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Effect of Plant age on DM yield and nutritive value of some leguminous plants (*Cyamopsis tetragonoloba*, *Lablab purpureus* and Clitoria (*Clitoria ternatea*)

A.G. Mahala[1], S.O. Amasiab[1], Monera .A. Yousif[1] and A. Elsadig[2]

[1]University of Khartoum, Faculty of Animal Production, Dept of Animal Nutrition
[2]University of Khartoum Faculty of Agri. Dept. of Agronomy

Abstract

Three leguminous crops, Guar (*Cyamopsis tetragonoloba*), lubia a fin (*Lablab purpureus*) and Clitoria (*Clitoria ternatea*), were harvested at three maturity periods 45 ,60, and 75 days to study the effect of maturity on the nutritive value in terms of dry matter (DM) yield, chemical composition, calculated *in vitro* organic matter digestibility (IOMD%), metabolizable energy (ME) and relative feed values (RFV). The experiment was carried out as a completely randomized design with three replication. The data were subjected to analysis of variance according to (ANOVA) for factorial arrangement. The results revealed that the highest CP was noted for *Cyamopsis tetragonoba* 22.3%, 23% and 22% at 45, 60 and 75days harvesting times respectively. The lower values of ADF were observed for *Cyamopsis tetragonoba* particularly at first and second harvesting times 35.56% and 33.61% at 45 and 60days respectively. Accordingly the highest RFVs were 141, 123 and 94 at 45 days recorded by *lablab purpures*, *Cyamopsis tetragonlob,* and *clitoria ternatea* respectively and then decreased with age with increasing NDF and ADF. The same trend was kept in IOMD% 42%, 38% and 34% among species respectively at 45days harvesting time and this might be due to low fibre content particularly ADF in younger plants. Macro minerals value were sufficient to meet animals requirements, Ca:P ratio of *Lablab purpureus* and *Cyamopsis tetragonoloba* were more favourable at the late maturity 2:1 this may be due to decline of Ca with age with slight increase in P contents. According to RFV and regardless CP content which is higher in *Cyamopsis tetragonloba, lablab purpureus* ranked first followed by *Cyamopsis tetragonloba,* and *Clitoria ternatea*.

Keywords: Leguminous, Rfv, Maturity, Minerals.

INTRODUCTION

Sudan is a vast country covering an area of 181 million hectars (1.8 million km2) .Rangelands cover 47% of the area of the country about 90% livestock depends on natural rangeland as a source of feed. However the range condition is deteriorating due to overgrazing, drought and expansion of rain fed agriculture at the expense of rangeland. This means that there is a shortage in feed supply for livestock in the country. This necessitates that forage crops need to be given a priority in the irrigated sector to bridge the gap between forage supply and animal feed demands.

The most important forage crops grown under irrigation are grass forage such as sorghum forage and legume forages which are dominated by alfalfa. Alfalfa, as a winter crop, cannot be grown successfully under irrigation in heavy clay soil in central Sudan (central clay plains), south of Kosti-Sennar railway line because climatic condition are not suitable there. Also it cannot be part of rotation as it crop along with other factors such as a unavailability of irrigation water during summer and the presence of noxious weeds that limit its perennial production in the irrigated schemes. The other legumes forage such as Clitoria (*Clitoria ternatea*), lablab bean (*lablab purpureus*) and philipsara (phaseolus trilobus), are tropical forage crops that can be grown as summer

Corresponding Author E-mail: ahmedgofoon9@uofk.edu

forage in different parts of the countries where water is not a limiting factor. In addition to forage, legumes are the most important because of the nitrogen fixing characteristic which may be beneficial to other crops when grown in rotation. However, these forages are grown in limited areas compared to alfalfa. They can be grown in pure stand and mixture with suitable grasses in different parts of the country to improve the quality of grasses.

