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NUTRITIVE VALUE, BIOMASS YIELD OF MAKU LOTUS - A TEMPERATE PERENNIAL LEGUME AND ITS EFFECT ON GROWTH PERFORMANCE AND INTAKE OF NUTRIENTS IN SANDYNO WEANER LAMBS

P.C. Sakthivel*, M. Prabhu, N. Prema and M. Iyue
Assistant Professor, Animal Feed Analytical and Quality Assurance Laboratory, Veterinary College and Research Institute, Namakkal -637 002
Sheep Breeding Research Station, Sandynallah -643 237, The Nilgiris
Tamil Nadu Veterinary and Animal Sciences University, Chennai -600 051
E-mail: sakthivelpc@gmail.com (**Corresponding Author*)

Abstract: A study was conducted to assess the nutritive value, biomass yield of Maku lotus and its effect on growth performance and intake of nutrients in Sandyno weaner lambs. A representative area of Maku lotus field was selected and harvested to find out the biomass yield and the same was analyzed for proximate composition and fibre fractions. 32 weaned Sandyno lambs were randomly divided in to four homogeneous groups with regard to sex and body weight. Group T1 animals were fed 200 g of concentrate feed and 5 hr grazing in kikuyu pasture. Group T2 animals were fed same amount of concentrate with rotational grazing in kikuyu pasture. Group T3 and T4 animals were fed Maku lotus legume fodder by replacing 50 and 100% of crude protein from concentrate mixture on protein basis. A 90 days feeding trial followed by digestion trial was conducted to assess the growth performance and intake of nutrients in Sandyno weaner lambs. Maku lotus contained average DM content of 13.20 %. It also contains high protein (24.20%) and calcium (1.39 %) content. Neutral detergent fibre, acid detergent fibre, cellulose and lignin contents of Maku lotus were 50.93, 35.69, 15.76 and 16.85%, respectively. The average yield of Maku lotus was 8.104 MT per acre per harvest. Average total body weight gain of the animals of group T1, T2, T3 and T4 was 5.519, 5.807, 5.058 and 4.890 Kg, respectively and they did not differ ($P>0.05$) significantly among the treatment groups. The overall average daily gain of animals of group T1, T2, T3 and T4 was 61, 65, 57 and 54 g/day, respectively for four groups and they did not differ ($P>0.05$) among the dietary treatment groups. Dry matter intake (per cent body weight), DCP intake (g/kg $W^{0.75}$), TDN intake (g/kg $W^{0.75}$) did not differ significantly ($P>0.05$) between four treatment groups. From this study it could be concluded that feeding of Maku lotus at 30% dry matter intake as replacement to concentrate feed did not affect the growth, average daily gain, dry matter intake, DCP intake and TDN intake in Sandyno weaner lambs.
Keywords: Maku lotus, nutritive value, yield, growth performance, intake of nutrients, Sandyno weaner lambs.

Introduction

Quantity and quality of the feed supply remains the major limiting factor for improved livestock productivity. Inadequate nutrition affects the expression of its full genetic

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potential. Balanced feeding is important to minimize the cost of production and increase the net profit of livestock rearing. The swamp areas in the Nilgiri hills are not suitable for any agricultural operation and fodder production since the pH of the soil is around 4.5 and mostly in acidic nature. Maku lotus is a perennial legume fodder most suitable for acidic, low fertility soils of the above type. Cossens (1983) concluded that Maku lotus should be looked upon as pioneer legume for soils where pH is less than 5.0 at altitudes greater than 900 M. Invermay Agricultural Research Centre have shown its potential on soils with a pH less than 5,2, where it can out yield white clover at equivalent rates of applied phosphorous (Scott and Mullis, 1981). Maku lotus has some frost tolerance. Frost will kill leaves and stolons of Maku lotus, but established plant will shoot again in spring season. Crude protein content of Maku lotus analysed previously at Sheep Breeding Research Station was around 18% (unpublished report). However, feeding value of fresh Maku lotus in sheep is limited to the preliminary report under Indian condition. Hence, the present study was undertaken to study nutritive value and biomass yield of Maku lotus and growth performance and intake of nutrients in Sandyno weaner lambs fed Maku lotus based diet.

