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Evaluation of Spanish Panicum Mombasa Plant at Different Cutting Intervals and It's Supplementation to Dairy Goat's Rations on Rumen Fermentation Parameters and Productive Performance

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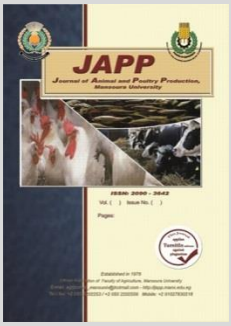

ABSTRACT

Two experiments were carried out to evaluate cultivation of Spanish Panicum Mombasa (SPM) in five Cutting interval (CI) 30, 45, 60, 75 and 90 day and its effect on *in vitro* rumen fermentation and dairy goats performance feeding at 0, 25 and 50% SPM as a replacement of clover hay (CH). 30 days CI recorded the highest values of CP, EE, and ash content being 17.9, 2.1 and 12.7, respectively. The lowest recorded CF content being 24.6%. Regarding *in vitro* rumen fermentation, methanogenesis trail of samples collecting from different SPM in CI days showed that the lowest gas production (GP) was at 90 days CI. In a performance trail, 24 baladi lactating goats were divided into (T1) control group, (T2) group fed rations supplemented with 25 and (T3) 50% of SPM as a replacement from CH. (T3) ranked the highest milk yield followed by (T2) compared significantly (P<0.05) with the control. T3 recorded (P<0.05) the best value of protein, fat, TS and Ash contents of milk Colostrum composition and the same results were obtained on the first, second and third months of milk composition. Blood analyses for AST, ALT cholesterol, TG, albumin, urea, creatine, and Malondialdehyde (MDA) contents exhibited significant differences (P<0.05) between diet (T3) and the control (T1), while diet T3 group exhibited higher values of Glutathione Peroxidase (GPx) compared with control. Diets contain 25 or 50% of SPM as a replacement of CH were suitable for feeding ruminant, greater profitability and animal health under Egyptian condition.

Keywords: *Dairy Goats; Economic efficiency; Methanogenesis; Spanish Panicum Mombasa, Tannin.*

INTRODUCTION

Increasing in the people density and the rising purchasing power have increased enormous amounts demand for animal proteins, particularly milk and meat. Human demand for consuming milk and meat is predictable to increase by 58% and 73 %, respectively, by 2050. Grossi, *et al*., (2019). Consequently, it urgent to maximizing livestock production by raising yield, efficient and beside sustainable, which today is a major challenge for animal production (Marchi *et al.*, 2019).

Clover hay is a profiteering plant that takes advantage of good growing and lactating conditions in ruminant nutrition when it is available. And due to the decrease in agricultural land in Egypt, a conflict occurred between the demand on human food against demand on animal feed, and the priority was given to human food, that resulted in an increase in the price of clover hay. in Egypt, animals suffer from shortage of feeds and the continuous increase in its costs which is reflected on clover hay prices Therefore, it become necessarily to find new alternatives available at a low price with the same nutritional value.

Among the available Africa herbaceous forage is Guinea grass (*Panicum Mombasa*) which grown in high fertility soil (Euclides *et al*., 2008). This grass is expected to induce additive performance values because of its high dry matter production potential beside palatability and quality of the forage produced (Jank *et al.*, 2013). Humphreys and Partridge, (1995) described Guinea grass as a tall dynamic perennial grass, its stems reached up to 3.5 m that differs vastly in growth variation. Guinea grass able to overcome continue quite long drought periods because it has dense, deep, and fibrous root system. Many countries in West and central of Africa and others in the tropical regions of South America and Asia cultivated Panicum Mombasa as a good forage for animals. It has many common names like panicum maximum, panicum mombasa, guinea grass, buffalo grass, and zacate guinea. This grass was traditionally used in these aeries as a fiber source in the diet of growing animal (Liu *et al*., 2018).Also, it is a promising feed source consequence different advantages like high quality, which contains, 30.66% crude fiber, 2.67% crude fat, and11.65% crude protein, amino acids methionine 0.16%, lysine 0.49%, valine 0.48%, alanine 0.61%, glycine 0.39%, serine 0.32%, cysteine 0.21%, glutamic 0.98%, threonine 0.34%, aspartic 0.80%, isoleucine 0.36%, tyrosine 0.32%, phenyl alanine 0.45%, histidine0.18%, arginine 0.45% as reported by Refaie *et al*., (2020). Also, it has a fast-growing rate, easy adaptation to the environment. However, only few researches have been done on the application as feed for livestock.

Ruminant is considered one of the main sources of greenhouse gases emission, like, carbon dioxide (CO2) and methane (CH4) representing almost 14–18% of global greenhouse gases emissions (IPCC, FAO); Gerber *et al.*,

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(2013) These greenhouse gases are directly correlated to worldwide warming climate change, which scare the welfare of human and future generations (Scholtz *et al*., 2020). Jafari et al., (2019) reported that emissions CH4 from ruminants pay special attention either to a serious environmental issue or a significant source of energy loss to the animals. Sejian et al., (2011) showed that energy ought to utilize to meet the demanded production. For this reason, various kinds of anti-methanogenic compounds have already been studied to evaluate their potential to decrease CH4 production, however, there are restrictions to their utilize due to their unfavorable impacts on rumen fermentation characteristics and they showed inconsistent with various feeding styles (Vázquez-Carrillo *et al*., 2020; Lee. *et al*., 2020; Jayanegara *et al*., 2020]. Recently, interest in green forage rich of tannin content has increased. Tannins have been increasingly investigated to reduce the methane emission of ruminants, feeding ruminant forage rich in Tannin became an important strategy as a methane mitigation (Fagundes *et al.*, 2021). It is extreme importance that panicum maximum considered a natural source rich of tannin (Refaie *et al.*, 2020). Sherein (2020) reported that plants rich in tannin have the great role of reducing ruminal methane production. Therefore, plants involved tannin may be has benefit in the development of new feed additives for reducing methane emission which may positively participate to decreasing global warming climate changes and global warming.

