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# IN- SITU DEGRADABILITY AND IN VITRO GAS PRODUCTION OF RHODES (*CHLORIS GAYAN*) AND BUTTERFLY (*CLITORIA TERNATEA*) AS AFFECTED BY STAGE OF GROWTH, PHOSPHOROUS FERTILIZATION AND INTERCROPPING

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**ABSTRACT**

Nutritive value and fermentation characteristics of *Chloris gayana* as sole crop, *Clitoria ternatea* as sole crop and a mixture of both *Chloris gayana* and *Clitoria ternatea* with the effect of stage of growth and phosphorous fertilization was determined using two different techniques: (i) the in vitro gas production and (ii) the in situ nylon bag degradability technique. Samples of 45 and 60 days from sowing were used. The phosphorous fertilization was applied at a rate of 0, 50, 75 and 100 kg $P_2O_5$ / ha. Samples were incubated in situ and in vitro for 4, 8, 16, 24, 48, 72 and 96 h. In situ and in vitro DM degradation kinetics were described using the equation y = a + b (1 - e $^{ct}$). For all forages, readily degradable fraction (a) and effective degradability at all out flow rates were higher than the late stage of growth. However, slowly degradable fraction (b) and degradation rate (c) were higher in the late stage of growth. The potential degradability (PD) is similar in both time of cutting. Phosphorous fertilization had no significant effect on in situ parameters. The gas produced was found to be higher in the early stage of growth than late stage of growth. For gas production paremeters, late stage of growth for Rhodes grass in the pure stand and in the mixture had higher value than the early stage of growth. But for clitoria early stage of growth had a higher value than late stage of growth. Also, Phosphorous fertilization had no significant effect on in situ parameters.



## INTRODUCTION

In Sudan, as in various parts of tropical areas, most small scale farmers rely on grasses as material feed input for animal maintenance. However, forage quality such as (digestibility, protein content and mineral content) decline during dry seasons which leads to nutritional imbalance that causes weight loss (Balgees *et al.,* 2013). The rate and extent of fermentation of dry matter (DM) in the rumen are very important determinants for the nutrients absorbed by ruminants (Kamalak *et al*., 2004). There is a wide array of methods available to assess the digestibility of ruminant forages. These methods consider the differences between the apparent digestibility (overall digestive tract), the ruminal digestibility (degradability) and the stomach digestibility (actual, bypass, digestibility) (Margareta *et al*., 2005). The techniques used to assess the nutritive value can be classified as follows: a. methods for in vivo digestibility; b. methods for in vitro digestibility – (in situ incubation with ruminal fluid or with cellulosolytic enzymes); c. methods derived from the in sacco method d. assessment using the regression equations; e. assessment using markers; f. assessment using NIRS. Irrespective of the used techniques, compared to the in vivo technique, the analytical advantages are increasingly visible by simplification and standardization, followed by the use for forage assessment and for the development of rumen models. Starting from the advantages of the in vitro, cellulase method for digestibility assessment (no need to use animals with fistulae, shorter working time, accuracy etc.) (Margareta *et al*., 2005) the aim of the current study is to to compare between insitu DM detetermen the nutritive value of Rhodes grass(*Cholris gayag*) and butterfly bean(*Clitoria ternatea*) and their response to harvesting time, phosphorous fertilization and intercropping, using in situ degradability and in vitro gas production test.

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## MATERIALS AND METHODS

The study was carried out at the University of Khartoum Demonstration Farm. The locality is the arid zone with hot summer and short rainy season from July to September. Samples of the forages were collected from the field at 45 days from sowing.

### Chemical analysis

The samples were to analysis for proximate componenet. chemical analysis. DM, Ash and CP were determined according to AOAC methods (AOAC, 1990). NDF, ADF and ADL were determined according to Georing and Van Soest (1970).