It was found that lubia, Clitoria and philipesara are the most productive forage legumes .Ibrahim *et al* (1996) clearly showed that lablab is better than both other crops in quantity. Lablab forage yield is relatively stable over season compared to Clitoria and philipesara. Clitoria was introduced as forage in the rotation in Gazera Scheme, but its problem is that it causes weed problems for the following crop in the rotation. Clitoria is grown in Sudan in area of about 105.00 feddans (1 fed 0.42ha). The average yield ranges between 7 and 12tons per fresh forage, which is equivalent to 3-5 to fed dry matter (Abdalla, 1999).

Irrigated forage contributes only about 4% of the total forage available to livestock in the Sudan (*Darag et al* 1995). They provide the most nutritious feed for their animals during the dry season when range forage and crop residues are limiting in nutritional quality. One way of improving the utilization of such crop residues is by proper supplementation with leguminous forages (Poppi and McLennan 1995). Recently, growing forage legumes as pure stand and mixture with grass are tremendously used in livestock production systems for ruminants. One of the management problems is the suitable time for harvesting and grazing time of forage to obtain optimum yield and quality since quality decline with age and yield increased with age. Hence the objective of this study is to investigate the effect of plant age on yield and nutritive value of some selected tropical forage legumes.

MATERLALS AND METHODS

This study was done in Faculty of Animal Production, Department of Animal Nutrition, University of Khartoum at Shambat. The experiment was conducted during the period March – July 2011. The treatments were three leguminous crops ,Guar (*Cyamopsis tetragonoloba*),lubia a fin (*Lablab purpureus*) and Clitoria (*Clitoria ternatea*), and three harvesting ages; 45, 60, and 75 days after sowing. The experiment was carried out as a factorial experiment in completely randomized design with three replications. The test crops were sown in plastic containers of 30cm diameter. Each plastic container was filled with 5kg of clay soil (Shambat soil). Sowing was on the first of March at a seed rate of 4-5 seeds per container. Irrigation was carried at two days intervals.

Collection of samples

Collection of samples was done by clipping the crops at 45, 60 days and 75 days after sowing. The plants were weighed immediately after clipping to obtain fresh weight. Then samples used for fresh weight were dried in the oven at 105°c for 24hours, to obtain dry weight

Chemical analysis

The dried samples were grinded in a hummer mill to be used for proximate analysis. Crude protein, crude fiber, ether extract and ash and were determined according to AOAC (1990), NFE was calculated. (NDF) Neutral detergent fiber, (ADF) acid detergent fiber and (ADL) acid detergent lignin were determined using (Van Soest *et al*. 1991). The relative feed value (RFV) was calculated according to Stallings (2005) following the equation:

RFV = (DMD * DMI) /1.29

Where

DMD = dry matter digestibility = 88.9 – (0.779 * %ADF)

DMI = dry matter intake = 120/ %NDF

1.29 = (the expected digestible dry matter intake as % of body weight for full-bloom alfalfa).

In –vitro Gas production Test:

Rumen fluid was obtained from fistulae steers fed alfalfa hay ad libitum and 1kg each of concentrate mixture. Two runs of gas production study were carried out by using calibrated glass syringes following the procedures of Menkes and Steingass (1988). Approximately 200 mg of DM sample was weighed in triplicate into glass syringes. The syringes were pre-warmed at 39 C° before the injection of 30 ml rumen fluid –buffer mixture into each syringe followed by incubation in a water bath at 39 C°. The syringes were gently shaken at 30 minutes after the start of incubation and every hour for the first 10 h of incubation. Gas production was recorded before incubation (0) and 24 hours after incubation.

The Metabolizable energy (M J/ Kg M g) content and *in vitro* organic matter digestibility (IOMD %) were calculated using equations suggested by (Menke *et al*, 1979) as follows:

M E (M J / K g DM) = 2.20 + 0.136 GP0.057 CP

IOM D (%) =14. 88 +0.889 GP + 0.45 CP + 0.065 I X A.

Where: GP: 24 h net gas production (M L / 200 mg DM),
CP: Crude protein (%).
X A: Ash content (%).

Macro mineral determination

Calcium, magnesium, sodium, potassium and

Table 1. Chemical composition of the three plants (*Cyamopsis tetragonoloba*, *Lablab purpureus Clitoria ternatea*).