This study was performed to provides new information about the effect of SPM on In Vitro rumen fermentation, digestibility, Gas production, microbial protein synthesis, which is very important for obtaining the whole picture of fermentation, and to evaluate the effect of partially replacement of SPM instead of CH on lactating goats diet starting from SPM cultivation and choosing the best cutting interval to dairy goats rations.

MATERIALS AND METHODS

This study trials were conducted at the Depart. of Animal Production, Fac. of Agric., Benha Univ., and El-Karada Experimental Station, Animal Nutrition Research Department, Animal Production Research Institute, ARC.

In-vitro methanogenesis and fermentation parameters were carried out at the laboratory of chemical analysis, antinutritional factor and total nutrient digestibility, regional center for food and feed, ARC, Giza. Egypt.

Milk and Blood samples analyses were conducted at food analysis center, Fac. of Veterinary Medicine, Benha Univ., Egypt.

The experimental techniques and methods contained two experimental studies. *In-vitro* experiment was the first one which methanogenesis and fermentation parameters for different Spanish Panicum Mombasa Cutting interval at 30, 45, 60, 75 and 90 (day) were determined, and to estimate the best cutting interval day according to its nutritional value on the production of rumen fermentation, total gas parameters and the microbial protein synthesis. The second experiment was lactating goats' trial. Goats were fed Spanish Panicum Mombasa replacing at 25 and 50% of clover hay. Lactating goats trial started from mating until the end of the milk production season, from August 2019 to March 2020.

Cultivation of Spanish Panicum Mombasa (SPM)

The field trial was divided into five parts. Each part was cut separately at cutting intervals after 30, 45, 60, 75 and 90 days from seedling transfer.

Chemical analysis

Spanish Panicum Mombasa were air dried overnight at 60^0C. Samples were prepared and were milled through a 1 mm sieve to be analyzed for *in vitro* gas production procedure. Dry matter (DM) was weighed after drying the samples at 105°C for 3hrs, and ash by by put weighted samples in weighted labeled-crucibles and placed in a muffle furnace at 600°C for about 2 hours, then cooled down to room temperature and weighted till constant weight. Nitrogen (N) content was determined according to the modified kjeldahl method. Crude protein (CP) was calculated by multiplying nitrogen percentage by 6.25, Ether extract (EE) and crude fiber (CF) were determined according to AOAC (1995).

Anti-Nutritional Factors

Using the method according to Pearson (1976) to determined Oxalate, saponin and tannin.. Phytate content determined using the method according to Oberleas (1973).

Determination Minerals:

The collected feed samples were analyzed for determination of their calcium, phosphorus, potassium, iron, zinc, sodium and manganese as trace elements based on wet weight according to the technique, Washing procedures (AOAC, 2006), Digestion technique (Alomary and Wedian, 2012), Preparation of blank and standard solutions (Bawiec *et al.*, 2014).

The first trial:

***In vitro* Gas production and some rumen parameters:**

Rumen fluid was collected from 3 fistulated Rahmani rams fed twice daily at the maintenance level with a (clover hay or alfalfa hay) as a basal diet (60%) and concentrate (40%). Rumen fluid from each sample were *in vitro* incubated according to the procedures of (Menke et al., 1979). 200 Milligram dried samples were weighed into calibrated glass syringes of 100 ml. Then, the syringe was kept 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. Gas production was recorded before incubation 0 and 2, 4, 6, 8, 12, 24, 48 h after incubation. Total gas values were corrected for blank incubation. The model of Orskov (1998) was used to determine a cumulative gas production. Digestible dry matter (DDM),Short chain fatty acids (SCFA) ,Digestible Organic matter (DOM) , net energy lactation (NEL) (MJ/Kg DM),Metabolizable Energy (ME) (MJ/Kg DM),digestibility organic matter intake (DOMI) (g/day) ,digestibility crude protein intake (DCPI) (g/day) , growth energy digestibility (GED) (g/Kg DMD), GED (g/Kg OMD) and TDN (%) values were determined using equations as below according to Menke et al., (1979). Where, gas production after 24h. incubation (ml.200mg^{-1} DM) was calculated as described by Orskov (1998).

Equations

$$\textbf{In vitro digestibility crude protein intake (DCPIinv)}\left(\frac{\textbf{G}}{\textbf{day}}\right) = (\mathbf{14.797 \times GP24 + 6.249 \times GP48}) - \mathbf{203.242}$$

$$\textbf{In vitro digestibility organic matter intake (DOMIinv)}\left(\frac{\textbf{G}}{\textbf{day}}\right) = (\mathbf{-1763.07 + 42.5 \times PG24}) + \mathbf{13.52 \times GP48}).$$

$$\text{Short chain fatty acid (SCFAinv)} \left(\frac{\text{mmol}}{\text{ml gas}}\right) = (0.0239 \times \text{GP} + 0.0601).$$

$$\text{Gas production structure fraction (GPSF)} \left(\frac{\text{ml}}{\text{g DM}}\right) = (\text{GP3h} - 5.5) \times 0.99 - 3$$

$$\text{Gas production non structure fraction GPNSFinv} \left(\frac{\text{ml}}{\text{g DM}}\right) = (1.02 \times (\text{GP24h} - 5.5) - (\text{GP3h} - 5.5) + 2)$$

Net energy (NE_{inv}) M cal.mlLb = (2.2+(0.0272×gas) +(0.057×cp) +(0.149×EE)/14.64. (Menke and steingass, 1988)

$$\text{Metabolic energy (MEinv)} \left(\frac{\text{MJl}}{\text{kg DM}}\right) = 2.04 + 0.1448 \times \text{GP} + 0.0036\ \text{CP} + 0.0243\text{EE}$$

$$\text{Net energy lactation (NELinv)} \left(\frac{\text{MJ}}{\text{kg DM}}\right) = 0.08 + 0.1101\text{GP} + 0.0022\text{CP} + 0.0161$$

$$\text{MP} = \text{Microbial protein g/kg (DOM)} = 120 * \text{DOM}/100. \text{(Czerkawski, 1986)}$$

$$\text{Organic matter digestibility OMDinv, \%} = 14.88 + 0.889\ \text{GP} + 0.45\ \text{CP} + 0.065\ \text{A, Nousiainen } \textit{et al.}\text{, (2009)}$$

$$\text{Growth energy digestibility GED (g/kg)} = -11.3 \pm 14.78 + 0.977 \pm 0.021 \times \text{OMD}$$

where DMD = DM digestibility.