### In vitro gas production test

The in vitro gas production of Rhodes grass and clitoria ternate as pure stand and mixture was determined according to the procedure of Menke and steingass (1988). Rumen fluid was collected from two rumen fistulated local breed calves at the morning before feeding. The rumen fluid was then transferred through two layers of cheese cloth into a warm flask. A sample of about 200 mg DM weight into 100 ml capacity glass syringe calibrated for gas measurement in duplicate. The syringes were incubated in a water bath at 39 C and covered with a Perspex lid fitted with holes to hold the syringes upright in the water bath. The gas volume produced was recorded at 3, 6, 12, 24, 48, 72 and 96 hours. The gas produced was determined in three runs for each sample. In every run, blanks (buffer rumen fluid solution without samples) were included. The gas volume measured was corrected for the blanks. The potential and rate of gas production was fitted to the equation Y= b (1- e -ct), where Y is the volume of gas production at time t, b the potential gas production and c the rate of gas production (Orskov and McDonal, 1979). The metabloizable energy (ME) was estimated from the gas data using the equation ME = 1.242 + 0.146GP + 0.007CP + 0.0224EE, where GP is the net gas production (ml/200mg DM) in 24 h incubation Menke and steingass (1988), CP and EE is the crude protein and either extract respectively.

### In situ degradability

**I**n situ degradability of the samples was determined according to procedure descried by (Orskov and McDonal, 1979). Each forge sample (Rhodes grass and clitoria ternate as pure stand and mixture) weighing 5 g was transferred into nylon bags with a dimension of 8 x 14 cm and a porosity of 40-45mm and incubated in duplicate in two rumen fistulated steers. The samples containing nylon bags were incubated for 3, 6, 12, 24, 48, 72 and 96 hours, and there after hand washed using tap water. Zero hour solubility was also determined by hand washing samples containing in nylon bags in a similar way to the incubated feed samples. The washed samples were air dried in oven at 105 c to constant weight to determine dry matter degradability. The in situ degradability parameters were fitted using the equation P = a+ b (1- e -ct), where Y is the DM disappearance at time t, a immediately soluble (wash loss), b the slowly degradable fraction and c the rate of degradation (Orskov and McDonal, 1979).

## RESULTS AND DISCUSSION

Table (1) summarized the Effect of intercropping on the chemical composition of Clitoria ternate, Chloris gayana when harvested after 45 days from sowing. As general butter fly bean as pure stand and in the mixture had a higher ($P<0.05$) OM, CP and EE and lower NDF and ADF than Rhodes grass in both pure stand and in intercropping system. Clitoroia as pure had a higher value ($P<0.05$) CP, EE, but ADF was found to be insignificant ADF was ADF, while had lower and NDF the clitorai in the mixture but with no significant difference. Rhodes grass in association with legume had highr but sifnificant OM and CP, and significantly higher EE and significantly ($P<0.05$) lower NDF and ADF. As expected, butter fly bean had a higher CP content ranging from 206- 216 g/kg than Rhodes grass which had CP from 103.2- 115.4 g/kg . (Sleugh *et al*., 2000; Zemenchik, 2002) reported that, Legumes have higher nutritive value than grass species so growing mixtures of grasses and legumes can improve forage quality compared to grass monocultures. The typical and obvious advantages of intercropping was observed for rhodes grass. The CP, OM and EE were higher in rhodes grass when growing in intercropping system tan the monoculter, in addation, NDF and ADF of rhodes grass in monoculter outnumbered these value for the grass in the mixture. The results in this study were in agreement with many researchers (Bakhashwain, 2010 and Ibrahim *et al*., 2006), who reported that, introducing legume fodder plants with cereal plants or grasses, will increase protein contents. Generally, mixing of legumes in cereal or grass fodder is a better way to increase the quality of cereal or grass fodder. That is because fodder quality of grassy hay is lower than that required to meet production goals for many livestock classes, whereas legume-cereal mixtures are important protein and carbohydrate sources for livestock (Karadau, 2003). The higher CP of Rhodes grass when associated with Clitoria ternatea is higher may be attributed to the accumulation of the N fixed by the legumes The symbiotic N fixed by the legumes and it is effect on the grasses has been reported by Shehu (1999) who repored that the crude protein content of the sorghum stem was higher in mix crop than in sole crop,

