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Acacia Karroo Pods and Leaves as Major Feed for Fattening of Goats

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Abstract

The objective of this study was to assess the effects of using *Acacia karroo* pods and leaves for fattening of goats. The experiment was carried out at a farm in Mashava, an area located in Masvingo Province within latitude 20° 2′ 43″ S and longitude 30° 40′ 29″ E in the south-eastern part of Zimbabwe. Mixed dried leaves and pods of *Acacia karroo* were ground using a 2 mm screen and then included at levels of 0, 20, 60 and 100%, replacing ground maize in the diets. Weaned goats (n=64) were allocated in weight order to groups of four animals and randomly assigned to the four treatments in a randomised block design. Growth rates of goats fed with diet containing 100% *A. karroo* had higher (15.48 ±0.069 kg) final weight compared to any other diets followed with goats fed diet containing 60% of *A. karroo* and results showed significant differences ($p<0.001$) between treatments. Feed intake over all treatments was comparable with around 500 g day^{-1}. Goats fed with control diet recorded highest voluntary feed intake of 504.5 g day^{-1} and lowest of 499 g/day was recorded from diet containing 60 % *A. karroo*. Goats which were fed with 60 % and 100% A. karroo had low feed conversion ratio (FCR) although the results show significant differences ($p<0.05$) among all treatments. Goats fed diets containing 0% *A. karroo* had the least average weekly weights as compared to all other diets. Average weekly weight gains for goats fed with 60 % *A. karroo* and 100% *A. karroo* diets rapidly increased in week 2 with those fed 100% *A. karroo* diets recorded a highest gain of 915.75 ±59.888 g and results were significantly different ($p<0.001$) between treatments. Farmers are recommended to use 60-100% A. karroo diets when pen fattening goats.

Keywords: Assessing, effects, Acacia karroo, pen fattening, goats

Introduction

Goat production is one of the major income generations for smallholder farmers in arid and semi-arid areas (Brown et al., 2018) due to low cost of production and short period of reaching maturity. Goats have a paramount role in human livelihoods in Zimbabwe and other southern African countries like South Africa (Ngambi et al., 2013; Brown et al., 2018). Goats provide milk, meat, manure, hide, skin and cash after selling them. Goat production is mainly limited by poor feeds during dry seasons in most dry regions. Feed availability has limited goat production in most communal areas (Alemu et al., 2014; Brown et al., 2016) in dry regions for example Southern Africa. Feed resources available during dry season are deficient in protein, minerals, vitamins and energy which negatively affect growth of goats (Brown et al., 2018). The vegetation in regions of low rainfall is associated with high densities of Acacia species such as Acacia karroo for which the browsing habit of goats is well adapted (Mapiye et al., 2011).

Acacia karroo is one of the most abundant indigenous legume trees in semi-arid and arid areas in Southern Africa (Halimani et al., 2005). Acacia karroo has been noted to supply high levels of crude protein (CP) to livestock production together with other legume trees such as A. nilotica and A. tortilis among other species. According to Mapiye et al. (2011) A. karroo leaves contain essential fatty acids such as linoleic and oleic acids which improve meat quality. The leaves also contain tannins which can improve the "bypass" characteristics of protein thus increasing its nutritive value (Brown et al., 2018).

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Condensed tannins contained in A. karroo (55-110 g/kg DM) have been reported (Mokoboki et al., 2005). Acacia karroo diets were mixed with fresh grass as means of diluting the effects of tannins. However, the presence of spines may reduce feed intake as these cause sores around the goat mouths. The pods and leaves can be harvested while still green, mixed together, dried and ground (to avoid problems of the spines).

Materials and Methods

The experiment was carried out at a farm in Mashava an area located in Masvingo Province located within latitude 20° 2′ 43″ S and longitude 30° 40′ 29″ E in the south-eastern part of Zimbabwe. The area receives on average 450 to 500 mm rainfall per annum. The area is dominated with Acacia species in the eastern part and *Colophospermum mopane* in the western part of the area. Acacia karroo leaves and pods were sun dried one month before used and ground using a hammer mill with a 2 mm screen, then mixed with ground maize grain at levels of 0, 20, 60 and 100% to form the 4 experimental diets. Weaned goats (n=64) were allocated in weight order to groups of 4 according to live weight and randomly assigned to the four treatments. The treatments were replicated four times to give a total of 64 goats. A complete randomised design was used. Goats were fed 5% feed of their body weights on daily basis. Goats were managed under intensive management system in pens for easy management and monitoring. All treatments were provided corresponding quantities of green grass to percentages of *Acacia karroo* as a source of energy. Goats were fed experimental diet together with green grass for one week (7 April -14 April 2019) before start of the experiment to allow them to adapt to the diet. The experiment was done for six weeks starting from 15 April 2019 to 27 May 2019. Goats were also vaccinated and dosed to prevent internal parasites. Weights of goats were measured on weekly basis and recorded to calculate average weekly weights and average weekly weight gain for each group. Weekly weights were measured on same day for all groups before feeding them to get accurate weights. Leaves and pods were analysed according to procedures of AOAC (2005).