Materials and Methods

Maku lotus was harvested in the swamp field of Sheep Breeding Research Station, Sandynallah and two representative samples were collected. The sample was dried in hot over at 65 ± 5 ^{0} C and ground to pass through 1 mm sieve for further analysis. Proximate composition of Maku lotus was analyzed as per AOAC (1995) methods and fibre fractions were estimated as per Van Soest *et al.* (1991). A measured area of Maku lotus field was harvested and yield of fodder was weighed to calculate yield of biomass per acre by extrapolation.

Sandyno weaner lambs were dewormed 30 days before the start of the trial. 32 weaned Sandyno lambs were randomly divided in to four homogeneous groups with regards to body weight and sex. Each group contained four male and four female lambs and they were randomly allotted the following four dietary treatments.

T1 – 200 g of concentrate mixture and 5 hours of normal grazing management with equal amount of kikuyu grass feeding in the evening hour.

T2 – 200 g of concentrate mixture and 5 hours rotational grazing management with equal amount of kikuyu grass feeding in the evening hour.

T3- 100 g of concentrate mixture plus 50 % of crude protein supplied by the concentrate mixture was replaced by Maku lotus fodder supplementation along with 5 hours of normal grazing management with equal amount of kikuyu grass feeding in the evening hour

T4 - 100 % of crude protein supplied by the concentrate mixture was replaced by Maku lotus fodder supplementation along with 5 hours of normal grazing management with equal amount of kikuyu grass feeding in the evening hour.

Concentrate mixture contained 19.70 % crude protein and 65% total digestible nutrients. Composition of concentrate mixture was as follows

Table 1 Ingredient composition of the concentrate mixture

S. No	Name of the ingredient	Quantity
1	Maize	108.000
2	De-oiled rice bran	58.000
3	Soya bean meal	39.200
4	Cotton seed cake	34.000
5	Salt	4.000
6	Calcite powder	10.500
7	Di-calcium phosphate	0.910
8	Non-Starch Polysaccharide degrading enzymes	0.130
9	Ultra trace mineral mixture	0.250

Animals of each group were housed together in a separate enclosure having arrangements for feeding and watering facility. Lambs of respective group were fed concentrate mixture and or half of Maku lotus fodder in the morning and remaining half of Maku lotus fodder in the evening time. Lambs of all groups except group T2 were grazed in the common pasture area for 5 hours grazing.

A total of 59200 square feet area of fenced kikuyu pasture land was divided in to four partitions and lambs of group T2 were allowed to graze 8-10 days in each partition on rotational basis depending upon the pasture availability. Lambs were provided with adequate drinking water and mineralized salt lick in the shed. Lambs were weighed once in 15 days to find out changes in body weight and average daily weight gain was calculated.

After the end of 90 days of feeding trial period, animals of each group housed in separate enclosure and maintained in their respective dietary regime same as that of feeding

experiment, but the animals were fed required kikuyu grass inside the shed. One week of preliminary adaptation feeding period followed by five days of collection period to find out the intake of nutrients. Animals were fed known quantity of concentrate mixture, Maku lotus and kikuyu grass at fixed time interval. For each day the left over kikuyu grass and Maku lotus were collected, weighed and a representative sample was taken for its dry matter (DM) estimation. DM content of concentrate feed, kikuyu grass and Maku lotus and left-over kikuyu grass and Maku lotus fodder samples were taken for each day and analyzed its dry matter content. Dung samples of each group was collected on the next day morning, weighed, mixed thoroughly and sub-samples were taken DM and nitrogen estimation for each day taking as a replicate. For nitrogen estimation dung samples stored in 20% H_2SO_4 solution in air tight container. Known fraction of dung samples were dried at 80 ± 5^0C for 14 hrs. to find out the DM content to obtain DM digestibility. Concentrate mixture, kikuyu grass, Maku lotus, left-over kikuyu grass and Maku lotus of each group and dung samples were analyzed for its proximate composition as per AOAC (1995) method. Nutrient intake was calculated for each day for each group and average intake of nutrient for each group was calculated.