TDN was calculated from ME value as per the equation of NRC (1989).
TDN (%) = [ME (MCal/kg DM) +0.45]/ 0.0445309
ME (MCal/kg DM) = ME (MJ/kg DM)/4.184

The second trial:

Lactating Trial

Daily feed allowance of goats was adjusted biweekly based on pregnancy stage, post-kidding, changes in body weight and milk yield. Fresh water is available freely through all daytime, while fasting LBW of each goat was recorded at the start of the experiment before morning feeding then biweekly until the study was finished. Three fertile adult Baladi bucks previously tested for a good semen characteristic, were used for mating, one for each experimental group. The mating period lasted for 35 days (nearly two estrous cycle) after which the bucks were separated from the does. Estrous was detected by means of colored grease on the buck brisket. Does were checked daily as defined by marking with the buck and the service was recorded. Colors used were changed weekly. Does were weighed before joining and biweekly intervals thereafter. All goats were kept under semi-open sheds. Body weights of goats were recorded at different stages of pregnancy, postpartum and lactation. The born kids were left with their dams during the first days of live to receive the colostrum. Born kids suckled individually their dam milk and weaned at 10-wks of age .

Twenty-four Baladi lactating goats (does), eight per group, on their first to third season of lactation were randomly allotted to Three matched experimental groups. First group served as a control, while the second and third group were fed Spanish Panicum Mombasa replacing of 25 and 50% from clover hay, respectively. Rations were weighed for each group two times a day, at 7 AM and 7 PM. The given feeds were calculated to cover the nutrient requirements for each dairy goat according to NRC (2007). The concentrate to roughage ratio in all rations was offered at approximately 50:50 on DM basis. Drinking clean water was available all the time during the day. Formula and chemical composition of experimental rations are presented in Table (1 and 2). Feed intake was adjusted every two weeks according to the changing in body weight and milk production.

Table 1. Feed ingredients percent of the concentrate feed mixture (CFM).

Ingredients	%
Yellow corn	32
Decorticated cotton seed meal 35% CP	38
Wheat bran	24
Molasse	3
Limestone	2
Sodium chloride	1
Total (%)	100

Table 2. Chemical composition of the experimental complete feed mixtures, concentrate feed mixture, clover hay and Spanish Panicum Mombasa (on 100% DM basis).

Items	Chemical Composition as 100% DM						
	DM	OM	Ash	CP	EE	CF	NFE
Concentrate feed mixture (CFM)	93.2	92.6	7.4	18.53	4.81	6.73	62.53
Clover hay (CH)	91.15	89.19	10.81	17.5	2.52	25.21	43.96
Spanish Panicum Mombasa (SPM)	92.5	87.3	12.7	17.9	2.1	24.6	42.70
T1 (Control)	91.6	92.8	7.2	15.6	3.2	27.5	49.5
T2	91.3	92.2	7.8	15.9	2.9	27.1	46.3
T3	92	91.7	8.3	16.4	2.7	26.9	45.7

DM: Dry Matter; OM: Organic Matter; CP: Crude protein; EE: Ether extract; CF: Crude fibre; NFE: Nitrogen free extract. Control group (T1) 50% CFM + 50% CH. (T2) 50% CFM + 37.5% CH + 12.5% SPM, (T3) 50% CFM + 25% CH + 25% SPM.

Milk samples

The lactating experimental period was three months. Dairy does were manually milked twice per day at 7.00 am and 7.00 pm. The milk yield was recorded each two weeks.

Milk samples were collected from four goats of each experimental group, throughout the experimental period (90 days) to determine its composition. Milk samples were analyzed for total , protein, fat lactose and solids, using Bentley 150 Infrared Milk Analyzer (Bentley Instruments, Chaska, MN, USA) according to A.O.A.C. 1995 procedures. Solids-Not-Fat (SNF) was calculated by subtracting fat from the total solids value. Milk ash content was determined after heating in a muffle furnace at 550°C for 8 hrs. mean yields of each milk component were calculated for each does by multiply milk yield by the component content of milk. Milk gross energy content was

estimated according to Tyrrell and Reid (1964). Fat corrected milk in goats was calculated according to the following formula of Mavrogenis and Papachristoforou (1988):

FCM (4%) kg = M x (0.411 + 0.147 x fat %). Where: M is milk production in kg.

Blood sampling

Blood samples were taken from jugular vein of four does of each group after parturition. Blood samples (10 ml) were taken 4 h after feeding of each does into a clean dry tube without anticoagulants. Blood samples were centrifuged at 3000 pm for 30 min to get blood serum. Serum was separated into 2-ml clean dried Eppendorf tubes and frozen at −20°C for later analysis. Serum total protein was measured according to the method of Armstrong and Carr (1964) and albumin was estimated according to Doumas *et al.,* (1971). Globulin was calculated by subtracting the albumin from total protein. Albumin globulin (A/G) ratio was calculated by dividing Albumin by total globulin, cholesterol was measured according to Rolschlau (1974). Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were determined according to Reitman and Frankel (1975). Creatinine determined method was applied according to the technique recommended by Julian (2000), Serum triglycerides concentrations were quantified spectrophotometrically according to Fossati and Prencipe (1982), Urea was determined by enzymatic colourimetric, urease salycilate method according to Patton and Crouch (1979) using the commercial kits from Sentinel CH. Antioxidant capacities estimation presented by determine Glutathione Peroxidase "GPx" according to (Fang *et al.,* 2011) and Malondialdehyde (MDA) according to (Wang *et al.,* 2011).