Crop	Harvest time (days)	CP%	CF%	E. E%	ASH%	NFE%
Cyamopsis tetragonoloba	45	22.8 ^{a}	20 ^{d}	1 ^{de}	12.7 ^{bc}	43 ^{bc}
	60	23 ^{a}	20 ^{d}	2.5 ^{a}	12.8 ^{b}	41.6 ^{bcd}
	75	22 ^{a}	25 ^{bc}	0.8 ^{e}	11 ^{e}	37.4 ^{e}
Lablab purpureus	45	17 ^{c}	23 ^{c}	1.8 ^{bcde}	13.7 ^{a}	44 ^{b}
	60	11 ^{c}	23 ^{c}	2.8 ^{bc}	13.6 ^{a}	49 ^{a}
	75	19 ^{b}	25 ^{bc}	1.5 ^{cde}	12 ^{d}	41 ^{cde}
Clitoria ternatea	45	17 ^{c}	25 ^{b}	3 ^{b}	12 .7 ^{c}	45 ^{b}
	60	17 ^{c}	25 ^{b}	2.6 ^{bcd}	12 ^{d}	44 ^{bc}
	75	18 ^{bc}	33 ^{a}	1 ^{de}	7 ^{f}	39 ^{de}
SE +_		1.1	1	0.7	0.1	1.5
Level of significance		**	**	**	**	**

Means with different superscripted are significantly ($p<0.05$) different. **= ($p<0.001$)
CP= Crude protein
CF = Crude fiber
EE =Ether Extract
NFE = nitrogen free extract
SEM = Stander Error of means

phosphorus of samples studied were determined according to the method described by (Chaman and Patt 1961) method.

Statistical Analysis

The data was subjected to analysis of variance (ANOVA) for the completely randomized block design (Steel and Torrie, 1980). The least significant difference (LSD) procedure was used for mean separation. .

RESULTS

Chemical composition of *Cyamopsis tetragonoloba, Lablab purpureus* and *Clitoria ternatea* are shown in Table 1. Crude protein values were significantly different among the plants for the three harvesting times. Generally CP decreased with maturity, *Cyamopsis tetragonoloba* had significantly ($P<0.01$) higher CP than *Lablab purpureus* and *Clitoria ternatea* for the three harvesting times.

The highest Crude fiber (33%) was obtained in (Clitoria *ternatea)* at 75 days. While the lowest value (20%) was obtained in Guar (*Cyamopsis tetragonoloba*) at 45, 60 days (Table 1).

Similar to CP and CF the E.E value were significantly ($P<0.01$) different between the three plants at the three harvesting times (Table 1).

Ash content significantly ($P<0.01$) decreased with ageing in the three crops with significantly ($P<0.01$) higher values observed for *Lablab purpureus* 13.7%, 13.6% and 12% at 45, 60 and 75days, respectively. (Table 1)

Nitrogen free extract similarly to CP and Ash decreased with maturity. The highest NFE (49%) was obtained in lubia (*Lablab purpureus*) at 60 days, while the lowest NFE (37%) was obtained in guar (*Cyamopsis tetragonoloba*) at 75 days (Table 1).

Values of dry matter yield (ton/ hectare) were significantly ($p< 0.01$) different among the plants for the three harvesting times. The yields for Lablab, clitoria and Guar were 5.02, 4.99, 4.45ton/hectare at75 days, respectively. Generally DM yield increased with maturity. *Clitoria ternatea* had significantly ($p< 0.01$) higher DM yield than *lablab purpureus and Cyamopsis tetragonloba* for the three harvesting time (Table 2).

NDF, ADF and ADL contents were significantly ($p<0.01$) different due to age in all plants. The lower values of ADF were observed for *Cyamopsis tetragonoloba* particularly at first and second harvesting times 35.56% and 33.61% at 45 and 60days, respectively (Table2). Accordingly, RFVs varied significantly ($p<0.01$) among species. The highest RFVs were 141, 123 and 94 at 45days recorded by *lablab purpureus*, *Cyamopsis tetragonoloba,* and *Clitoria ternatea*, respectively.

