate, and phytate from 2.01 to 3.33 mg/100g. Compared to other forage samples, the concentration of tannin in *Terminalia catappa* (0.099 mg/100g) was higher (P<0.05). But, *Ficus thonningii* had the least (P<0.05) tannin concentration (0.006 mg/100g). Saponin levels were lowest (P<0.05) in *Ficus thonningii* (0.00 mg/100g) with no observable count, but highest in *Mangifera indica* (1.90 mg/100g). *Dacryodes edulis* had the highest (P<0.05) oxalate value (2.63 mg/100g), whereas *Ficus thonningii* had the least (1.00 mg/100g) compared to other forages. Also, *Dacryodes edulis* leaves had more phytate (3.52 mg/100g) compared to other forages, while phytate levels of *Ficus thonningii* (2.03 mg/100g) and *Terminalia catappa* (2.01 mg/100g) were the lowest.

Table 4: Composition of phytochemicals present in selected forages for rabbit production

Parameters (mg/100g)	Tannin	Saponin	Oxalate	Phytate
Griff	0.038c	1.05d	2.36b	3.33b
Mang	0.067b	1.90a	2.14c	3.26c
Mor	0.042c	0.01hi	1.44f	2.70g
Leu	0.062b	0.03g	1.71e	2.79f
Ficus	0.006f	0.00i	1.00h	2.03i
Glir	0.013e	0.02h	1.80d	2.36h
Termi	0.099a	0.69f	1.74e	2.01i
Alb	0.043c	1.57b	1.15g	2.94e
Macro	0.027d	1.02e	2.14c	3.11d
Dacry	0.097a	1.10c	2.63a	3.52a
SEM	0.0016	0.003	0.02	0.006
P value	<.0001	<.0001	<.0001	<.0001

abcdefg Means with similar superscripts along a row are significantly the same (P<0.05). Griff- *Griffonia simplicifolia*, Alb- *Albizia odoratissims*, Ficus- *Ficus thonningii*, Leu- *Leucaena leucocephala*, Mang- *Mangifera indica*, Mor- *Moringa oleifera*, Glir- *Gliricidia sepium*, Termi- *Terminalia catappa*, Macro- *Pentaclethara macrophylla*, Dacry- *Dacryodes edulis*, SEM- Standard error of means, P value- Probability

Acceptability Test of the Different Forages by the Rabbits

Table 5 shows the acceptability coefficient of rabbits fed different forages. The highest dry matter intake was obtained in *Leucaena leucocephala* at week 10 of feeding, while the least dry matter intake was recorded in *Gliricidia sepium* and *Dacryodes edulis* at week 2 and *Pentaclethara macrophylla* at week 6. Also, the highest dry matter intake was observed at weeks 8 and 10 for the forages. The coefficient of preference was consistently higher in Leucaena for the 10 weeks except for the slight decrease that was observed in week 8. The value, however, for leucaena ranged from 1.31 to 2.49. Similar to DM intake, the CoP recorded for *Glyricida sepium* and *Dacryodes edulis* at week 2 and *Pentaclethara macrophylla* at week 6 was 0. The highest CoP (0.91) was recorded at week 8 for *Griffonia simplicifolia*, 1.81 at week 6 for *Mangifera indica*, 1.58 at week 4 for *Moringa oleifera*, 2.49 at week 10 for *Leucaena leucocephala*, 2.35 at week 10 for *Ficus thonningii*, 1.48 at week 10 for *Gliricidia sepium*, 0.9 at week 6 for *Terminalia catapa*, 1.64 at week 1 *for Albizia odoratissims*, 0.81 at week 8 for *Pentaclethara macrophylla* and *Dacryodes edulis*.

The average CoP for the feeding period in Table 5 shows that *Leucaena leucocephala* had the highest CoP (2.12) while the least was *Dacryodes edulis* (0.25). The result from the pooled CoP for all selected forages, as shown in Figure 4.1 and the average CoP in Table 5 showed that *Leucaena leucocephala*, *Ficus thonningii*, *Albizia odoratissims*, *Moringa oleifera*, and *Mangifera indica*, in that order, had the highest CoP and thus were the five most preferred by the rabbits.