Economic efficiency:

Cost of clover hay = Amount of clover hay (kg) × price of berseem hay (LE).

Cost of Spanish Panicum Mombasa = Amount of Spanish Panicum Mombasa (kg) × price of Spanish Panicum Mombasa (LE).

Cost of concentrate = Amount of concentrate (kg) × price of concentrate (LE).

Total feed cost (h/d/LE) = Cost of Spanish Panicum Mombasa + Cost of berseem hay + Cost of concentrate. (for each experimental ration)

Average revenue of milk production (LE) = price of 1 Kg goats' milk × Actual daily milk yield (kg).

Net feed revenue (LE) = Average revenue of milk production - Average feed cost.

$$\text{Economic feed efficiency \%} = \frac{\text{Net feed revenue}}{\text{Average feed cost}} \times 100$$

If relative economic efficiency to T1 (control group) =100%.

$$\text{Relative economic efficiency to T2} = \frac{\text{Economic feed efficiency to T2}}{\text{Economic feed efficiency to T1}} \times 100$$

$$\text{Relative economic efficiency to T3} = \frac{\text{Economic feed efficiency to T3}}{\text{Economic feed efficiency to T1}} \times 100$$

Statistical analysis

Statistical analysis was done using SAS (2013) as procedure of general linear model. The used design was one-way analysis. For comparison among mean Duncan's multiple tests (1955) were utilized.

The following model was used:

Yij (Individual observation)= μ (overall mean)+ Ti (effect of treatment)+ eij (random error).

RESULTS AND DISCUSSION

Chemical composition, height (cm) and Mineral's content of Spanish Panicum Mombasa on different Cutting interval day:

The chemical composition contents of the SPM forage reported in this study is within the range recorded in literature, while lower values due to increased lignification associated with maturity. Results of chemical composition, height (cm) and Mineral's content (mg/100 g) for five Cutting interval (day) 30, 45, 60, 75 and 90 days are presented in Table 3, 4. Results showed that 30 day cutting interval recorded the highest values of CP, EE and ash content (17.9, 2.1 and 12.7) respectively, and the lower CF content 24.6% was recorded. On the other hand, higher CF and lower CP Were clearly noticed by increasing cutting interval days. These results may be related to the leaf: stem ratio. On the first phase of plants growth protein and mineral content increases due to being leaf increases, longer cutting intervals day led to increases in CF due to the increases of stem: leaf. These results agreed with (Da Silva and Nascimento, 2007).

Reynoso *et al.,* (2009) reported that grass accumulation, morphogenic structure and pasture composition in mombasa grass can be affected through defoliation intervals fine-tuned to plant response and environmental conditions. It favors greater leaf proportion in accumulated herbage. Longer cutting intervals bring about more plant height and herbage accumulation, which drive down and leaf: non leaf ratios and altered sward structure which in turn can diminish efficiency in pasture utilization, intake, and animal performance. (Carvalho *et al.,* 2000) reported that the Increasing of fiber content in forage is due to stem accumulation and leaf senescence. Dry matter yield generally increases with increasing fertilizer amount and cutting interval. Barbosa *et al*., (2011) reported that chemical characteristics are highly affected by season changes. Also, they reported that plant growth and better leaf length increased in the summer season, as observed in the present study. Also, in harmony with the current study, Silveira *et al*., (2010) found that panicum mombasa reached to 79 cm after re-growth for 30 day.

Carnevalli *et al.,* (2006) on dairy cattle trail found that Panicum Mombasa 95% leaf length (LI) at a height of 70 cm and a pre-grazing height of 90 cm and 115 cm produced 95% and 100% leaf length (LI), respectively . These values are like those obtained in 30 day cutting interval. However, forage mass and the number of leaves available to feed dairy animal was higher in T 30 day cutting interval and Panicum Mombasa Leaf area index was also higher in T 30 day cutting interval.

Table 3. Chemical composition of Spanish Panicum Mombasa hay on different Cutting interval (day) as 100% DM.

Cutting interval (day)	height (Cm)	DM	OM	CP	EE	CF	ASH	NFE	NDF
30	120	92.5	87.3	17.9	2.1	24.6	12.7	35.2	70.5
45	150	92.4	87.7	17.6	2	25.1	12.3	35.4	74.9
60	185	92.6	87.9	17.2	2	25.4	12.1	35.9	75.0
75	210	92.9	88.2	16.7	1.9	25.9	11.8	36.6	75.9
90	230	93.1	88.4	16.5	1.8	26.2	11.6	37	76.8

The highest Minerals content (mg/100 g) also was recorded for 30 Cutting interval (day), Ca, P, k, Fe, Zn, Na and Mn (being 508.7, 196.4, 785.1, 15.9, 2.8, 241.7 and 8.2), respectively. Results of Minerals content (mg/100 g) clarify and explain why Ash was recorded higher content on 30 Cutting intervals (day).

Table 4. Mineral's content (mg/100 g) of Spanish Panicum Mombasa on different Cutting interval (day)

Cutting interval	Macro minerals				Micro Minerals		
(day)	Ca	P	K	Na	Fe	Zn	Mn
30	508.7	196.4	785.1	241.7	15.9	2.8	8.2
45	496.1	192.9	768.7	283.5	15.3	2.7	7.9
60	482.4	183	760.6	229.8	14.8	2.5	7.8
75	469.5	177.3	737.4	224.2	14	2.5	7.6
90	462.8	175.1	722.9	221.6	13.3	2.4	7.6

After reviewing the obtained results of the five Cutting interval (day), 30 cutting interval day has been chosen to be used in the lactating feeding trials.