Metabolic energy in this study was significantly ($p<0.01$) different between the plants with age. The highest ME (7.2Mj/Kg DM) was obtained in *Clitoria ternatea* at 75 days, while the lowest ME (4Mj/Kg) was obtained in *Clitoria ternatea* at 60 days (Table 2).

In vitro organic matter digestibility values in *Cyamopsis tetragonloba* and *Clitoria ternatea* increased

Table 2. Chemical composition, dry matter (DM Yield ton/ ha), In vitro organic matter digestibility (IOMD) and Metabolic energy (M J/Kg DM) of *Cyamopsis tetragonoloba* , *Lablab purpureus* and *Clitoria* ternatea.

Crop	Harvesting time	DM yield (ton/ha)	NDF%	ADF%	ADL%	RFV	ME (MJ/Kg DM)	IOMD%
Cyamopsis tetragonoloba	45	1.85^{b}	44.64^{f}	35.56^{h}	14.9^{l}	123^{b}	5^{cd}	38$^{b c d}$
	60	2.62^{b}	51.2^{c}	33.61^{l}	16.3^{g}	98^{d}	6.1^{b}	37$^{b c d}$
	75	4.45^{a}	47.65^{e}	46.12^{c}	21.66^{d}	118^{bc}	4.7^{ef}	40$^{b c}$
Lablab purpureus	45	2.53^{b}	41.09^{g}	43.29^{d}	15.27^{h}	141^{a}	5.2^{de}	42^{e}
	60	2.94^{b}	49.46^{d}	40.24^{f}	21.02^{e}	107^{c}	4.7^{g}	26^{e}
	75	5.02^{a}	50.77^{cd}	47.61^{b}	22.65^{b}	106^{cd}	5.9^{b}	33$^{d e}$
Clitoria ternatea	45	3.29^{b}	52.06^{c}	36.24^{g}	17.89^{f}	94^{e}	5 .8^{bc}	34$^{c d}$
	60	3.57^{ab}	59.09^{b}	41.11^{e}	22.07^{c}	80^{f}	4^{f}	36$^{b c d}$
	75	4.99^{a}	66.99^{a}	48.73^{a}	23.75^{a}	71^{g}	7.2^{a}	49^{a}
SEM		0.85	0.27	0.78	0.07		0.26	3.33
Level of significance		**	**	**	**	**	**	**

Means with different superscripted in some column were significantly at p<0.001
DM = dry matter yield ton/ha
NDF = Neutral detergent fiber
ADF = Acid detergent fiber
ADL = Acid detergent lignin
REV = relative feed value
OMD = Organic matter digestibility (%)
ME = Metabolizable energy (MJ/Kg DM)

with the time from 38% and 34% to 40% and 49%, respectively. The significantly (P<0.01) highest IOMD (49 %) was obtained in (*Clitoria ternatea*) at 75days. The significantly (P<0.01) lowest OMD (26%) was obtained in lubia (*Lablab purpureus*) at 60 days, (Table 2).

Macro Mineral

Values for calcium contents significantly (P<0.01) decreased with age in the three forage plants. The significantly (P<0.01) high values were observed for (*Clitoria ternatea*) 2.3%, 2.2% and1.9% at 45, 60 and 75 days, respectively (Table 3).

For sodium contents, the values were not significantly different with age. The highest Na values 1.1%, 1.2% and 0.9% were obtained in (*Clitoria ternatea*) at 45, 60 and 75 days, respectively. The lowest Na (0.1%) was obtained in guar (*Cyamopsis tetragonoloba*) at 45days,(Table 3).

Potassium contents, similar to Na were significantly (P<0.01) decreased with age in the three plants at the three harvesting time. The significantly (P<0.01) higher values were observed for *Clitoria ternatea* 18.7%, 17%, and 11.8% at 45, 60 and 75days, respectively (Table 3).

Sodium, potassium and magnesium contents increased with maturity. The significantly (P<0.01) highest Mg (7.8%) was obtained for *Clitoria ternatea* at 75 days (Table 3).