All statistical analyses were performed as per standard methods (Snedecor and Cochran, 1989) by using SPSS version 17.0 computer package. For comparison of multiple groups generalized linear model of ANOVA procedures and Turkey's multiple range tests were used.

Result and Discussion

Proximate Composition of Maku lotus

Dry matter (DM) content

Representative samples of Maku lotus contains average DM content of 13.20 ± 0.34 per cent during spring season. During digestion trial, Maku lotus contains average DM of 12.29 ± 0.85 per cent. The highest and lowest DM values are 18.17 and 8.66 per cent, respectively. DM content is low during rainy days and early morning harvest whereas, higher during the sunny days and summer months. Wide variations in DM content and higher moisture content are the constraints to control the intake of Maku lotus. So, this legume fodder may be wilted for some time and then fed to animals to avoid wet housing condition which may predispose to foot problems.

Two representative samples of Maku lotus were analysed for its proximate, mineral and fibre fractions during spring season. Nutrient content is presented in Table 2 on DM basis. Maku lotus contains high protein and calcium content of 24.20 & 1.39 per cent, respectively.

Table 2. Nutrient composition of Maku lotus during spring season

S. No.	Parameter	Value (%) on DM basis
1	Crude Protein	24.20 ± 0.37
2	Crude Fibre	18.56 ± 0.88
3	Ether Extract	04.82 ± 0.30
4	Total Ash	08.01 ± 0.31
5	Acid Insoluble Ash	00.34 ± 0.16
6	Nitrogen Free Extract	44.43 ± 0.50
7	Calcium	01.39 ± 0.01
8	Phosphorous	00.37 ± 0.02
9	Neutral Detergent Fibre	50.93 ± 0.90
10	Acid Detergent Fibre	35.69 ± 1.68
11	Cellulose	15.76 ± 0.23
12	Lignin	16.85 ± 3.18
13	Hemicellulose	15.24 ± 0.78

During digestion trial period, Maku lotus contains lower crude protein (21.81% vs 24.20 %) and ether extract (2.90% vs 04.82) and higher crude fibre (24.64% vs 18.56%) content than the previous spring season. This might be due to higher maturity of the fodder which increases the crude fibre content and proportionately reduces the remaining nutrients present in the Maku lotus fodder. John and Lancashire (1981) found that the crude protein (26.70%), readily fermentable carbohydrate and structural carbohydrate is similar to that of other legumes grown in New Zealand, but the lignin content (11.60) of lotus species is higher than three to four times that of white and red clover. Crude protein content of Maku lotus of the present study is lower (24.20 -21.81%) than that reported by John and Lancashire (1981). However, Crude protein levels can be as high as 28% in young growth, declining with age to 20% or less in *Lotus pedunculatus* as reported in tropical forage. Lotus had about 28–40 g N/kg DM (17–24% crude protein) as reported by Waghorn *et al.* (1998). Barry (1985) found that lotus contained 9.0% soluble carbohydrate, 7.8% hemicellulose, 20.80% cellulose and 16.3% lignin on DM basis. Schiller and Ayres (1993) found that the level of nitrogen and *in-vitro* organic matter digestibility for lotus declined and structural fibre progressively with the onset of winter and these effects were most marked with the occurrence of severe frosting.

Biomass Yield

Yield of Maku lotus varied from 5.126 to 13.516 MT of green fodder per acre per harvest depending upon the height of the plant growth. The average yield is 8.104 MT per acre per harvest and three to four harvests per year is possible. Phosphate fertilization may be required in poor fertility soils to obtain higher yield. Waghorn *et al.* (1998) reported that the dry matter production of pure swards of *Lotus pedunculatus* ranged between 7–13 t/ha in New Zealand pasture field.

Feeding Trial

Changes in Body Weight

Change in fortnightly body weight of experimental animals is presented Table 3.