Table 5: Acceptability coefficient of rabbits fed different selected forages

Forages	Acceptability (Days)										Mean
	2		4		6		8		10		
	DMI (g)	COP	DMI (g)	COP	DMI (g)	COP	DMI (g)	COP	DMI (g)	COP	
Grif	54.00	0.58	25.00	0.45	31.00	0.37	113.00	0.91	51.00	0.51	0.57
Mang	97.00	1.05	100.00	1.48	151.00	1.81	98.00	0.80	58.00	0.57	1.14
Mor	102.00	1.10	112.00	1.58	102.00	1.22	102.00	0.82	121.00	1.21	1.19
Leu	219.00	2.35	148.00	2.03	201.00	2.41	163.00	1.31	251.00	2.49	2.12
Ficus	163.00	1.76	106.00	1.45	98.00	1.18	178.00	1.44	231.00	2.35	1.64
Glir	0.00	0	25.00	0.45	52.00	0.62	151.00	1.21	149.00	1.48	0.75
Termi	57.00	0.61	35.00	0.47	75.00	0.90	57.00	0.50	12.00	0.12	0.52
Alb	152.00	1.64	73.00	1.0	95.00	1.14	178.00	1.44	113.00	1.12	1.27
Penta	52.00	0.56	58.00	0.79	-	-	101.00	0.81	9.00	0.09	0.45
Dacry	-	-	8	0.11	28	0.33	100	0.81	7	0.07	0.25

Griff- *Griffonia simplicifolia*, Alb- *Albizia odoratissims*, Ficus- *Ficus thonningii*, Leu- *Leucaena leucocephala*, Mang- *Mangifera indica*, Mor- *Moringa oleifera*, Glir- *Gliricidia sepium*, Termi- *Terminalia catappa*, Penta- *Pentaclethara macrophylla*, Dacry- *Dacryodes edulis*