Phosphorus values significantly decreased with maturity. *Clitoria ternatea* had significantly (P<0.01) higher P than (*Cyamopsis tetragonoloba*) and (*Lablab purpureus*) for the three harvesting times (Table 3).

In general, *Clitoria ternatea* had significantly (P<0.01) higher Ca, K, Na and Mg contents and significantly (P<0.01) lower P content than *Cyamopsis tetragonoloba* and *Lablab purpureus*

Table 3. Macro mineral of the three plans (*Cyamopsis tetragonoloba , Lablab purpureus*, *Clitoria* ternatea).

Crop	harvest /time	Ca %	k%	Na%	Mg%	P %	Ca:P ration was calculated
Cyamopsis tetragonoloba	45	2.3[a]	6.3 [c]	0.1 [b]	0.7 [c]	0.6 [ab]	3:1
	60	2.2 [a]	5.9 [c d]	0.2 [b]	0.7 [c]	0.5 [b c d]	4:1
	75	2.0 [b]	2.9 [e]	0.4 [b]	1.2 [c]	0.6 [a]	2:1
Lablab pursuers	45	1.9 [bc]	5.1 [c d]	0.3 [b]	0.8 [c]	0.4 [c d]	3:1
	60	1.6 [bcd]	5.6 [c d]	0.3 [b]	1.1 [c]	0.5 [a b c]	3:1
	75	1.6 [bcd]	4.3 [d E]	0.2 [b]	1.4 [c]	0.6 [a b]	2:1
Clitoris ternate a	45	1.2 [cd]	18.7 [a]	1.1 [a]	6.9 [a]	0.4 [c d]	5:1
	60	0.9 [d]	17 [a]	1.2 [a]	5.1 [b]	0.4 [c d]	6:1
	75	0.8 [d]	11. [b]	0.9 [a]	7.8 [a]	0.4 [d]	5:1
SEM		0.8	0.8	0.2	0.6	0.1	
Level of significant		**	**	**	*	**	

means with different superscripts in the some column were significantly different at (p<0.05)
*= (P< 0.05) **= (P< 0.001)
Ca = Calcium (%)
K = potassium (%)
Na = Sodium (%)
Mg = Magnesium (%)
p = phosphorus (%)
SE = Standard error of means

DISCUSSION

Lablab Forage yield in this study were 2.5, 2.9 and 5t/ha at 45, 60 and 75 days respectively. This result at early harvesting times is similar to 2.6 t/ha dry matter reported by Mustafa *et al*. (1999). However, Osman and Osman (1981) reported a yield from 1.47 to 2.46 t/ha dry matter in saline Soil in Soba. Katiyar *et al* (1970) found the fresh yield of clitoria was 24.3 t/ ha with 21.8% DM.

The highest CP was noted for *Cyamopsis tetragonoloba* 22.3%, 23% and 22% at 45, 60 and 75days harvesting times respectively. These values were slight higher than 21.5% which reported by Kalamani and Michael (2001) for *Clitoria ternatea,* and their nutritive quality values declines less with age. These results were similar to Barro and Ribeiro.(1983) who found that the CP content was decline from 23% to 19%. *Cyamopsis tetragonoloba* ranking first in term of CP contents at the three harvesting times when compared with *Clitoria ternatea* and *Lablab purpureus*. The CP, ADF and NDF for most of the annual legumes were >15g kg–1, <35 g kg–1 and <45 g kg–1, respectively, which provides a relative nutritive value index of >140 (Van Soest1994) that would be able to meet the nutritive requirements of beef cows (NRC 1996).

The lower values of ADF were observed for *Cyamopsis tetragonoloba* particularly at first and second harvesting times 35.56% and 33.61% at 45 and 60days respectively. NDF and ADF were varied between plants species and lower at early stage 45 days. Accordingly RFVs were varied among species, the highest RFVs were 141, 123 and 94 at 45 days recorded by *lablab purpureus*, *Cyamopsis tetragonloba,* and *Clitoria ternatea* respectively and then decreased with age with increasing NDF and ADF. The same trend was kept in IOMD% 42%, 38% and 34% among species respectively at 45days harvesting time and this might be due to least fibre content particularly ADF in younger plants, with unexplained increases in IOMD% with age from 38% and 34% to 40% and 49% in *Cyamopsis tetragonoloba* and *Clitoria ternatea* respectively. While IOMD% of lablab in this study declines with maturity that similar to (Milford and Minis 1968).