Anti-nutritional factors content (mg/100 g) of Spanish Panicum Mombasa:

As shown in Table 5. early cutting interval (30 day) results of Spanish panicum for tannin, phytate, saponin and oxalate concentration were found to be 1.71, 3,57, 0.2 and 0.44 mg/100g respectively. Compared to Clover Hay tannin, phytate, saponin and oxalate concentration were found to be 0.44, 3.64, 0.84 and 1.03 mg/100g respectively. The values for Anti-nutritional factors which determined were agreement with the values found by (Refaie *et al.*, 2020) while disagree with results obtained by Onyeonagu, *et al.*, (2013) who stated that panicum maximum contains 3.9 tannin, 10.24 phytate, 0.9 saponin and 3.38 mg/100 g oxalate respectively of forage grass. This may be attributed to the variance among cutting interval day between samples.

Table 5`. Anti-nutritional factors content (mg/100 g) of Spanish Panicum Mombasa and Clover Hay:

Anti-nutrients	Spanish Panicum Mombasa	Clover Hay
Tannins	1.71	0.44
Phytate	3.57	3.64
Saponin	0.2	0.84
Oxalate	0.44	1.03

First experiment

***In Vitro* rumen fermentation parameters of different samples on different Cutting interval day of Spanish Panicum Mombasa:**

Results given in Table 6. for GP (ml/200mg DM), GPSF (ml/g DM) GPSNF (ml/g DM), CH4 (MJ/d) and SCFA (mml/ml gas) as affected by different cutting intervals (30, 45, 60, 75 and 90 day) of SPM revealed that the more the plant advanced in height and age the lower ($P<0.01$) the values recorded, while differences at earlier stages among interval cutting in the a fermented parameters were not significant. The lowest GP was recorded to 90 day cutting interval. The highest ($P<0.05$) average of DDM, DOM, DCPL (g/day) and DOMI (g/day) noticed to be in 30 and 45 cutting interval days, while, the lowest values ($P<0.05$) was found in 90 cutting interval day. These results could be due to the increase in the values of CP, EE, and ash content of 30 and 45 cutting interval day. Also, ME (MJ/Kg DM), NEL (MJ/Kg DM) and NE were significantly ($P<0.01$) high with 30, 45, 60, 75 day and the lowest ($P<0.05$) was recorded on 90 cutting interval day. No significant difference in Microbial protein were founded in 30, 45, 60, 75 cutting interval days. While the lowest was recorded on 90 cutting interval day. These recorded results may attribute to high tannin content at different SPM cutting interval days. Tannins can protect protein from degradation at rumen and let it to bypass to true stomach for intact digestion. (McSweeney *et al.*, 2001).

Table 6. *In- vitro* rumen fermentation parameters to different Cutting interval (day) of Spanish Panicum Mombasa.

Items	Cutting interval day of SPM					
	30	45	60	75	90	SE
Gas production (GP) (ml/200mg DM)	32.65^{ab}	34.83^{a}	31.92^{ab}	34.38^{a}	29.56^{b}	1.36
Gas production structure fibre (GPSF) (ml/g DM)	8.58^{ab}	9.07^{a}	7.09^{b}	7.09^{b}	8.95^{ab}	8.58
Gas production non-structure fibre (GPNSF) (ml/g DM).	21.47^{ab}	22.50^{ab}	22.46^{ab}	24.50^{a}	19.82^{b}	21.47
short chain fatty acid (SCFA) (mml/ml gas)	72.07^{ab}	76.91^{a}	70.44^{ab}	75.89^{a}	65.19^{b}	3.03
Digestible dry matter (DDM %)	50.99^{ab}	61.01^{a}	42.87^{b}	43.67^{b}	25.35^{c}	5.26
Digestible organic matter (DOM%)	61.55^{a}	63.08^{a}	60.12^{b}	61.79^{a}	57.23^{b}	1.21
Metabolizable energy (ME) (MJ/Kg DM)	6.54^{ab}	6.80^{a}	6.44^{ab}	6.73^{a}	6.15^{b}	0.16
Net energy lactation (NEL) (MJ/Kg DM)	3.87^{ab}	4.03^{a}	3.79^{ab}	3.97^{a}	3.56^{b}	0.11
Net energy (NE) (M cal./Lb)	3.87^{ab}	4.03^{a}	3.79^{ab}	3.97^{a}	3.56^{b}	0.09
Digestible crude protein lactation (DCPL) (g/day)	51.87^{b}	64.69^{b}	60.10^{b}	95.94^{a}	33.38	10.24
Digestible organic matter intake (DOMI) (g/day)	181.2^{ab}	265.2^{a}	126.1^{b}	197.6^{ab}	128.0^{b}	38.7
Microbial protein (g/DOM kg)	74.25^{a}	76.10^{a}	72.52^{ab}	74.54^{a}	69.04^{b}	1.21
Growth energy digestibility (GED) (g/Kg DMD)	48.83^{a}	50.33^{a}	47.43^{ab}	49.07^{a}	44.62^{b}	1.18
TDN (%)	86.00^{ab}	86.58^{a}	83.35^{b}	83.30^{b}	79.43^{c}	0.89

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

***In vitro* rumen fermentation parameters of the experimental concentrate feed mixtures containing various levels of Spanish Panicum Mombasa:**

As illustrated in table 7. for predicted gas production, nutrient degradability and rumen fermentation parameters, the highest significant value (P<0.01) of GP, GPSNF and GPSF recorded by the control (T1) 50.35 (ml/200mg DM), 16.0 (ml/g DM), 32.59 (ml/g DM), respectively, while, the lowest values recorded by diet contained 50% from SPM as a replacement of CH. These results could be due to the rumen gas production was inversely influenced by tannins content, the mean of DDM and DOM of diet (T3) contained 50% SPM as a replacement of CH. T3 appeared to be the lowest in the recoded value, while, the highest value (P<0.05) were recorded with control diet (T1).

