NUTRITIVE VALUE AND VOLUNTARY FEED INTAKE OF AFRICAN TULIP (*SPATHODEA CAMPANULATA*) AND LEMON (*CITRUS LIMON*) FOLIAGE AS SUPPLEMENTS IN UNTREATED AND UREA TREATED MAIZE STOVER DIETS BY GROWING GOATS

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Four growing crossbred Anglo-Nubian goats, 10–15 months old, pre-trial mean live weight 14.8 ± 1.6 kg were used in a randomized 4 x 4 Latin Square design with a 2 x 2 factorial arrangements to investigate the nutritive value and voluntary feed intake of African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*) foliage as supplements in untreated and urea treated maize stover diets. The four diets used were: Diet 1 – untreated maize stover + *Spathodea campanulata*; Diet 2 – untreated maize stover + *Citrus limon*; Diet 3 – urea treated maize stover + *Spathodea campanulata;* and Diet 4 – Urea treated maize stover + *Citrus limon.* The diets were thoroughly mixed. Crude protein (CP) and gross energy of *Spathodea campanulata* and *Citrus limon* (CL) were 13.1% CP; 14.8 MJ/kg DM GE and 14.8% CP; 14.3 MJ/kg DM GE, respectively. Urea treatment increased the CP of the stover from 4.6 to 5.3%. Supplementation with *Spathodea campanulata* and *Citrus limon* reduced the crude fibre (CF) content in urea treated maize stover than in the untreated maize stover diets. Intake of individual feed component was higher ($P < 0.05$) for urea treated maize stover and *Spathodea campanulata* than untreated maize stover *Citrus limon*. Voluntary feed intake and dry matter intake (DMI) of D1, D2, D3 and D4 were 388.3; 373.2; 521.8 and 430.6 g/head/d; and 87.5; 84.9; 109.2 and 94.5 g/kg$^{-0.75}$ d, respectively. Digestibility of DM, CF, OM, CP, total carbohydrates and total digestible nutrients (TDN); and daily protein (N x 6.25) intake (g/kg^{-1}W $^{0.75}$/d) were higher ($P < 0.05$) in urea treated maize stover than in untreated maize stover. Urea treatment did not affect CF digestibility, but goats on urea treated maize stover + *Spathodea campanulata* and urea treated maize stover + *Citrus limon* tended to have higher digestible DMI than those on – urea treated maize stover + *Spathodea campanulata;* and untreated maize stover + *Citrus limon*. Supplementation of the maize stover with *Spathodea campanulata* and *Citrus limon* improved DMI and nutrient digestibility of the diets above 50%. In conclusion, the non rejection of the diets demonstrated that the foliage of *Spathodea campanulata* and *Citrus limon* can be effectively utilized as supplements in goats' nutrition without adverse effects on feed intake, digestibility and utilization; however the leaves of *Spathodea campanulata* was consumed more than those of *Citrus limon*s.

African tulip (*Spathodea campanulata*); Lemon (*Citrus limon*); urea-ammoniation; maize stover; goats; DMI; daily protein intake; digestibility

INTRODUCTION

There is the need to look inward for locally available feed resources to accommodate the nutritional needs of the ruminant livestock in the South Pacific regions (SPR). There are some unknown but well adapted forages and browse plants in the SPR not yet utilized in ruminant feeding.

In the tropics there is always high pressure on popular tree legumes. Subsequently, leaves of trees and shrubs have the potential for alleviating some of the feed shortages and nutritional deficiencies experienced during the dry season period in the SPR. The importance of leaves of trees and shrubs as component in the nutrition of grazing small ruminants has been stressed (Topps, 1992; Kaito et al., 1998). Goats were observed to browse the leaves of the African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*), an indication of acceptance/palatability (Aregheore, personal observation, 2002).