Data collected was analysed using IBM SPSS version 25 and means which were different were identified using Duncan's multiple range of test at 5 %.

Results and Discussion

Proximate Analysis of *Acacia karroo* pods and leaves and growth performance of goats

The pods were richer than the leaves in crude protein (Table 1) but had higher proportions of NDF and ADF. Live weight gain increased with a curvilinear trend (Table 2) as the ground A. karroo pods was mixed leaves and green grass. In contrast, the feed conversion was declining with increasing percentage of A. karroo. The results showed that pods have high crude protein and a possibility of increasing growth rates of goats. Goats are ruminants and are also able to synthesise proteins hence this will combine with proteins from pods and leaves to increase growth and development. All experimental goats fed A. karroo pods and leaves showed higher average weight gains as compared to the control because the diets contained higher CP content which promotes microbial functioning (Masiku, 2013) and this increased feed intake. These results coincide with those of Halimani et al. (2005) and Mapiye et al. (2010) who reported that A. karroo leaves contain high levels of CP and essential amino acids. This result is similar to findings by Mapiye et al. (2009c) who reported that high CP in A. karroo increases growth rate of livestock animals especially ruminants. This also coincides with findings by Dube (2000) who reported that an increase of A. karroo leaf meal from 40 % to 60 % in goat diet significantly increased feed intake and body weight gain. This also coincides with results by Kahiya et al. (2003) and Halimani (2002) who reported an increased average weekly weight gain in goats and pigs respectively. Similar results were reported by Ngongoni et al. (2007) who indicated that A. karroo has high digestibility and this may increase voluntary feed intake, weight gain and growth rate of ruminants. The result also coincides with work by Marume et al. (2012a) who reported that high CP content in A. karroo leaves and pods increases digestibility and nutrient availability to goats leading to increased meat quality.

Table 1. Chemical composition of *A. karroo* pods and leaves (Dry matter basis, except for DM which is on air-dry samples)

A. karroo	DM	OM	Ash	CP	NDF	ADF
Pods	900	906	60.9	190.1	462.8	375.1
Leaves	919	897	67.8	127	296.5	123.5

Where: DM= Dry matter (g kg^{-1}); OM=Organic matter (g kg^{-1}); CP=Crude Protein (g kg^{-1}); Neutral Detergent Fibre (g kg^{-1}); Acid Detergent Fibre (g kg^{-1}).

Same superscripts in the same column denotes no significant different between treatments at $p \leq 0.05$.

Table 2. Growth performance of the goats during the 6 weeks experiment

Treatments	Initial Live Weight (LWT) (kg)	Final LWT (kg)	Average weekly Gain (g/goat)	Average Daily Gain (ADG) (g/goat/day)	Voluntary Feed Intake (VFI) (g/goat/day)	Feed Conversion Ratio (FCR) (kg feed/kg live weight gain)
AK0	10.09±0.114[a]	14.28 ± 0.18[c]	705.08±107.226[c]	100.72± 15.307[c]	504.5± 12.254	5.057± 0.032[a]
AK20	10.00± 0.136[a]	14.89± 0.116[b]	814.87±158.577[b]	116.43±22.641[b]	500.0± 12.032	4.294± 0.024[b]
AK60	9.98±0.142[a]	15.29± 0.103[a]	889.04±49.358[a]	126.97±7.065[a]	499.0± 10.98	3.947± 0.019[c]
AK100	9.995±0.092[a]	15.48 ± 0.069[a]	915.75±59.888[a]	130.87±8.57[a]	499.75 ± 11.15	3.827± 0.017[c]