Table 7. *In vitro* rumen fermentation parameters of the experimental rations.

Items	Experimental concentrate feed mixtures			
	T1	T2	T3	SE
GP (ml/200mg DM)	50.35[a]	49.68[a]	45.0[b]	1.56
GPSF (ml/g DM)	16.0[a]	14.27[b]	13.28[b]	0.74
GPNSF (ml/g DM)	32.59[a]	27.45[b]	25.9[b]	1.51
SCFA (mml/ml gas)	111.9	104.3	102.3	3.51
DDM %	66.53[a]	54.70[b]	59.07[b]	1.45
DOM %	72.65[a]	70.22[b]	69.92[b]	8.60
ME (MJ/Kg DM)	9.51	9.01	8.87	0.37
NEL (MJ/Kg DM)	5.74	5.36	5.26	0.28
NE (M cal./Lb)	3.79	3.71	3.70	0.03
DCPL (g/day)	194.5[a]	147.0[b]	128.7[c]	2.47
DOMI (g/day)	1241.3[a]	832.8[b]	685.3[c]	8.60
Microbial protein (g/DOM kg)	87.64[a]	84.72[b]	84.35[b]	2.16
GED (g/Kg DMD)	59.81[a]	57.31[b]	57.00[b]	2.25
TDN (%)	91.38	90.75	90.21	1.72

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant. T1,T2 and T3 refare to concentrate feed mixture (control diet), control diet supplemented with 25% and 50% from SPM as a replacement of CH, respectively.

This reduction in the recorded value may be due to the opposite relationships among higher levels of digestibility and tannins. Tannins is known to interfere together with microflora and attaches to feed particles and appear the opposite effects on the microbial population inhibiting ruminal degradability (Ammar et al., 2005). Min and Wright (2014) reported that tannins can modulate the ruminal microbiome that related to decreased ruminal digestibility of proteins, decrees of rumen methanogenesis and inhibition of biohydrogenation of rumen unsaturated fatty acids. No significant differences between all experimental diets on *In- vitro* SCFA (mml/ml gas), ME (MJ/Kg DM), NEL (MJ/Kg DM) and NE. Also, higher significant were recorded with control diet on DCPL (g/day), Microbial protein (g/DOM kg), DOMI (g/day) and GED (g/Kg DDM). No significant differences were recorded amongst all experimental diets on TDN (%). These results are matching like ones obtained by Fagundes *et al*., (2020) who founded that *in vitro* rumen methane production and rumen microbiome in beef cattle, protozoa and methanogenic bacteria populations, methane emission was decreased (P < 0.05) by condensed tannin (CT). Piñeiro-Vázquez *et al*., (2018) reported that quebracho tannins extract supplementation at 2 or 3% of dry matter can decrease methane emission up to 29 and 41%, respectively, with no reducing of feed intake and nutrients degradability on the *In vivo* trial.

Some phytochemicals, such as phytate, phenol, saponins, oxalate, and tannins, have been founded to reduce feed intake and nutrient absorption, besides being toxic at high concentrations (Jesuyon *et al.,* 2020). However, these compounds are reported to have strong antibacterial effects and may be useful in modulating rumen fermentation specially in mitigating rumen methane formation (Adejoro *et al.*, 2019), therefore, highly generated interest and taking advantage for sustainable livestock production (Adejoro *et al*., 2019). There is sufficient evidence that the presence of tannins in diets can decrease enteric CH4 production (Adejoro *et al.*, 2019). Recently, interest in green forage rich of tannin content has increased. Tannins have been increasingly investigated to reduce the methane emission of ruminants, feeding ruminant forage rich in Tannin became an important strategy as a methane mitigation (Fagundes *et al*. 2021). Fagundes *et al.*, (2021) reported that the tropical plant species rich source in condensed tannin were effective at mitigating methanogenesis on *in vitro* trails. Williams *et al.*, (2020) reported that methane yield was reduced when tannin was added directly to the rumen by ruminal cannulated Holstein-Friesian cows fed four diets in a double Latin-square.

Patra and Saxena (2010) reported that *In vitro* trials are helpful to show the different of natural tannin sources for their effects on methane and differentiate the most effective ones suitable to be used in animal feed. Bhatta *et al.,* (2009) stated that attention should be given to rumen fermentation parameters and digestibility because adding tannin sources often decreases rumen digestibility and total rumen VFA's production. Tannin also increasingly investigated to reduce the methane emission from rumen, via inhibiting the rumen protozoa. Marchi *et al*., (2019) studied the effects of the feeding 10 shrub and herbaceous legume species plants rich in condensed tannin (CT) on Four rumen-cannulated Nellore cattle grazing a tropical grass pasture on *in vitro* methane emissions and rumen microbiota for beef cattle and founded that methanogenic archaea and protozoa populations were reduced.

condensed tannin in different plant species will have a potential interest as a nutritional strategy to manipulate rumen microbiota and mitigate enteric methanogenesis in ruminant production systems. The antimicrobial and protein-binding properties of CT make these bioactive compounds a natural feed to manipulate rumen microorganisms and reduce methanogenesis (Fagundes *et al*., 2020).

Second experiment Dairy goat's performance:

Changes in Body Weight on Lactating Trial:

As illustrated in Table 8. analyses of variance showed insignificant (P>0.05) differences among groups fed rations supplemented with 25 and 50% from SBM as a replacement of CH and the control in the change of live body weight on different stages of pregnancy (Month) at Initial body weight 1, 2, 3, 4 and 5 Months of pregnancy as well as body weight (kg) at Postpartum periods (Day) at 15, 30, 45 and 60 days.