The African tulip (*Spathodea campanulata*) is a tropical evergreen tree that has compound leaves and showy orange-scarlet or yellow flowers. It is also known as the flame of the forest. The bark and leaves are used in traditional medicine in Ghana (West Africa). *Spathodea campanulata* and Lemon (*Citrus limon*) abounds in the Pacific island countries that have large population of ruminant livestock (Fiji, Vanuatu, Papua New Guinea, Tonga, Samoa, Solomon Islands).

Except for the report of Hernandez et al. (1998) there is scant information on the nutritional composition and utilization of leaves of *Citrus limon* as supplementary feed in ruminant nutrition. Chemical analyses results from our laboratory demonstrated that young leaves of *Spathodea campanulata* and *Citrus limon* have nutrient composition similar to popular tree legumes regularly used to supplement low quality roughages in the tropics. It is very likely that the leaves of *Spathodea campanulata* and *Citrus limon* contain little or no anti-nutritional factors that will make animals to reject them since they are always exposed to light and goats are usually seen picking or browsing on them.

Maize stover is widely used in commercial agriculture and it is the best cereal stover for livestock feed. However,

its feeding value is limited due to deficiencies in crude protein, metabolizable energy and minerals therefore livestock productivity based on the feeding of maize stover alone is constrained by low dry matter intake and poor nutrient digestibility. Urea-ammoniation offers an avenue to improve its nutrient quality and feeding value (Owens, 1985; Aregheore, 2005). Also supplementation with leaves of browses and multipurpose trees improve roughage utilization because of supply of nitrogen, carbohydrates and micronutrients (Aregheore, Perera, 2004.

There is no available information on the utilization of leaves of the African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*) as forage crops or as supplements for ruminant animals on low quality roughage such as maize stover. This therefore necessitated the need to investigate their nutritional value and revalidate them to sustain ruminant nutrition in the absence of popular tree legumes such as *Leucaeana leucocephala*, *Gliricidia sepium*, *Erythrina* spp., *Moringa oleifera* during adverse weather condition. Therefore to provide research update on their nutritive value, the objectives of this study was to investigate the chemical composition and voluntary feed intake of African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*) foliage as supplements in untreated and urea treated maize stover diets by growing goats.

MATERIALS AND METHODS

Feed description

African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*) grow within the University of the South Pacific, School of Agriculture and Food Technology, Alafua Campus, Apia, Samoa (13.5 °S, 172.5 °W). Temperatures in Samoa are seasonally uniform with the mean maximum temperature ranging from 27 to 30 °C and the mean minimum temperature ranging from 20 to 23 °C. Samoa has humid tropical climate.

Maize stover of an improved sweet variety (*Zea mays*) was obtained from the Crop Science Department farm, within the Alafua Campus after the maize cobs had been harvested. The maize stover was allowed to dry in the sun to a constant moisture level. Both the maize stover and fresh leaves of the two browse were chopped with a bush knife.

Maize stover treatment

Maize stover was chopped into pieces of 6–8 cm and divided into two equal portions. A portion was treated with 4% urea to give 40% moisture content, and incubated for 2 weeks, while the second portion was untreated. In brief 10 kg of chopped maize stover was spread on concrete floor covered with polyethylene sheet and urea solution (0.72 kg urea dissolved in 10 litres of water) was sprayed on the stover. The stover was then thoroughly hand mixed to allow the urea solution to mix uniformly with the stover, tightly packed and sealed in polyethylene bags of 112 cm x 76 cm, 0.2 mm thick; and stored at room temperature. The bags were opened after 2 weeks.

Leaves of *Spathodea campanulata* and *Citrus limon*

The leaves from stands of African tulip (*Spathodea campanulata*) and Lemon (*Citrus limon*) were harvested within the School of Agriculture premises in the morning for feeding in the afternoon, with some allowed to wilt overnight for feeding in the morning. Stalks were removed from the forage to ensure that the fodder composition was uniform. The leaves of both browse were chopped to a uniform size to facilitate uniform mixing with the maize stover.