### In situ dry matter degradability

Table 3 shows the effect of different times of cutting on in situ degradation characteristics for different types of forages. The data revealed that at early stage of growth, readily degradable fraction (a) and effective degradability at all out flow rates were higher than the late stage of growth. However, slowly degradable fraction (b) and degradation rate (c) were found to be higher in the late stage of growth. The potential degradability (PD) is similar in both time of cutting. The new protein systems (AFRC 1993) base the evaluation of dietary protein on the concept of readily degradable fraction and slowly degradable fraction for protein to meet the needs of rumen microflora, and undegradable dietary protein to meet host animal requirements. The readily degradable fraction comprises non-protein-nitrogen, free amino acids and small protein molecules (AFRC 1993). The difference in dry matter degradability between the early and the late stage of maturity could be due to the fact that in mature Sporobolus there is greater deposition of lignin and other indigestible secondary cell wall constituents. In addition, Marandure and Masama (2012) reported that the increase of DM degradability in early stage of growth may be due to the fact that during the juvenile stage of growth there is rapid accumulation of dry matter as most energy and protien are partitioned towards the vigorous growth that occurs at this stage.

**Table 1. Effect of intercropping on the chemical composition of Clitoria ternate, Chloris gayana when harvested after 45 days from sowing**

| Forage type | OM (g/kg) | CP (g/kg) | EE (g/kg) | NDF (g/kg) | ADF (g/kg) |
|---|---|---|---|---|---|
| Rhodes grass pure stand | 895.9c | 103.2de | 5.9e | 749.2b | 493.8cd |
| Rhodes grass in the mixture | 905.5bc | 115.4cd | 22.3ab | 777.2a | 469.7e |
| Clitoria ternate pure stand | 911.7ab | 216.0a | 25.7a | 617.3d | 402.2e |
| Clitoria ternate in the mixture | 915.0a | 206.3bc | 18.6bcd | 624.5d | 338.2e |
| SEM | 0.369 | 0.5812 | 01705 | 0.708 | 0.8018 |

OM = organic matter; CP = crude protein; EE = ether extract; NDF = neutral detergent fibre; ADF = acid detergent fibre.
Means with different subscription in the same column differ significant.

**Table 2. Rmen degradability kinetics (%) for Rhodes grass as pure stand (R), Clitoria in the pure stand (C), Rhodes grass in the mixture ( MR), Clitoria in the mixture (MC) as affected by different time of cutting**

| | | a | B | c | PD | ED 0.02 | ED 0.05 | ED 0.08 |
|---|---|---|---|---|---|---|---|---|
| R | 45 | 17.77cd | 56.90ab | 0.028cd | 74.67ab | 47.05c | 35.76c | 30.90c |
| | 60 | 19.15cd | 53.78bc | 0.030cd | 72.92cd | 54.68c | 37.50c | 32.55c |
| MR | 45 | 20.32c | 49.13cd | 0.025cd | 69.91cd | 47.41c | 36.65c | 32.05c |
| | 60 | 15.67d | 60.66a | 0.018cd | 76.31cd | 43.05d | 31.05d | 26.40d |
| C | 45 | 32.53a | 37.47e | 0.050b | 70.02bc | 59.07a | 54.15a | 46.92a |
| | 60 | 30.31a | 34.07e | 0.057ab | 64.35ab | 60.23b | 47.90c | 44.18ab |
| MC | 45 | 31.82a | 38.27e | 0.035c | 70.07c | 55.58b | 47.28b | 43.32b |
| | 60 | 25.31b | 46.51e | 0.069d | 71.80d | 48.78a | 51.10a | 45.86ab |
| | SEM | 1.37 | 2.15 | 0.0041 | 1.7 | 0.838 | 0.96 | 1.02 |

R =Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture.
Means with different subscription in the same column differ significant.
a= readily degradable fraction, b= slowly degradable fraction, c= degradation rate, PD=potential degradability, ED=effective degradability.