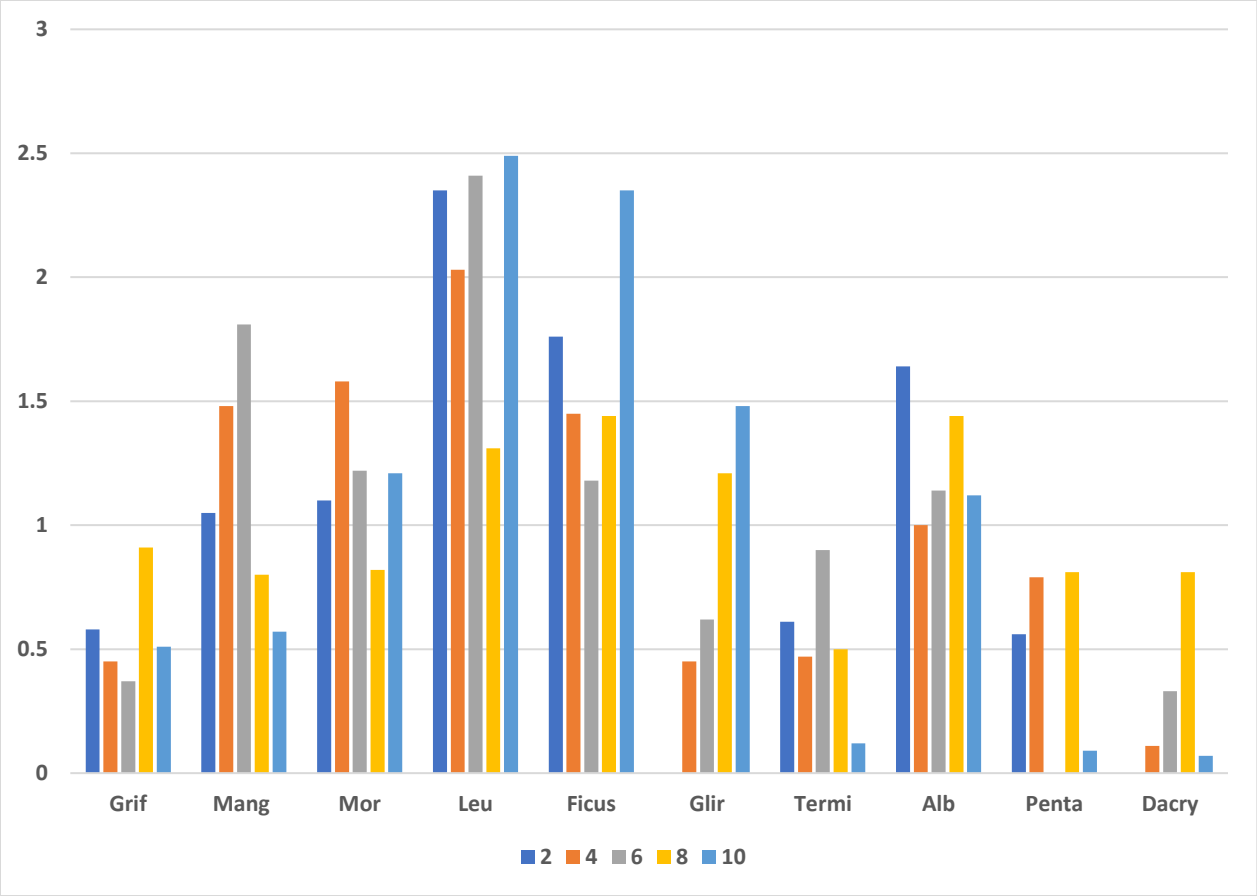

Figure 1: Coefficient of preference by rabbits fed different selected forages for a period of 10 days

DISCUSSION

Chemical composition of selected forages for rabbit feeding

This study showed that two of the forages (*Pentaclethara macrophylla* and *Griffonia simplicifolia*) had lower dry matter (DM) contents compared to others within the 10-13% moisture content range. Forages with lower DM may be useful in silage preparation for livestock use due to their high moisture content. However, the implication of a low DM diet would mean that there will be a need for a higher intake of such forage. This sµggests that animals that are fed on these forages would have to consume more to meet their requirements for CP, energy, minerals, etc. The low DM observed in this study for Griffonia supports the earlier findings of Ogunbosoye and Otukoya (2014) in the evaluation of preference of some browse forages by WAD goats. In the study, the authors reported that Griffonia had a DM of 39.08%, while macrophylla had a DM of 41.6%. Mawussi *et al.* (2022), however, in a study of the forages of the maritime region in Togo, reported a higher DM of 93.2% for Griffonia, while Ogwu *et al.* (2016) reported that *Pentaclethara macrophylla* had a DM of 89.9%. The differences observed could be attributed to differences in the geographical location of these forages.

Crude protein of 18 to 22% has been reported to be optimum for the production of tropical rabbits (Akande, 2015), while CF of 12-14% was reported adequate (Abu and Turner, 2017). The high CP content of Moringa (22.32%) in this study was within the range of 11.7 - 26.5% reported by Abdukadir *et al.* (2016) and 25.1% reported by Gadzirayi *et al.* (2012). While 26.15% recorded for Leucaena in this study was close to 25.57% reported by Aletor and Omodara (1994) in their findings. Similar to what was observed in this study, Castillo *et al.* (1997) noted that *Leucaena leucocephala* forage contained approximately 22.76% crude protein and was superior to other selected forages in their study. As observed, the fibre content in Mango (26.95%), Ficus (26.80%), and Macrophyllus (28.2) are very high. The crude fibre contents for mango and ficus obtained in this study, though lower, were closer to 32.05 and 35.39%, respectively, as reported by Ogunbosoye and Otukoya (2014). The fibre content of Macrophyllus obtained in this study was at variance with 3.15% reported by Ogwu *et al.* (2016) but similar to the value reported by Ogunbosoye and Otukoya (2014).

The value of crude fibre (19.41) obtained for Ficus thonningi by Tegbe *et al.* (2006) was much lower than the values obtained in this study. Atawodi *et al.*, (2008) reported an average ash content of 9.73% in Leucaena. Mawussi *et al.* (2022) reported 7.4 % ash and 4.03 % ether extract contents for Moringa, respectively. The values were different from 10.45% and 1.41%, respectively, observed in this study. Similarly, the ash content and EE content of ficus (17.34% and 5.54%) and Mango (11.29% and 5.84%) reported by Jokthan *et al.* (2003) were higher than 10.7% and 1.60% observed in this study for ficus and 7.35% and 1.41% for mango, respectively. Although the crude fibre of *Griffolia* and Mango was high in this study, they were not the highest. However, they contained a higher component of fibre fractions than the other selected forages. This could be due to their lower DM content compared to the other forages

The wide variability in the composition of nutrients among the forages selected in this study may be as a result of specie differences while variability amidst results in this study and those of other authors could be due to differences in location, season of harvest, age and part of the plants used for the analysis among other factors. The NDF measures the total fibre component of the forage including cellulose, hemicellulose and the lignin fraction as well as determines the ability of animals to experience satiety (Merten, 2009). The ADF, on the other hand, represents the digestible portion of the fibre, and it gives an evaluation of how much energy could be obtained from a plant material, while ADL represents the indigestible portion of the feed. The higher NDF and ADF levels in *Griffolia* as observed in this study suggest that the forage would be able to enhance intestinal fill or fullness and at the same time make available a high amount of nutrients compared to other forages. Ogunbosoye and Otukoya (2014), in their study, observed that Peltophorum pterocarpum and Pterocarpus santalinoides had higher NDF and ADF than over 30 forages evaluated in the study. The NDF and ADF values for *Griffolia* (62.1 and 41.1) obtained in their study were higher than 58.7 and 43.1% for NDF and ADF in this study, though the ADL in their study (12.1%) was lower than 14.1% recorded for *Griffolia* in this study.