Diets preparation

Four dietary treatments that comprised untreated and urea treated maize stover with the leaves of *Spathodea campanulata* and *Citrus limon* were used. The diets were: Diet 1 – untreated maize stover + *Spathodea campanulata*; Diet 2 – untreated maize stover + *Citrus limon*; Diet 3 – urea treated maize stover + *Spathodea campanulata;* Diet 4 – urea treated maize stover + *Citrus limon.* The diets were designated as UnTM+SC; UnTM+CL, UTM+SC and UTM+CL, respectively and their contents were thoroughly mixed before they were offered to the goats.

Animals, experimental design and management

Four growing crossbred Anglo-Nubian goats, 10–15 months old, a pre-trial mean live weight of 14.8 ± 1.6 kg were selected for the experiment. Prior to the study the goats were drenched with levamizole (Levicare, Anoare, Birkenhead, Auckland, New Zealand) to control worms. The goats were drenched on body weight basis (it was delivered over the tongue in the back of the throat with a drench gun). The goats were allocated to treatments in a complete randomized 4 x 4 Latin Square design and a 2 x 2 factorial arrangement per treatment. The two factors were maize (urea treated and untreated) and two foliages (*Spathodea campanulata* and *Citrus limon*).

Goats were on each dietary treatment for 21 days before the treatment was changed; first 10 days was for adaptation and adjustment to feed intake, last 11 days for intake measurement and collection of faeces prior to being allocated to a new dietary treatment. The goats were housed in individual metabolic cages (130 cm x 130 cm x 140 cm) under a common roof. The cages have slatted floor covered with a very fine wire netting that allows only urine to pass through. Each goat received a daily allotment of 1.5 kg fresh weight of the dietary treatment that was fed in two equal amounts at 09.00 and 16.00 h adjusted daily for increase or decrease intake at approximately 10–20%. All the goats had free access to mineral/vitamin lick block. The mineral/vitamin contained common salt (NaCl), 120 g/kg; calcium, 60 g/kg; phosphorus, 60 g/kg magnesium, 150 mg/kg; copper, 1.5 mg/kg; iodine (I), 600 mg/

kg; manganese, 750 mg/kg; iron, 600 mg/kg; zinc, 1.5 mg/kg; selenium (Se), 3 mg/kg; 7,5000,000 iu vitamin A, 5000 iu vitamin D and 2500 iu vitamin E, with copra meal and molasses added (Summit multi-mineral salt block; Lake Grassmere, New Zealand). The leaves of *Spathodea campanulata* (SC) and *Citrus limon* (CL) were sampled on a weekly basis for dry matter determination.

Dry matter intake was determined by daily weighing in and weighing out feed offered, separating the leaves of SC and CL from maize stover as required and correcting for the DM content of each dietary component.

At early morning feeding feed refusals were collected each day and weighed to assess intake before any new feed was offered. During the period the goats also had free access to fresh clean water. Records of voluntary feed intake were kept for each goat during each phase. Cleaning of the cages and removal of leftovers from the previous day was done daily before supplying each day's diet.

Digestibility study

A dustpan and brush were used to collect faeces each morning before feeding. Total daily faecal output for each goat was weighed before 25% sample was removed for dry matter determination. Daily samples of faeces and diets were dried in a forced-draught oven at 70°C for 48 h. Faeces were bulked separately for each goat during each period; milled with a simple laboratory mill and stored in airtight bottles until required for analysis.

Analytical procedures

The determination of dry matter, protein, ash, and crude fibre of feed stuffs, diets and faecal samples, were undertaken according to the methods of the AOAC (1999). All analyses including crude fibre were done in triplicate. Dry matter (method ID 934.01) was determined by drying at 102 °C for 24 h, ash (method ID 924.05) by placing samples in a muffle furnace at 600 °C for 4 h; ether extract (method ID 7.045) and crude protein (method ID 984.13) by the micro-Kjeldahl procedure. Total carbohydrate contents of the diets were calculated as the organic matter content minus the content of both crude protein and ether extract.