NDF, ADF, and ADL in lablab plant in this study were 50.77%, 47.61% and 22.65% respectively at 75days which is relatively higher than that reported by (Norton and Poppy1995) 43%, 38.6%, and 7.1% respectively. In Clitoria the levels of crude protein and crude fiber in the leaves were 21.5% and 29% respectively (Kalamani and Michael 2001) while Katiyar *et al* (1970) found 21.4% CP, 3.1% EE 33.3% CF, 34.7% NFE, 7.5% ash, 0.8% Ca and 0.28% P. In general the total plant protein ranges from 14-20% which is similar to the obtained results 17%, 17% and 18% at 45, 60 and 75 days respectively.

Legumes accumulate more calcium than grasses Mahala *et al* (2010) which is adequate to meet animals requirement 6g/kg DM (NRC, 2000) Ca contents observed for (*Clitoria ternatea*) were 2.3%, 2.2% and1.9% at 45, 60 and 75 days, respectively. These results were comparable with 0.8% founded by Katiyar et al (1970). Ca was decreased slightly with age this result was agreed by Mahala *et al* (2010).

The daily requirement of sodium for lactating cows (0.1-0.19%), lactating ewes (0.09-0.18%) (NRC, 1985) and beef cattle (0.06-0.08%) (NRC,1996).

The highest Mg level 7.8% observed in *Clitoria ternatea* this is lower than that reported by (Thompson, 1978) who found 10-25%. The theoretical requirement of Mg for beef cattle (0.02-(0.12%) (NRC, 1996) and for lactating cow (0.12- 0.21%) (NRC, 2001), for growing lambs (0.08 -0.15%), lactating ewes (0.09-0.18%) (INRA, 1989)

Phosphorus content in forage decreases with plant maturity (McDowell, 1996). Lablab P content is adequate proper nutrition of ruminant animals. This is because the range of lablab P concentration values in the present study (4.0-6.0 g P kg^{-1}) was within the range of the National Research Council (NRC) recommendation

The values of Ca: P ratios recorded for all plants in this study are adequate for various species of ruminant animals. The recommended Ca: P ratio in ruminant feeds is 2:1 (Buxton, 2008). The Ca:P ratio of *Lablab purpureus* and *Cyamopsis tetragonoloba* were more favourable at the late maturity 2:1 this may be due to decline of Ca with age with slight increase in P contents.

CONCLUSIONS

At 45days *lablab purpureus*, *Cyamopsis tetragonloba,* and *Clitoria ternatea* CP contents were 17%, 22.8%, and 17%, ADF values were 43.29%, 35.56% and 36.24% and NDF values were 41.09%, 44.64% and 52.06% with RFVs 141, 123 and 94 respectively. Accordingly *lablab purpureus* ranked first followed by *Cyamopsis tetragonloba,* and *Clitoria ternatea*.

REFERENCES

Abdalla AA (1999). Effect of phosphorous Application and Sowing Methods on Growth and Yield of Clitoria ternatea, M.Sc. Thesis, Faculty of A Griculture University of Khartoum, Sudan.

AOAC (1990). Officinal Method of Analysis Association of Officinal Analytical Chemists Pp: 66-88 .15 th. *Edition Washington , D.C. USA*.

Barro C, Ribeiro A (1983). The study of *Clitoria ternatea* L. hay as a forage alternative in tropical countries evolution of the chemical composition at four different growth stages. J. Sc. of Food A griculture, 34: 780 -782.

Buxton DR (2008). Growing quality forages under variable environmental conditions. http://www.wcds.ca/proc/1995/wcd95123.htm.