Table 8. Change in body weight at different stages of pregnancy (Month) and Postpartum periods (Day) in goats at different experimental group

Item	Experimental rations			
	T1	T2	T3	±SE
Weighing time at different stages of pregnancy (Month)				
Initial body weight	26.48	26.57	26.55	1.95
1 Month	27.74	27.85	27.48	1.91
2 Month	28.58	28.93	28.68	1.96
3 Month	29.21	30.35	30.21	1.92
4 Month	30.58	31.45	31.65	1.89
5 Month	31.10	31.98	32.06	1.87
Weighing time at Postpartum periods (Day)				
15 Day	25.00	25.50	26.00	1.59
30 Day	25.23	25.11	25.72	1.59
45 Day	25.20	25.17	25.66	1.60
60 Day	26.52	25.66	26.02	1.77

Milk Yield and Feed Efficiency:

Results of milk yield and feed efficiency of experimental goats as shown in Table 9 ,10 revealed that SPM groups had significantly (P<0.05) higher Milk yield. The 50% SPM fed group (T3) showed significantly (P<0.05) the highest milk yield followed by group (T2) fed 25% SPM, while the control group (T1) had the lowest milk yield. The improved milk production as result of SPM supplementation could be attributed to the fact that SPM is rich in tannin which act on reducing methane production in the rumen and saved energy to be used in production of milk.

Furthermore, tannin played on protecting protein from degradation by rumen microflora and let it to bypass to the true stomach (abomasum) for intact and more efficient digestibility to support higher milk production (Mustafa *et al*., 2003).

Farina *et al.*, (2011) found that productivity can be enhanced by raising either milk production or stocking rate per cow. Stocking strategy influenced toward the height, leaf area index, light interception and herbage mass production, but these effects do not interfere in mean milk yield production /cow. Management of SPM at 30-day fallow period for re-growth gave productivity than allowing sward to reach a height of 70 cm, providing higher herbage mass production and stocking density. This system can be applied by small farms holder and can increase dairy farm productivity without additional resources.

Table 9. Milk production at different stages of dairy Goats on different experimental groups.

Items	Milk production (g/day)			±SE
	T1	T2	T3	
Week 2	189.3^{b}	199.3^{b}	255.0^{a}	4.22
Week 4	295.6^{b}	290.6^{b}	468.1^{a}	5.36
Week 6	380.0^{b}	353.7^{b}	520.5^{a}	4.55
Week 8	421.2^{b}	406.8^{b}	621.0^{a}	12.2
Week 10	278.1^{b}	254.3^{b}	485.1^{a}	4.21
Week 12	143.1^{b}	153.7^{b}	385.6^{a}	3.11

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

As shown in table 10. results of average daily milk yield and fat corrected milk (4%) (FCM) for the whole experimental period illustrate that groups fed diets supplemented with SPM recorded significantly (P<0.05) higher yield of both actual and 4% fat corrected milk than the control. Results of feed conversion ratio (FCR) in terms of the amount of DM used for producing one Kg actual or 4% fat corrected milk, showed that groups fed the 25 and 50 % SPM as a replacement of CH recorded significantly (P<0.05) better values compared with control.

Lima *et al.*, (2013) founded that dairy cows grazing cycle affect Panicum Mombasa composition, at 30-day grazing cycles where higher (P=0.0060) production of leaf was achieved. Milk yield and milk chemical composition were not affected by the stocking systems.

Table 10. Average daily feed intake, milk yield and feed efficiency

Items	Experimental rations			
	T1	T2	T3	±S E
Average daily feed intake as feed (g/h/d)				
Concentrate feed mixture	325	325	325	
Clover hay	332.4	249.29	166.19	
Spanish Panicum Mombasa	0	365.625	731.25	
Average daily feed intake (on DM basis) kg/h/d				
Total DMI	0.606	0.603	0.601	
Milk yield (kg/ h/ d)				
Actual daily milk yield	0.328^{b}	0.340^{b}	0.407^{a}	0.001
4% fat corrected milk	0.313^{b}	0.332^{b}	0.405^{a}	0.009
Feed conversion ratio				
DM kg / kg 4% FCM	1.94^{a}	1.83^{a}	1.48^{b}	0.027

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant..

Milk composition:

As shown in Table 11. The results of Colostrum samples of the experimental groups recorded higher significant (P<0.05) differences among groups supplemented with SPM than control in the content of protein, fat, TS, Ash, and lactose. The same trend of these results were recorded on milk composition from first month of lactation to the end as showed in table (12 and 13)

Blood constituents:

Results of blood analyses are shown in Table 14. Statistical analyses for AST, ALT cholesterol, TG, albumin, urea, creatine, and MDA contents of the blood showed lower significant (P<0.05) differences between SPM (T3) as a replacement of CH and the control (T1), while 50% SPM fed group (T3) recorded (P<0.05) higher values of GPX compared with the control. However, all recorded values of blood constituents for the three tested groups were found to be within the normal range of analysis results. These results are found in agreement with the result obtained by Yusuf *et al*., (2012).

Economic efficiency:

Results in Table 15. of the economic study showed that control ration was the highest daily feed cost (2.63 LE) while, the lowest daily feed cost (2.34 LE) was observed for goats fed ration contained high level of SPM (T3). The best relative economic efficiency was significantly (P<0.05) recorded by (T3) being 247% when compared with the control group (100%). The best economic efficiency as a result of supplementation of SPM could be related to the recorded improvement in the milk yield and productive performance of dairy goats in this current study**.**

Table 11. Colostrum composition of the experimental groups

	Experimental rations			±SE
	T1	T2	T3	
Protein %	5.51^{b}	5.68^{a}	5.75^{a}	0.03
Fat %	4.66^{b}	4.83^{a}	4.90^{a}	0.04
TS %	17.78^{c}	18.14^{b}	18.5^{a}	0.09
Lactose %	3.61^{b}	3.68^{b}	3.81^{a}	0.04
Ash %	1.10^{b}	1.18^{ab}	1.20^{a}	0.02
Moisture %	82.21^{a}	81.85^{b}	81.4^{c}	0.09

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

Table 12. Milk composition of the experimental groups after first and second months of lactation.