Table 3. Fortnightly average body weight changes of experimental animals

Sl. No.	Days	T1	T2	T3	T4	P value
1	0	13.820 ± 0.32	13.825 ± 0.31	13.825 ± 0.32	13.835 ± 0.34	1.00
2	15	14.703 ± 0.31	14.854 ± 0.43	14.365 ± 0.38	14.658 ± 0.41	0.84
3	30	15.744 ± 0.23	16.017 ± 0.43	15.374 ± 0.36	15.662 ± 0.46	0.70
4	45	16.344 ± 0.21	17.070 ± 0.47	16.136 ± 0.36	16.280 ± 0.54	0.40
5	60	17.401 ± 0.20	18.071 ± 0.49	17.004 ± 0.36	17.015 ± 0.61	0.30
6	75	18.554 ± 0.26	19.202 ± 0.50	18.111 ± 0.41	18.025 ± 0.63	0.29
7	90	19.339 ± 0.30	19.707 ± 0.59	18.883 ± 0.68	18.725 ± 0.65	0.64
8	Body weight gain	5.519 ± 0.35	5.807 ± 0.42	5.058 ± 0.67	4.890 ± 0.45	0.55

Fortnightly average body weight of experimental animals of group T1, T2, T3 and T4 did not differ significantly ($P>0.05$) between groups for the whole trial period. Initial average body weight of animals of the four experimental groups was 13.820, 13.825, 13.825 and 13.835 Kg, respectively for T1, T2, T3 and T4. The final average body weight of the animals of group T1, T2, T3 and T4 was 19.339, 19.707, 18.883 and 18.725 Kg, respectively. Average total body weight gain of the animals of group T1, T2, T3 and T4 was 5.519, 5.807, 5.058 and 4.890 Kg, respectively. Body weight of animals of Maku lotus fed group was numerically lower than the control and rotational grazing group, but they did not differ significantly between treatment groups. The numerically lower body weight of animal fed Maku lotus may be due to varying dry matter content of Maku lotus depending up on the time

of harvest and time lapse between harvesting and feeding. John and Lancashire (1981) concluded that the enhanced nutritive value of Maku lotus with presence of condensed tannins could be one reason for the higher animal performance than with some other legumes. The growth of lambs grazing pure lotus (116 g lignin/kg DM) was very high (153-315 g/d) and averaged 87 % of that for lambs grazing pure white clover (190-354 g/d; John & Lancashire, 1981). Similarly, Marten and Jordan (1979) had shown that substitution of a pure stand of *Lotus corniculatus* for one-third of a lucerne-grass pasture system gave a 23% increase in daily weight gain of lambs.

Average Daily Gain

Fortnightly average daily gain of the experimental animals is presented in Table 4.

Table 4. Fortnightly average daily gain of experimental animals

Sl. No.	Days	T1	T2	T3	T4	P value
1	15	59 ± 17	69 ± 15	36 ± 18	55 ±13	0.54
2	30	69 ± 11	78 ± 6	67 ± 8	67 ± 6	0.76
3	45	40^{a} ± 8	70^{b} ± 4	51^{ab} ± 6	41^{a} ± 8	0.02
4	60	71^{b} ± 6	67^{ab} ± 3	58^{ab} ± 3	49^{a} ± 8	0.04
5	75	77 ± 7	75 ± 1	74 ± 7	67 ± 5	0.62
6	90	52 ± 4	32 ± 6	51 ± 22	47 ± 9	0.76
7	Overall	61 ± 4	65 ± 5	56 ± 7	54 ± 5	0.56

Average daily gain of the animals of group T1, T2, T3 and T4 did not differ significantly (P>0.05) between treatment groups except for the third and fourth fortnight. For the third and fourth fortnight, lower average daily gain in group T3 & T4 may be due to dry matter content variation in Maku lots fed to the animals. Group T2 animals had higher amount of kikuyu pasture in rotational grazing area with low stocking density. The overall average daily gain of animals of group T1, T2, T3 and T4 is 61, 65, 57 and 54 g/day, respectively for four groups.

Digestion Trial

Proximate composition of concentrate feed, kikuyu grass and Maku lotus fed during the digestion trial is presented in Table 5. Crude protein content of concentrate feed, kikuyu grass and Maku lotus is 19.73%, 11.02% and 21.81%, respectively.