Leucaena and *Gliricida* had relatively higher amounts of calcium compared to other selected forages. Minerals are essential for digestion and optimum productivity. The concentrations of Ca, Mg, Fe, Zn, P, and Mn in these three forages differ greatly from what

was reported by previous authors (Anjorin *et al.*, 2010; Asaolu *et al.*, 2011; Aye and Adegun, 2013). The mineral content of *Leucaena* as reported by Thamaga *et al.* (2021) was 1.76 for Ca, 2.65 for Mg, 347.76 for Zn, and 342.56 for Mn. Except for Ca, Mg, and P, which were lower than what was reported by Zapata-Campos *et al.* (2020), other values reported in this study were higher than what they observed. El-Baha (2002) had earlier reported that leaves of *Leucaena leucocephala* contained the most significant level of minerals among forages evaluated in the study. Similarly, the mineral composition of *Gliricidia sepium* in this study was higher than the values reported by Akinsoyinu and Onwuka (1988), except for Mn (80 ppm), which was comparable to the 84 ppm reported in this study. The high degree of variability in the mineral contents reported in this study and those of previous authors may be ascribed to variability due to soil type and geographical locations. El-Baba (2002) also noted that the variability in the mineral composition among forages evaluated was due to differences in planting period, plant species, geological area, and season.

Anti-nutrients in plants are secondary metabolites secreted by plants in the form of defense mechanisms to protect themselves from external threats. All the browse plants evaluated had an appreciable level of phytonutrients present in them. *Dacryodes edulis* seems to have the highest total concentration of phytochemicals present, while ficus appears relatively safer with less concentration. Tannin and saponin concentrations of the *Dacryodes edulis* in this study were lower than 0.47–0.72 and 2.08–3.98mg 100g−1, respectively, as reported by Okwu and Nnamdi (2008). The phytonutrient concentration of various forages evaluated in this study have been documented in literature. Phytochemicals like phenol, flavonoid, and carotenoid have been reported to be present in *T. catappa* (Anand *et al.*, 2015). The presence of squalene, oxalic acid, phytols, essential oils and esters have been demonstrated in Leucaena by other authors (Chen and Wan, 2010; Salem *et al.*, 2011; Zayed and Benedict, 2016).

Bamikole *et al.* (2010) reported that tannin and saponin were abundant in Ficus. The presence of terpenoids, alkaloids, steroids, cardiac glycosides, anthraquinone glycosides, oxalate, and saponin has also been reported (Harbone, 2008; Ogunwande *et al.*, 2008; Ramawat *et al.*, 2009; Usman *et al.*, 2009; Ahur *et al.*, 2010). The presence of these phytochemicals in these plants has been associated with the possession of antimicrobial, antiseptic, hypocholesterolemic, hypo-glycemic, and antibacterial properties, which makes them important in the pharmaceutical industries (Ramawat *et al.* 2009; Zayed and Benedict, 2016).

Acceptability of Selected Forages by Rabbit for Intensive Production

The high CoP (Table 5) and DMI values of Mango, *Moringa*, *Leucaena*, *Ficus*, and *Albizia*, which were consistently higher compared to others, were the basis for the selection of the forages for the feed trial. The high dry matter intake in *Leucaena leucocephala* and *Moringa oleifera* may be associated with their high CP values, which may be a factor in the preference of the rabbits for these forages. The presence of essential oils in Leucaena may also be a factor that attracts the animals to the forage. However, ficus, mango, and albizia had lower CP contents compared to leucaena and moringa; their preference for these forages could probably be explained by the presence of phenols and flavonoids, two sweet aroma compounds which may have attracted the animals. Contrarily, the lowest intake and

CoP recorded in the other forages could be due to a high presence of alkaloids and saponins that are known to possess a bitter taste that may dissuade the rabbits from selecting them. Another possible factor could be that the odour emanating from these forages that are repulsive to the rabbits thereby causing the low interest shown in them.

CONCLUSION

It can be concluded that the selected forages had rich array of chemical constituents adequate to meet the nutrient requirements of the commercial rabbit though *Leucaena leucocephala* was the most preferred by the rabbits.

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