**Table 3. Rumen degradability kinetics (%) for Rhodes grass as pure stand (R), Clitoria as pure stand (C), Rhodes grass in the mixture (MR), Clitoria in the mixture (MC) as affected by different level of phosphorous fertilization**

| | | a | B | c | PD | ED 0.02 | ED 0.05 | ED 0.08 |
|---|---|---|---|---|---|---|---|---|
| R | 0P | 16.9ef | 56.8bc | 0.03def | 73.7bc | 42.2ef | 34.9e | 30.1e |
| | 1P | 22.2de | 46.1de | 0.04cde | 68.3cde | 53.4d | 43.4d | 38.2d |
| | 2P | 18.0ef | 36.4a | 0.02fg | 84.8a | 48.4e | 35.8e | 30.7e |
| | 3P | 16.8ef | 42.0bcd | 0.02fg | 68.9bcd | 43.6g | 32.5e | 27.9e |
| MR | 0P | 20.0e | 55.8bc | 0.02g | 75.8b | 43.6g | 32.8e | 28.8e |
| | 1P | 20.7bcd | 54.9bc | 0.02g | 75.6b | 44.6fg | 33.9e | 29.8e |
| | 2P | 14.3f | 59.6ab | 0.03fg | 70.8bcd | 47.3ef | 34.1e | 28.5e |
| | 3P | 16.9ef | 49.4cde | 0.03efg | 66.3bcd | 45.6efg | 34.7abc | 29.9e |
| C | 0P | 26.7cd | 42.6ef | 0.07ab | 69.4bcd | 58.8ab | 50.4ab | 45.6abc |
| | 1P | 30.8abc | 35.7gh | 0.06abc | 66.6e | 56.8bcd | 49.5abc | 45.5abc |
| | 2P | 35.3a | 32.3h | 0.04cde | 67.6cde | 57.3abc | 34.1ab | 28.5ab |
| | 3P | 32.8ab | 32.2h | 0.05cde | 65.3e | 54.6cd | 47.9e | 44.5bc |
| MC | 0P | 29.7bc | 40.8ef | 0.05cd | 69.5bcd | 57.1abc | 48.3bc | 43.6bc |
| | 1P | 27.2bcd | 45.8de | 0.04def | 73.0bcd | 55.8bcd | 46.2cd | 41.6cd |
| | 2P | 31.5abc | 39.1fg | 0.07a | 70.6bcd | 60.2a | 53.0a | 48.9a |
| | 3P | 26.9cd | 43.8de | 0.05bc | 70.7bcd | 58.6bcd | 49.4abc | 44.4bc |
| | SEM | 1.94 | 3.05 | 0.0058 | 2.41 | 1.19 | 1.36 | 1.44 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture;
MC = Clitoria in mixture.
0P, 1P, 2P and 3P are 0, 50, 75 and 100 kg/ ha the rate of phosphorous application
a= readily degradable fraction, b= slowly degradable fraction,
c= degradation rate, PD=potential degradability, ED=effective degradability.

**Table 5. Rumen degradation of DM (%) for rhodes grass, clitoria ternatea and the mixture as affected by time of cutting**

| | | 4 | 8 | 16 | 24 | 48 | 72 | 96 |
|---|---|---|---|---|---|---|---|---|
| R | 45 | 24.45 | 28.02 | 31.94 | 43.61 | 54.13 | 60.46 | 64.20 |
| | 60 | 25.26 | 31.03 | 36.77 | 37.38 | 57.28 | 66.45 | 72.00 |
| MR | 45 | 28.09 | 30.29 | 30.34 | 40.48 | 59.86 | 61.14 | 62.75 |
| | 60 | 21.64 | 22.27 | 24.25 | 31.72 | 56.14 | 56.95 | 62.31 |
| C | 45 | 40.76 | 54.81 | 52.72 | 61.07 | 63.18 | 69.09 | 70.33 |
| | 60 | 38.89 | 48.20 | 57.79 | 58.35 | 60.50 | 61.25 | 62.60 |
| MC | 45 | 36..97 | 42.60 | 47.06 | 49.92 | 66.14 | 65.42 | 66.43 |
| | 60 | 38.11 | 49.25 | 57.25 | 59.30 | 62.00 | 62.44 | 70.30 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture.