Table 5. Proximate composition of concentrate feed, Kikuyu grass and Maku lotus on dry matter basis

Sl. No	Parameter	Concentrate feed	Kikuyu grass	Maku lotus
1	Crude protein, %	19.73	11.02 ± 0.13	21.81 ± 0.22
2	Ether extract, %	1.60	1.96 ± 0.03	2.90 ± 0.09
3	Total Ash, %	14.05	9.17 ± 0.44	7.10 ± 0.18
4	Acid insoluble ash, %	5.42	2.60 ± 0.57	0.55 ± 0.05
5	Crude fibre, %	11.67	30.54 ± 0.43	24.64 ± 0.60
6	Nitrogen free extract,%	53.77	49.11 ± 0.06	45.00 ± 1.05
7	Gross Energy (Calculated), Kcal/kg	3851	3922 ± 18.04	4233 ± 1.43

Dry matter content of the dung of four groups of experimental animals varied between 20.86 to 29.56%. But the total ash and acid insoluble ash content of group T3 was higher than other three groups. This might be due to contamination of sand in the shed while collecting the dung. Lower total ash and acid insoluble ash content of groupT4 group might be due to lower sand and silica content of Maku lotus. Concentrate feed and kikuyu grass contain medium amount of acid insoluble ash. So, the groups T1 & T2 contained higher acid insoluble ash than group T4. There is no concentrate feeding in T4 group may also be a contributing factor.

Intake of Nutrients

Intake of different nutrients by the experimental animals is presented in the Table 6

Table 6. Nutrient content of the diet and intake of nutrients by experimental animals

Sl. No	Nutrients	T1	T2	T3	T4	P value
1	Dry matter intake, per cent body weight	3.00 ± 0.19	2.38 ± 0.15	3.07 ± 0.32	2.60 ± 0.81	0.086
2	DCP intake, g/kg $W^{0.75}$	4.74 ± 0.72	3.76 ± 0.28	4.39 ± 0.52	4.84 ± 1.15	0.733
3	TDN intake, g/kg $W^{0.75}$	40.17 ± 2.39	36.04 ± 1.35	35.98 ± 3.73	33.81 ± 7.30	0.770
4	DCP content of the diet, %	7.59 ± 1.16	6.45 ± 0.31	6.90 ± 0.66	8.67 ± 1.17	0.356
5	TDN content of the diet, %	64.32 ± 4.12	62.32 ± 3.26	56.53 ± 3.75	61.63 ± 5.76	0.632

Dry matter intake (per cent body weight), DCP intake (g/kg $W^{0.75}$), TDN intake (g/kg $W^{0.75}$) did not differ significantly ($P>0.05$) between four treatment groups. Dry matter intake varied from 2.38 to 3.07% of body weight. DCP intake varied from 3.76 to 4.84 g/kg $W^{0.75}$

and TDN intake ranges from 33.81 to 40.17 g/kg $W^{0.75}$ in experimental animals. Dietary DCP and TDN content did not differ significantly (P>0.05) between four treatment groups. DCP and TDN content of the diet ranged between 6.45 to 8.67% and 56.53 to 64.32%, respectively. The increased animal performance has been observed in ewes in late pregnancy (Orr *et al*., 1990) and finishing lambs (Fraser *et al.*, 2004) when increasing the ratio of white clover in the DM content of the diet. Higher intakes are pivotal to higher performance with legume forages since effects on feed efficiency are inconsistent.

Conclusion

Maku lotus fodder contains 21.81 to 24.20 % crude protein and 1.39% calcium on dry matter basis. This fodder can be used as a potential protein and calcium supplement to livestock. Yield of Maku lotus is 5.126 to 13.516 MT of green fodder per acre per harvest depending upon the height of the plant growth. The average yield is 8.104 MT. Feeding of Maku lotus at 30% dry matter intake as replacement to concentrate feed did not affect the growth, average daily gain, dry matter intake, DCP intake and TDN intake in Sandyno weaner lambs

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