Statistical analysis

Data obtained from these analyses were used in computing the digestibility of crude protein, crude fibre, organic matter, total digestible nutrients and gross energy (GE MJ/kg). Data on voluntary feed intake, body weight change and nutrient digestibility were statistically evaluated as a 4 x 4 Latin square design with a 2 x 2 factorial arrangement of treatments using analysis of variance (ANOVA) with goats, period and dietary treatments included as main effects. Significant differences between means were compared using Duncan multiple Range Test with the aid of SAS/STAT program (Statistical Analysis Systems Institute Inc, 1988). Also data between and within treatments were subjected to a Student's *t*-test.

RESULTS AND DISCUSSION

The first recognisable change in cereal straw treated with urea is a change in colour (browning or caramelisation) due to the Maillard reaction between carbohydrates and N-containing bonds. There was difference between the urea treated and untreated maize stover in colour and our observation concurred with the report of Abebe et al. (2004). Also the moisture content of the straw upon opening the stack was lower in the urea treated maize stover. Table 1 presents data of chemical composition of feedstuffs used in the experiment. Urea treatment increased the crude protein (CP) of the stover from 4.6 to 5.3% (No = 4) (Table 1), however the CP content of both the urea treated maize stover is lower than value earlier reported by Aregheore and Perera (2004).

The CP value of foliage of *Spathodea campanulata* (SC) and *Citrus limon* (CL) was 13.1% and 14.8%, respectively and this was similar to the CP of popular tree legumes such as *Leucaeana leucocephala*, *Gliricidia sepium, Calliandra calothyrus Erythrina* spp. and *Moringa oleifera* regularly used as supplement to low quality roughages in the tropics (Topps, 1992; Masama et al., 1997; Aregheore, Perera, 2004; Aregheore et al., 2006). The CP content of CL (13.4%) used in this study is higher than 11.2% CP reported for *Citrus limon* in Spain (Hernandez et al., 1998). Climatic and environmental factors, varietal differences and stage of maturity before harvest might be responsible for the differences in the CP content. Also the gross energy values of 14.8 MJ/kg DM GE and 14.3 MJ/kg DM GE for SC and CL, respectively are close (data not reported). The GE contents of the leaves are consistent with values reported for foliage of tree and shrub used as supplements in the Pacific island countries (Aregheore, 2004). The chemical composition of SC

Table 1. Chemical composition of feedstuffs

Feed stuffs	DM	CP	CF	EE	NFE	OM	TCHO
Spathodea campanulata	39.4	13.1	16.1	3.0	59.8	92.0	75.9
Citrus limon	37.2	14.8	17.5	3.9	54.2	90.5	71.8
Untreated maize stover	89.3	4.6	35.8	1.8	49.5	91.2	84.8
Urea treated maize stover	79.2	5.3	33.4	1.2	51.4	91.3	84.8

DM – dry matter, CP – crude protein, CF – crude fibre, EE – ether extract, NFE – nitrogen free extract, OM – organic matter, TCHO – total carbohydrates

and CL showed that they posses good potential as supplements for feeding ruminant due to their high CP and low fibre (CF), the indigestible fraction of the carbohydrates present, and average nitrogen free extract (NFE) the readily digestible carbohydrate fraction.

Table 2 presents the chemical composition of the dietary treatments (diets) used. Dry matter (DM) content of the UTM+SC and UTM+CL diets was numerically lower than that of UnTM+SC and UnTM+CL.

The inclusion of the leaves of SC and CL improved the CP contents of the diets (8.9 to 10.1% CP). CP contents of all the experimental diets were however, not below the level at which they could be considered deficient (Norton, 1994), but within requirements range of growing goats in the South Pacific region (Aregheore, et al, 2003). Supplementation of the ammoniated stover with the foliage of SC and CL reduced the crude fibre (CF) content of the diets (Table 2).