**Table 6. Rumen degradation of DM (%) for rhodes grass, clitoria ternatea and the mixture as affected by phosphorous fertilization**

| | | 4 | 8 | 16 | 24 | 48 | 72 | 96 |
|---|---|---|---|---|---|---|---|---|
| R | 0P | 24.04 | 25.93 | 31.88 | 46.17 | 50.17 | 61.81 | 62.67 |
| | 1P | 30.25 | 30.64 | 35.14 | 59.90 | 58.87 | 65.63 | 69.23 |
| | 2P | 25.34 | 29.69 | 31.57 | 38.51 | 56.80 | 62.20 | 66.60 |
| | 3P | 21.78 | 22.75 | 29.62 | 37.14 | 50.34 | 57.90 | 57.94 |
| MR | 0P | 25.27 | 26.81 | 28.66 | 43.71 | 48.90 | 56.03 | 57.40 |
| | 1P | 28.03 | 28.95 | 27.79 | 35.88 | 51.44 | 59.77 | 58.95 |
| | 2P | 24.20 | 25.00 | 30.30 | 38.33 | 62.46 | 65.29 | 66.37 |
| | 3P | 24.69 | 25.15 | 41.75 | 41.07 | 53.41 | 61.78 | 62.07 |
| C | 0P | 38.38 | 38.89 | 51.06 | 63.48 | 65.64 | 67.80 | 68.51 |
| | 1P | 39.15 | 40.39 | 51.40 | 59.38 | 58.95 | 67.46 | 69.44 |
| | 2P | 42.42 | 41.75 | 50.77 | 58.47 | 60.47 | 65.30 | 70.06 |
| | 3P | 38.57 | 40.49 | 48.58 | 55.54 | 57.37 | 61.98 | 64.47 |
| MC | 0P | 36.79 | 40.67 | 47.05 | 56.08 | 63.56 | 64.76 | 72.74 |
| | 1P | 31.04 | 38.36 | 45.41 | 50.14 | 63.95 | 66.52 | 70.56 |
| | 2P | 43.62 | 50.76 | 56.68 | 58.68 | 67.53 | 67.66 | 71.50 |
| | 3P | 31.71 | 41.50 | 48.81 | 52.81 | 69.87 | 67.77 | 71.03 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture. 0P, 1P, 2P and 3P are 0, 50, 75 and 100 kg/ ha the rate of phosphorous application

**Table 7. Gas production constant (ml/200 mg DM) at the different hours of incubation of Rhodes grass as pure stand (R), Clitoria in the pure stand (C), Rhodes grass in the mixture (MR), Clitoria in the mixture (MC) as affected by different time of cutting**

| | R | | MR | | C | | MC | | SEM |
|---|---|---|---|---|---|---|---|---|---|
| | 45 | 60 | 45 | 60 | 45 | 60 | 45 | 60 | |
| a | -1.62b | -1.44b | -1.7ab | -1.95b | 1.2a | -2.04b | -1.7b | -2.68b | 0.88 |
| B | 42.0ab | 65.9a | 40.4ab | 50.1ab | 29.0b | 26.7b | 36.5b | 33.0b | 8.95 |
| C | 0.05b | 0.030b | 0.05b | 0.04b | 0.09a | 0.09a | 0.09a | 0.08a | 0.01 |
| a+ b | 40.39ab | 64.45a | 38.69b | 48.07ab | 30.161b | 24.635b | 35.4b | 30.271b | 8.78 |

R = Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture. a= readily degradable fraction, b= slowly degradable fraction, c= degradation rate, (a+b) = potential degradability , Means with different subscription in the same rows differ significant.