Effects of A. karroo on weight gain and feed conversion ratio

The results showed that average daily gain was significantly different for all treatments with $p<0.001$. Feed intake was also not significantly different between all the treatments with $p>0.05$ feed conversion ratio was significantly different between treatments with $p<0.05$. Average daily gain (ADG) was high from goats fed with 100 % A. karroo diet but no significant differences with goats fed diet with 60 % A. karroo (Fig 1). Control treatment recorded the lowest ADG of 100.72 g and was 23.04% less than diet with 100% A. karroo content. Average daily weight gain was highly correlated ($R^2=0.99$) to increase in A. karroo level in the diet (Fig 1). Goats fed with control diet recorded highest voluntary feed intake of 504.5 g/day and lowest of 499 g/day was recorded from diet containing 60 % A. karroo. Goats which were fed with 60 % and 100% A. karroo had low FCR although there were significant differences ($p<0.05$) among all treatments. High tannin content in diets with high levels of A. karroo leaf and pod meal contributed to low FCR. The lowest FCR (3.827) was recorded from goats fed 100% A. karroo leaf and pod meal and highest FCR was recorded from goats fed control diet (0% A. karroo). Results on weight gain from this experiment were also similar to findings by Nyamukanza & Scogings (2008) who reported that feeding goats with diet containing A. karroo pods and leaves increased feed intake and weight gain. This was also similar to findings by Masiku (2013) who reported that supplementing Boar goats with A. karroo leaves increased body condition score, average daily gain and slaughter weight. Increase in inclusion of A. karroo pods and leaves in diet increased daily weight gain of goats. Results on average daily weight gain were in the same range with results by Masiku (2013) who reported higher average daily gain from goats fed with 25 % A. karroo. Higher average daily gain was noted in goats fed with a 100% A. karroo inclusion. This may have been caused by an increase in digestibility caused by increased protein content in the diet since body weight of goats is sensitive to protein and energy content in diet.

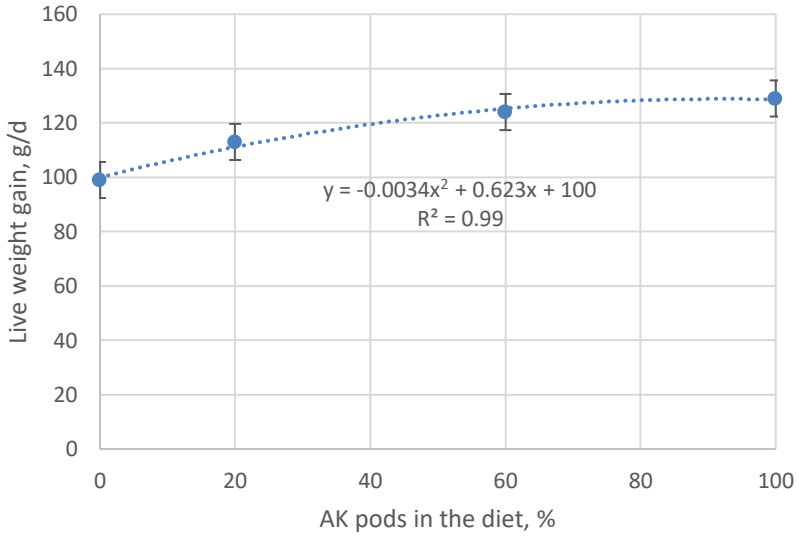

Figure 1. Effect of level of *A. karroo* pods-leaves replacing maize grain on live weight gain of the goats

Effects of *A. karroo* on weekly weight gain and average weekly weight gain of goats

Average weekly weights of goats increased with increase in inclusion of *A. karroo* in diet. Average final weight of goats fed with AK100 was 15.48±0.069 kg which was the highest with lowest from control being 14.28±0.18 kg (Table 3). Two weeks after feeding goats with different diets, their weights increased but not rapidly. After six weeks of feeding goats those in group AK100 fed with 100% *A. karroo* attained an average weight of 15.48±0.069 kg which was 1.2 % higher than those fed with 60%, 3.8% higher than those fed with 20% A. karroo and 7.8 % higher than those fed with 0% *A. karroo* (Table 3). Average weekly weight gain was higher in the first week for goats fed with AK100 diet which contained100% *A. karroo* but not different much to those fed AK60 diets which contained 60% *A. karroo*. The results also show that there was 100% weight gain for those fed AK100 diets (Table 4). There was no difference in average weekly weight gain for those fed with AK0 and AK20 diets in the second week of feeding. Goats fed with AK20 diets indicated an increase in average weekly weight gain in week 2 compared to all other groups which recorded a slight increase in weight gain. Goats fed AK100 diet showed a slight decline of weight gain in week 3 of feeding compared to all other treatments which had rapid declines in weight gain (Table 4). Goats fed with diet containing 100 % *A. karroo* recorded the highest average weekly weight gain (AWG) of 915.75 g which was 23% higher than AWG recorded from control diet (0% *A. karroo*). The results show significant different ($p<0.05$) between all treatments. Average weekly weight gain continue to decline rapidly for those fed with AK0-AK60 diets and only goats fed with AK100 diets showed a slight decline in average weekly weight gain from week 4 to week 6. Results on Fig 2 also indicate that average weekly weight gain for goats fed with AK0 and AK20 declined rapidly and were always below other treatments with AK0 being the lowest. Average weekly weight gain showed a decline for all goats fed diet containing *A. karroo* pods and leaves. This might have been caused by tannins which are contained in *A. karroo* leaves especially. This was also reported by Brown et al. (2016) as a way of diluting the effects of tannins. Tannins content was ranging from 3.8g/kg DM for diet with 20% A. karroo inclusion and 19.5g/kg DM for diet with100% A. karroo inclusion. Tannin levels less than 50g/kg DM can be easily tolerated by goats without any problem and values from 50g/kg DM have detrimental effects to ruminants (Brown et al., 2016). This also coincides with work by Dube et al. (2001) who reported that weight gain declined to goats fed with high levels of A. karroo due to presence of tannin which reduces protein digestibility. The same sentiment was rasied by (Ngongoni et al., 2007) who reported that tannin significantly reduces protein digestibility leading to reduced feed intake and weight gain. This coincides with report by Aganga et al. (2000) and Halimani et al. (2005) who indicated that A. karroo contains tannins which reduced digestibility and this may have effect on growth rate of animals. This also concurs with work by Dube et al. (2001) who reported that tannins have negative effect on growth and weight gain. These results were also in agreement with Kugedera and Chimbwanda (2018) who reported a decline in weight gain from broilers fed Red Swazi which contains condensed tannins.