Voluntary feed intake (VFI) and dry matter intake (DMI) (g/kg$^{-0.75}$ d) of the single component feeds of UnTM; UTM; leaves of SC and CL and the mixtures (UnTM+SC; UnTM+CL; UTM+SC and UTM+CL) by the goats are presented in Table 3. DMI of individual feed component demonstrated that the goats on UTM were significantly higher ($P < 0.05$) than those on UnTM. Also intake of SC was higher than CL. The high intake observed in the goats on UTM might have occurred because urea-ammoniation improved the nutritive value of the maize stover and subsequently resulted in apparent increase in the population and/or activity of rumen bacteria digesting cellulose. Urea was broken down to NH_3, thus subjecting the stover to an alkaline treatment and, at the same time, increasing its nitrogen content.

Total voluntary feed intake (VFI) and dry matter intake (DMI) of UnTM+SC; UnTM+CL; UTM+SC and UTM+CL diets was 388.3; 373.2; 521.8 and 430.6 g/head/d, and when expressed on a metabolic weight basis DMI was 87.5; 84.9; 109.2 and 94.5 as g/kgW$^{0.75}$/day respectively. Dry matter intake (g/kgW$^{0.75}$/day) followed the same pattern of VFI. However, the intake of the leaves of CL was significantly lower ($P < 0.05$) than that of SC in both UTM and UnTM based diets in a manner similar to some legume forages (Aregheore, Perera, 2004). The high intake of SC compared to CL in both the UnTM and UTM based diets might be due to its tender leaves and aromatic twigs, which endure the goats to it a consequence of animal plant complex in forage preference/palatability phenomena. The leaves of CL have a natural phytochemical (monoterpenes) that is associated with a repelling odour which might have made the goats to consume it less. Overall DMI was comparatively lower in UnTM+SC and UnTM+CL than in UTM+SC and UTM+CL diets.

However, throughout the experimental period, the goats remained healthy and did not reject the diets offered. This is an indication that the diets did not possess any toxic substances at a lethal level to militate against their intake and utilization.

The improved intake of the UTM supports Han and Garrett (1986) who reported that animals fed ammoniated straw ad libitum, typically increase DMI by 30% or more. Urea-ammoniation of maize stover is a potential process to enhance roughage utilization and to provide a functional rumen environment if correct supplementation is supplied in the form of protein which escapes (partially) the rumen. A supplement of green legume forage, from shrubs and tree leaves enhance the utilization of straw/stover by ruminants (Prasad, Reddy, 2000; Aregheore, Perera, 2004). Foliages of tree and shrub are an important component of goat and sheep diets and they play an important role in the nutrition of ruminant animals fed low quality diets (Holecheck, 1984; Papachristou, Nastis, 1996).

Supplementation of the untreated and urea treated maize stover improved DMI and in vivo nutrient digestibility and our data supports Han, Garrett (1986), Fahey et al. (1993), Prasad, Reddy (2000) and Aregheore, Perera (2004) who reported that partial supplementation of urea- ammoniated maize stover with foliage of legumes, shrubs and multipurpose trees improved DMI and nutrient digestibility of cereal straws/stovers. Digestibility of DM, CF, OM, crude protein, total carbohydrates, total digestible nutrients (TDN) and daily protein (N x 6.25) intake (g/kg^{-1}W$^{0.75}$/d) were higher ($P < 0.05$) in UTM than the UnTM. Urea treatment did not affect CF digestibility although the goats on UTM+SC and UTM+CL tended to have higher digestible DMI than those on UnTM+SC; UnTM+CL.