**Table 8. Gas production volume (ml/200mgDM) for Rhodes grass as pure stand (R), Clitoria as the pure stand (C), Rhodes grass in the mixture (MR), Clitoria in the mixture (MC)**

| | R | | MR | | C | | MC | |
|---|---|---|---|---|---|---|---|---|
| | 45 | 60 | 45 | 60 | 45 | 60 | 45 | 60 |
| 3 | 5.25 | 2.5 | 5.22 | 4.00 | 9.10 | 7.56 | 9.47 | 7.13 |
| 6 | 11.39 | 8.45 | 11.76 | 11.37 | 21.55 | 24.74 | 23.13 | 23.62 |
| 12 | 22.01 | 16 | 21.93 | 19.61 | 34.06 | 38.87 | 35.77 | 36.11 |
| 24 | 40.54 | 35.67 | 41.37 | 41.21 | 42.62 | 50.34 | 42.87 | 46.21 |
| 48 | 54.14 | 51.58 | 56.53 | 60.56 | 49.84 | 59.00 | 49.66 | 55.19 |
| 72 | 58.18 | 58.58 | 60.57 | 65.85 | 51.96 | 60.98 | 52.65 | 57.23 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture.

**Table 9. Gas production constants (ml/200 mg DM) at the different hours of incubation, for Rhodes grass and Clitoria ternate and the mixture at two time of cutting**

| | | a | b | c | a+b |
|---|---|---|---|---|---|
| 45 | R | -1.62b | 41.97ab | 0.05b | 40.39ab |
| | MR | -1.7ab | 40.41ab | 0.0488b | 38.69b |
| | C | 1.2a | 28.96b | 0.0925a | 30.161b |
| | MC | -1.72b | 36.53b | 0.085a | 35.4b |
| 60 | R | -1.44b | 65.89a | 0.030b | 64.45a |
| | MR | -1.95b | 50.03ab | 0.0388b | 48.07ab |
| | C | -2.04b | 26.67b | 0.0863a | 24.635b |
| | MC | -2.68b | 32.96b | 0.0788a | 30.271b |
| | SEM | 0.88 | 8.95 | 0.01 | 8.78 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture, a= readily degradable fraction, b= slowly degradable fraction, c= degradation rate.

Means with different subscription in the same rows differ significant.

**Table 10. Gas production constants (ml/200 mg DM) at the different hours of incubation, for Rhodes grass and Clitoria ternate and the mixture at different level of phosphorous fertilization**

| | | A | b | c | a+ b |
|---|---|---|---|---|---|
| R | 0P | -2.5b | 49.67ab | 0.045d | 47.17ab |
| | 1P | -1.02ab | 39.42b | 0.035d | 38.4b |
| | 2P | -0.86ab | 44.50b | 0.045d | 43.64b |
| | 3P | -0.176ab | 82.13a | 0.040d | 80.37a |
| MR | 0P | -3.46b | 48.27ab | 0.04d | 44.18ab |
| | 1P | -0.61ab | 44.36b | 0.050cd | 43.75b |
| | 2P | -3.12b | 32.76b | 0.050cd | 32.23b |
| | 3P | -0.173ab | 52.90ab | 0.102d | 52.72ab |
| C | 0P | 1.22a | 29.21b | 0.088abc | 56.54b |
| | 1P | -0.08ab | 28.36b | 0.070bcd | 28.27b |
| | 2P | -0.30ab | 25.12b | 0.087abc | 24.81b |
| | 3P | -2.50b | 28.57b | 0.112a | 26.06b |
| MC | 0P | -2.62b | 36.91b | 0.068bcd | 34.29b |
| | 1P | -2.34ab | 38.98b | 0.052cd | 36.63b |
| | 2P | -2.13ab | 32.76b | 0.105ab | 30.62b |
| | 3P | -0.52ab | 30.32b | 0.035ab | 29.80b |
| | SEM | 1.258 | 12.661 | 0.0138 | 12.42 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture, a= readily degradable fraction, b= slowly degradable fraction, c= degradation rate.
Means with different subscription in the same rows differ significant.