Chapman HD, Part PF (1961). Methods of analysis for soil, plant and water. University of California Riverside, Division of Agricultural Sciences.

Darag A, Khider OE, Khair MA (1995). Range and other forage resource used in livestock improvement sector in kusti, Sudan OCT .1995. (in Arabic).

Ibrahim AE, Osman EK, Mohammed MA (1996). Effect of phosphorous fertilizer on growth and forage yield of *Clitoria ternatea ,Lablab purpureus* and vigna ungulate, U.K. J. Agriculture. Sci. 4(2): 18-29.

INRA (1989). Mineral requirements. In: jarring R (Editor) Ruminant Nutrition : recommended allowances and feed table - Institute National de La research A gronomique, (INRA). John Libbey Euro text publication, Paris – Pp 49 -59.

Kalamani AS, Michael Gomez S (2001). Genetic variability in clitoria spp. Ann. Agr. Re. 22:243-245.

Katiyar RC, Ranjhan SK, Shukla KS (1970). Journal Indian, J. Dairy. Sci. 23. No. 2 Pp. 79- 81.

Mahala AG, Fadel Elseed AMA, Abdalla L (2010). Effect of maturity on Nutritive value of Natural Pasture in Butana, Eastern Sudan. U of K. J. Vet. Med. and Anim. Prod.No.2,(116 – 133).

McDowell LR (1996). Feed mineral to cattle in pasture A mineral. Feed. Sci –Technol. 60. 247 - 271.

Menke KH, Steingass H (1988). Estimation of the energetic feed value obtained from chemical analysis and gas production using rumen fluid Animal Research Development, 28: 7 -55.

Menke H, H Raabl, SA Steingass, H Fritz D, Schneider W (1979). The estimation of digestibility and metabolizable energy, content of ruminant feed stuff from the gas production when they incubated science (Combrige) 92: 217 – 222.

Milford R, Minson DJ (1968). The effect of age and method of haymaking on the digestibility and voluntary intake of the forage legumes Dolichos lablab and Vigna sinensis. Australian Journal of Experimental Animal Husbandry. 8:409-418.

Mustafa HO, El-Goni, Mohammed A (1999). Manual for range management and improvement. Dry Land Husbandry Project (Sudan).

NRC (1996). Nutrient requirement for beef cattle (7th Ed). National Academy press Washington, D. C.

NRC (2001). Nutrient requirement of dairy cattle. 7th received edition. National academy of science, Washington, D. C. USA.

NRC (1985). Nutrient requirement of domestic animal N0.5 nutrient requirement of sheep. Sixth edition, National Academic of science, Washington, D. C.

Norton BV, Poppi DP (1995). Composition and nutritional attributes of pasture legumes. In: D'Mello, J.P.F., Devendra, C., (Eds.). Tropical legumes in Animal Nutrition. CABI Publishing, Wallingford, UK. Pp 23-47.

Osman AE, Osman AM (1981) Performance of mixture of cereal and legume forage under irrigation in Sudan. J. Agric. Cambridge. 98:17-21

Poppi DP, McLennan SR (1995). Protein and energy utilization by ruminants at pasture. Journal of Animal Science 73:278-290.

Stallings CC (2005). Test available for measuring forage quality. Dairy publication, 404 – 124 Pp: 1 -3 www .ext .vt .edu.

Steel RGD, Torrie JH (1980). Principles and procedures of statistics, 2nd ed. McGraw –Hill publishing Company. NY.

Thompson DJ (1978). Calcium phosphorus and fluorine in animal nutrition.1: canard, J. H. and McDowell, L. R., Latin American symposium on Mineral nutrition Research with grazing Ruminants. University of Florida, Gainesville Florida. 47.

Van Soest PJ, JD Roberts on, Lewis BA (1991). Methods for dietary

fiber, neutral detergent fiber and non - starch polysaccharides 1n relation to animal nutrition. Journal of Dairy Science, 74: 3583 -3597.
Van Soest PJ (1994). Nutritional Ecology of the Ruminant. 2n ed. Comstock publishing Associates, Cornell University press, Ithaca, NY.