Table 2. Chemical composition of dietary treatments (diets)

	UnTM+SC	UnTM+CL	UTM+SC	UTM+CL
Percentage of maize stover : foliage	50 : 50	50 : 50	50 : 50	50 : 50
Nutrients				
Dry matter	56.1	65.6	44.5	48.6
Crude protein	8.9	9.7	9.2	10.1
Crude fibre	27.7	28.3	24.7	24.2
Ether extract	1.4	1.2	1.0	1.0
Nitrogen free extract	53.8	50.6	55.9	55.5
Organic matter	91.8	89.8	90.8	91.8
Total carbohydrates	81.5	78.9	80.6	80.7

D1 – UnTM+SC (untreated maize stover + *Spathodea campanulata)*, D2 – UnTM+CL (untreated maize stover + *Citrus limon)*, D3 – UTM+SC (urea treated maize stover + *Spathodea campanulata),* D4 – UTM+CL (urea treated maize stover + *Citrus limon)*

Table 3. Voluntary feed intake (VFI), dry matter intake g/kg$^{-0.75}$ d^{-1}) and nutrient digestibility of untreated and urea treated maize stover supplemented with *Spathodea campanulata* and *Citrus limon* by goats

Parameters	Diets*			
	UnTM+SC	UnTM+CL	UTM+SC	UTM+CL
Percentage of maize stover and forage	50 : 50	50 : 50	50 : 50	50 : 50
Voluntary feed intake (g/d)				
Maize stover (g/d)	285^{b1}	296^{b1}	379 ^{a2}	365^{b2}
Forage (g/d)	103.3^{b1}	77.2^{a1}	142.8^{a2}	65.6^{a2}
Total VFI (maize stover + forage) (g/d)	388.3^{a1}	373.2^{a1}	521.8 ^{a2}	430.6 ^{b2}
Dry matter intake (g/kgW$^{0.75}$/day)	87.5^{b1}	84.9^{b1}	109.2 ^{a2}	94.5 ^{b2}
Nutrient digestibility (%)				
Dry matter (%)	68.7^{a1}	60.0^{a1}	75.4^{a2}	71.4^{b2}
Crude protein (%)	62.5^{a1}	59.7^{a1}	78.1^{b2}	73.0^{b2}
Crude fibre (%)	53.0	45.4	55.6	47.7
Organic matter (%)	69.3^{a1}	62.9^{a1}	74.3^{a2}	71.5^{b2}
Total carbohydrates (%)	71.3^{1}	67.0^{1}	88.3^{2}	76.2^{2}
Total digestible nutrient	57.2^{a1}	44.6^{a1}	71.8^{b2}	68.1^{b2}
Daily protein (N x 6.25) intake (g/kg^{-1}W $^{0.75}$/d)	5.6^{1}	5.8^{1}	7.2^{2}	7.4^{2}

* D1 – UnTM+SC (untreated maize stover + *Spathodea campanulata)*, D2 – UnTM+CL (untreated maize stover + *Citrus limon)*, D3 – UTM+SC (urea treated maize stover + *Spathodea campanulata),* D4 – UTM+CL (urea treated maize stover + *Citrus limon)*

[a, b] Means within row with different superscript differs ($P < 0.05$)

[1, 2] Means within row with different superscript differs ($P < 0.05$)

Urea treatment of maize stover has three primary interrelated benefits such as increased nitrogen concentration; digestibility and increased feed intake (Djajanegara, Doyle, 1989; Abebe et al., 2004). In this study urea-ammoniation of the maize stover effected a typical increase in DMI and nutrients digestibility (Djajanegara, Doyle, 1989; Abebe et al., 2004). Also the leaves (foliages) of *Spathodea campanulata* and *Citrus limon* contributed to improve DMI and digestion of the maize stover diets (Han, Garrett, 1986; Fahey et al., 1993; Aregheore, Perera, 2004).

Consequently, the high total carbohydrates digestibility observed in the goats demonstrated that all the diets promoted strong ruminal digestion (yielding high levels of energy production), that supported high yields of microbial protein synthesis, and maintenance of a stable fermentation. The overall effects of supplementing UnTM and UTM based diets with leaves of SC and CL were improved feed intake and nutrient digestibility that was above 50% by the goats. This therefore indicated that available carbohydrates in the diets were effectively fermented to stimulate the growth of bacteria in the large gut leading to an increase in the total number of bacteria or biomass.