**Table 11. Gas production volume (ml/200mgDM) for Rhodes grass as pure stand (R), Clitoria as the pure stand (C), Rhodes grass in the mixture (MR), Clitoria in the mixture (MC) as affected by phosphorous fertilization**

| | | 3 | 6 | 12 | 24 | 48 | 72 |
|---|---|---|---|---|---|---|---|
| R | 0P | 3 | 9.62 | 17.17 | 36.09 | 54.50 | 60 |
| | 1P | 2.75 | 8.62 | 16.92 | 40.00 | 55.50 | 62.42 |
| | 2P | 2.5 | 8.45 | 16.07 | 35.47 | 51.58 | 58.28 |
| | 3P | 1.75 | 7.12 | 13.92 | 30.34 | 44.75 | 52.42 |
| MR | 0P | 2.25 | 8.37 | 15.42 | 37.59 | 56.25 | 58.42 |
| | 1P | 4.25 | 11.87 | 21.17 | 44.34 | 64.75 | 72.17 |
| | 2P | 4.25 | 12.12 | 20.92 | 42.34 | 63.00 | 62.42 |
| | 3P | 5.25 | 13.12 | 21.17 | 40.09 | 58.25 | 65.42 |
| C | 0P | 7.5 | 25.87 | 40.67 | 50.84 | 58.50 | 61.17 |
| | 1P | 6 | 21.37 | 34.97 | 49.59 | 60.75 | 64.67 |
| | 2P | 8.5 | 29.62 | 43.67 | 53.84 | 61.25 | 63.67 |
| | 3P | 8.25 | 22.12 | 36.17 | 47.09 | 55.50 | 58.42 |
| 3P | 0P | 5.5 | 13.62 | 21.17 | 28.59 | 35.75 | 38.17 |
| | 1P | 9.25 | 30.12 | 44.42 | 55.84 | 64.25 | 62.17 |
| | 2P | 5.75 | 20.62 | 37.42 | 48.09 | 59 | 63.42 |
| | 3P | 8.00 | 30.12 | 41.42 | 52.34 | 61.75 | 65.17 |

R Rhodes grass; c=Clitoria; MR=Rhodes in mixture; MC = Clitoria in mixture.
a= readily degradable fraction, b= slowly degradable fraction, c= degradation rate.
Means with different subscription in the same rows differ significant.

The general decrease in CP with maturity is supported by Alemayehu (2006) who indicated that range forage species vary in quality and quantity from time to time and from place to place. It is during the growth stages that plants are most nutritious (Alemayehu, 2006). Similarly the increases in EE, ash, ADF and NDF with maturity also follows the trends that were recorded by Theander and Aman (1984) who indicated that as plants mature, CP, P and the more readily digested carbohydrates decrease, in contrast, fiber, lignin and cellulose increase. Once mature (Alemayehu, 2006). Jocelyne *et al.* (2003) reported that The degradability of dry matter decreased progressively with the maturity of the plant ($p > 0.05$). The reduction in readily dagradable fraction content of the legumes with increasing maturity is due to a decline in the soluble cell contents while cell wall contents increased (Balde *et al.*, 1993). Concerning the effect of different types of forages on DM degradability (table 3), readily degradable fraction (a) was found to be higher in pure clitoria (C) ($P <0.05$) followed by clitoria in a mixture (MC) which in turn found to be higher than Rhodes grass (R) in a pure stand and the least mean value in Rhodes grass in the mixture (MR). The slowly degradable fraction (b) was found to be higher in (R) and (MR) ($P <.05$) than (MC) and (C). The degradation rate (c) was found to be similar for (C) and (MC) and greater ($P <0.05$) than (R) and (MR). The potential degradability (PD) is similar for forages (R), (MR). ranked as follows: (MC), (C), (R) and (MR). It could be concluded that, the high readily dagradable fraction content of the legumes even, at advanced stages of maturity, shows that they can supply sufficient quantities of N to meet rumen microbial requirements (Mupangwa *et al.*, 2003). The high radily dagradable fraction observed in this study for Clitoria pure stand and in the mixture than both rhodes grass probably due the contents of different proportion of digestible fiber particles which led to difference in degradation and subsequently potential degradation in the rumen, Therefore, feeding of Clitoraia to the ruminants may provide adequate nutrients and may reach to potential intake and digestion. More over (Margareta *et al.*, 2005) stated that the digestability of Alfalfa was found to be higher than barely silage of Sudan grass silage. The effect of phosphorous fertilization on Dry matter degradability was illustrated in Table 7. The results showed that phosphorous fertilization affects the potential degradability (PD) and the effective degradability (ED) at all out flow rates significantly ($P <0.05$). Level 2 of phosphorous fertilization recorded the highest mean value followed by level 1 and zero level for (PD) and (ED). Readily degradable fraction (a) slowly degradable fraction (b) and degradation rate did not affect significantly by phosphorous fertilization, however, the ranking phosphorous fertilization was as follows 2 > 1 > 0 >3. These results were in comformaity of (Tolera *et al*., 2008) who worked on fertilizer application on nutritive value of durum wheat Straw, found that phosphorous fertilization had no significant effect on dry matter degradability.