Table 3. Average weekly weight (kg) for goats in different groups

Acacia level (B)	weekly weight (mean ± SD) (kg) (A)						Pooled mean ± SD
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**1-6**
AK0	10.85±0.21^{a}	11.67±0.24^{b}	12.4±0.22^{c}	13.09±0.18^{c}	13.72±0.17^{d}	14.28±0.18^{d}	12.67±1.21^{d}
AK20	10.82±0.14^{a}	11.92±0.12^{a}	12.71±0.1^{b}	13.49±0.12^{b}	14.23±0.13^{c}	14.89±0.12^{c}	13.01±1.41^{c}
AK60	10.87±0.15^{a}	11.82±0.15^{a}	12.74±0.15^{ab}	13.63±0.13^{a}	14.47±0.12^{b}	15.29±0.1^{b}	13.14±1.55^{b}
AK100	10.87±0.068^{a}	11.85±0.066^{a}	12.82±0.057^{a}	13.76±0.052^{a}	14.65±0.065^{a}	15.48±0.069^{a}	13.24±1.62^{a}
P-value: A							<0.001
B							<0.001
AB							<0.001

Same superscripts in the same column denotes no significant different between treatments at $p\leq0.05$.

Table 4. Average weekly weight gain (kg) for goats in different groups

Acacia level (B)	weekly weight gain (mean ± SD) g kg^{-1} (A)						Pooled mean (SD)
Treatments	**1**	**2**	**3**	**4**	**5**	**6**	**1-6**
AK0	805 ±80.22^{d}	820.75±75.039^{d}	729.75±26.42^{d}	692.5±53.15^{d}	630±34.64^{d}	552.5±26.3^{c}	705.08±107.27^{d}
AK20	824.25±11.79^{c}	1100±162.48^{a}	785±17.32^{c}	785±20.82^{c}	735±20.82^{c}	660±25.8^{b}	814.87±158.58^{c}
AK60	911.75±34.94^{a}	947.5±5^{c}	917.5±12.58^{b}	892.5± 17.08^{b}	845±12.91^{b}	820±39.16^{a}	889.04±49.36^{b}
AK100	897±36.092^{b}	975±10^{b}	975±10^{a}	935±12.91^{a}	895±12.91^{a}	817.5±43.49^{a}	915.75±59.89^{a}
P-value: A							<0.001
B							<0.001
AB							<0.001

Same superscripts in the same column denotes no significant different between treatments at p≤0.05.

Conclusion

Goats fed with AK100 diets recorded the highest average weight at week 6 compared to all other goats fed different diets. High CP content in *A. karroo* was noted to increase weight for goats fed with diets containing *A. karroo* pods and leaf meal. It was also noted that an increase in composition of *A. karroo* in diets increases weights of goats fed with that diet. Goats fed with AK0 diets had the lowest weights at week 6 and also lowest weekly gain compared to all other diets. Effects of anti-nutritional factors in *A. karroo* were also noted by causing a decline in weight gain to goats fed AK60 and AK100 diets. Effects of high CP content were also noted due to high weights for those goats fed with AK100 diets at week 6.

Recommendations

Farmers are recommended to fatten their goats with diets containing above 50% content of *A. karroo* due to high growth rate. Resource poor farmers in the smallholder farming areas are also recommended to use *A. karroo* to improve goat production because *A. karroo* is readily available in Zimbabwean smallholder farming areas.

Compliance with Ethical Standards

Conflict of interest

The authors declared that for this research article, they have no actual, potential or perceived conflict of interest.

Author contribution

The contribution of the authors to the present study is equal.

All the authors read and approved the final manuscript. All the authors verify that the Text, Figures, and Tables are original and that they have not been published before.

Ethical approval

Ethics committee approval is not required.

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Data availability

Not applicable.

Consent for publication

Not applicable.

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