CONCLUSION

Supplementation of the maize stover based diets with the leaves of SC and CL improved DMI and nutrient digestibility of the goats and throughout the experimental period all animals remain healthy. The acceptance of both forages is of significant nutritional interest because there is little or no information on their utilization as supplements in low quality roughage diets. Both are unconventional forages. Finally the non rejection of the diets indicates that *Spathodea campanulata* and *Citrus limon* leaves can effectively be utilized in ruminant diets without adverse nutritional effects, however the leaves of *Spathodea campanulata* (African tulip) was preferred and consumed more than those of *Citrus limon*.

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Nutriční hodnota a dobrovolný příjem krmiva listí afrického tulipánu a citronu jako výživových doplňků v krmení rostoucích koz suchým krmivem kukuřice neošetřeným a ošetřeným močovinou.

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Čtyři rostoucí kozy anglo-nubijského plemene ve věku 10–15 měsíců, s průměrnou živou hmotností před pokusem 14,8 ± 1,6 kg byly zařazeny do randomizovaného pokusu s rozmístěním 4 x 4 latinských čtverců s faktoriálním uspořádáním 2 x 2, který měl za cíl sledovat nutriční hodnotu a neomezený příjem krmiva listí afrického tulipánu (*Spathoda campulata*) a citronu (*Citrus limon*) jako doplňky suchého krmiva kukuřice ošetřené (MOK) a neošetřené močovinou (MNK). Byly použity čtyři diety: dieta 1 – neošetřené suché krmivo kukuřice + *Spathoda campulata* (MNK+SC); dieta 2 – suché krmivo kukuřice neošetřené + *Citrus limon* (MNK+CL); dieta 3 – suché krmivo kukuřice ošetřené močovinou + *Spathoda campulata* (MOK+SC); dieta 4 – suché krmivo kukuřice ošetřené močovinou + *Citrus limon* (MOK+CL). Krmivo bylo řádně rozmixované. Hodnoty dusíkatých látek (DL) a brutto energie (BE) *Spathoda campulata* (SC) a *Citrus limon* (CL) byly 13,1 % dusíkatých látek; 14,8 MJ/kg sušiny brutto energie a 14,8 % dusíkatých látek, resp. 14,3 MJ/kg DL BE. Ošetření močovinou zvýšilo DL suchého krmiva ze 4,6 na 5,3 %. Přísun SC a CL snížil obsah hrubé vlákniny (HV) víc u diet MOK než u diet MNK. Příjem jednotlivých složek krmiva byl vyšší ($P < 0,05$) pro MOK a SC než pro MNK a CL. Hodnoty dobrovolného příjmu krmiva a příjmu sušiny (PS) MNK+SC; MNK+CL; MOK+SC a MOK+CL byly: 388,3; 373,2; 521,8 a 430,6 g/kus/den; a 87,5; 84,9; 109,2 a 94,5 g/kg$^{-0,75}$. Stravitelnost sušiny, hrubé vlákniny, dusíkatých látek, OM, celkových uhlovodanů a celkově stravitelných živin (CSŽ) a denní příjem proteinů (N x 6,25)(g/kg^{-1}W^{0,75}/den) měly vyšší hodnoty ($P < 0.05$) u MOK než u MNK. Ošetření močovinou nemělo vliv na stravitelnost hrubé vlákniny, ale kozy na dietě s MOK+SC a MNK+CL měly tendenci mít vyšší příjem stravitelné sušiny než u MNK+SC a MNK+CL. Doplnění s SC a CL zlepšilo příjem sušiny a stravitelnost živin diet nad 50 %. Neodmítání diet prokázalo, že listy SC a CL lze efektivně využít jako doplňky výživy koz bez negativních dopadů; avšak listy *Spathoda campulata* kozy konzumovaly víc než listy citronu.

africký tulipán (*Spathoda campulata*); citron (*Citrus limon*); močovina – nasycení amoniakem; suché krmivo kukuřice; kozy; příjem sušiny; denní příjem proteinů; stravitelnost

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