**Gas production test**

The volume of gas produced by different types of forage is presented in table (8) the gas produced was found to be higher in the early stage of growth than late stage of growth. Low gas production in late stage due to increase in insoluble fractions over the soluble fractions as reported, which described negative effect on digestion of the cell wall associated compound, like phenolic acids and the cross-linkage of lignin and wall polysaccharides. As the fermentation process is partially regulated by the fibrous content of the feeds, the relatively low content of fibre can facilitate the colonisation of the feed by the microbial rumen population, which in turn might induce higher fermentation rates, therefore improving digestibility (Akinfemi *et al*., 2012).These results similar to that obtain by (Bayatkouhsar, 2012) for ensiled corn fotage. Also similar result was found by (Van Soest, 1994) who stated that, the legume cell wall contains about twice the lignin as grass but ferments faster than grass at the same stage of maturity. This could be attributed to availability of immediately fermentable carbohydrates in the young forages and legumes (soluble fractions). Contradicting results were obtained (Kazemi *et al*., 2009) who noted that, the cumulative gas production for the Sorghum halepense was significantly high in comparison to other weed forages. Sallam *et al*. (2008) reported that cell wall content (NDF and ADF) were negatively correlated with gas production at all incubation times and estimated parameters. Despite of higher cell wall in Sorghum halepense in this study, the cumulative gas production was higher for it. Gas production is basically the result of fermentation of carbohydrates to acetate, propionate and butyrate and substantial changes in carbohydrate fractions were reflected by total gas produced. In addition to that this result was higher than the results obtained by (Kamalak *et al*., 2005) found that the gas produced at 24 hrs incubation time for alfalfa was found to be 38%. The results showed that 68.03 % of the gas for the legumes produced in the first 24 hours, while the grasses produce 67.2% of the gas in the first 24 hours of incubation. This finding is of highly interesting shows that the 24h value quoted as the most relevant value in estimating the rumen degradability rate and quality of roughages needs to be determined by gas production test. (Menke *et al*., 1979) found that the amount of gas which is released in 24 hrs when the feed stuffs incubated with rumen liquor is closely related to digestibility and metabolizable energy value of feed. The gas production parameters of 72 hours of incubation of the forage harvested at two times is given in table (9). For all gas production constant (a, b, a+b), late stage of growth for Rhodes grass in the pure stand and in the mixture had higher value than the early stage of growth. But for clitoria early stage of growth had a higher value than late stage of growth. The gas production of 72 hours of incubation of the forage harvested at two times is given in Table (9).

The gas produced from insoluble fraction (b) and potential gas production (a+b) for rhodes grass were higher 60 days cut for Rhodes grass but with only significant differences, incontrast, The gas produced from insoluble fraction (b) and potential gas production (a+b) for clitroia ternata was found to be higher in 45 days cut with only significant differences in clitoria ternatea in pure stand. The rate of fermentation (c), however was increased with the advance of ripening in all forages but with significant differences only between the grasses and the legumes ($P < 0.05$). It was clear that the cumulative gas production of Rhodes grass and its association with legumes was lower than clitoria ternate, so the estimated parameter ((a, b, c and a+b) was also lower. Same results were reported by (Kamalak *et al*., 2005).the gas produced from slowly degradable fraction and potential gas production were lower than that reported by (Kamalk *et al*., 2005) For alfalfa. The potential gas production a+b for corn forage was found to be 72.6 % (Bayatkouhsar *et al*., 2012)

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