Item	1 M			±SE	2 M			±SE
	T1	T2	T3		T1	T2	T3	
CP %	4.75^{c}	4.85^{b}	4.96^{a}	0.02	4.69^{b}	4.75^{ab}	4.82^{a}	0.03
EE%	3.70^{b}	3.81^{ab}	3.93^{a}	0.04	3.58^{b}	3.66^{b}	3.79^{a}	0.04
TS %	13.29^{c}	13.70^{b}	14.07^{a}	0.07	12.83^{b}	13.27^{b}	15.17^{a}	0.85
Lactose %	3.25^{b}	3.35^{a}	3.41^{a}	0.02	3.13^{b}	3.24^{a}	3.32^{a}	0.02
Ash %	0.90^{b}	0.97^{a}	0.99^{a}	0.02	0.83^{b}	0.90^{a}	0.94^{a}	0.02
Moisture %	86.70^{a}	86.29^{b}	85.92^{c}	0.07	87.16^{a}	86.72^{a}	84.82^{b}	0.85

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

Table 13. Milk composition of the experimental groups after third and fourth months of lactation.

Item	3 M			±SE	4 M			±SE
	T1	T2	T3		T1	T2	T3	
CP %	4.55^{b}	4.64^{ab}	4.71^{a}	0.03	4.79^{b}	4.89^{ab}	4.98^{a}	0.05
EE%	3.35^{b}	3.55^{a}	3.68^{a}	0.03	3.70^{b}	3.85^{ab}	3.96^{a}	0.06
TS %	12.49^{c}	12.88^{b}	13.31^{a}	0.07	13.72^{a}	14.12^{a}	14.48^{a}	0.27
Lactose %	3.07^{b}	3.17^{ab}	3.26^{a}	0.02	3.21^{c}	3.31^{b}	3.40^{a}	0.03
Ash %	0.78^{b}	0.83^{b}	0.90^{a}	0.02	0.86^{a}	1.07^{a}	1.09^{a}	0.10
Moisture %	87.50^{a}	87.10^{b}	86.68^{c}	0.07	86.27^{a}	85.87^{ab}	85.21^{b}	0.31

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

Table 14. Blood constituents of the experimental groups

Item	Experimental rations			
	T1	T2	T3	±SE
Total Protein	6.64^{b}	6.65^{b}	7.11^{a}	0.02
Albumin	4.25^{a}	3.95 ^{b}	4.14 ^{a}	0.04
Globulin	2.20 ^{c}	2.69 ^{b}	2.96^{a}	0.05
A/G	1.93 ^{a}	1.5 ^{b}	1.41 ^{b}	0.04
AST	51.0 4 ^{a}	49.07^{b}	44.77^{c}	0.29
ALT	32.38 ^{a}	28.26 ^{b}	22.15 ^{c}	0.26
Cholesterol	72.01^{a}	67.63^{b}	59.62 ^{c}	2.77
Triglyceride	62.99^{a}	55.85^{b}	49.53^{c}	0.05
Urea	18.55^{a}	17.51^{b}	16.74^{c}	0.13
creatine	0.93^{a}	0.80^{b}	0.75^{c}	0.08
Glutathione Peroxidase (GPx)	276.1^{c}	317.9^{b}	344.5^{a}	1.52
Malondialdehyde (MDA)	2.87^{a}	2.19^{b}	1.74^{c}	0.04

Means followed with the same letter (a, b, c) are not significantly different at 5% level of significant.

Table 15. Effect of experimental rations on economic efficiency

Items	Experimental rations			
	T1	T2	T3	±SE
Actual daily milk yield kg/h/day	0.328^{b}	0.340^{b}	0.407^{a}	0.001
Fat corrected milk (4%)	0.313^{b}	0.332^{b}	0.405^{a}	0.009
Total DMI	0.606	0.603	0.601	
Daily feed cost (LE)	2..63^{a}	2.48^{b}	2.34^{c}	0.016
Av. Revenue daily of milk yield (LE)	3.69^{b}	3.83^{b}	4.58^{a}	0.125
Net feed revenue (LE)	1.06^{b}	1.35^{b}	2.25^{a}	0.126
Economic feed efficiency %	40.5%^{b}	54.2%^{b}	69.1%^{a}	5.11
Relative Economic efficiency %	100%^{b}	144.5%^{b}	247%^{a}	2.54

Market price at the time of experimentation for 1-ton CFM were 4500 LE/ ton Egyptian berseem hay were 3500 LE / ton Spanish Panicum Mombasa were 2000 LE/ton, price of 1kg goats' milk were 11.25 LE.

CONCLUSION

The results obtained in the present study, support the conclusion that by associating the results obtained for planting Spanish Panicum Mombasa. Green House Gases (GHG) production potential and dairy goat's performance trail a mitigation of GHG emissions and greater profitability can be achieved by feeding diet with 50% from Spanish Panicum Mombasa as a replacement of CH by SPM at 30 days cutting interval. This may guarantee achieving an environmental sustainability and economic to the production of ruminants under Egyptian condition.

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تقييم نبات البونيكام موميساسا الإسباني عند فترات قطع مختلفة و تأثير أضافته لعلائق الماعز الحلابه على مقاييس الكرش و الأداء الإنتاجي .

رفعت زعرب عياد قليني[2] ، محمد محمد عبد اللا [1] ، جمال علي الدين الصياد[1] ، جمال فاروق شاهين [2] و شيرين حمدي محمد[1]

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تم إجراء تجربتين لتقييم نبات البونيكام موميساسا الإسباني علي خمس فترات قطع 30 و 45 و 60 و 75 و 90 يومًا وتأثيرها على تخمرات الكرش في المختبر وتغذية الماعز الحلابه 0 و 25 و 50٪ من SPM كبديل من دريس البرسيم. سجل 30 يوم من القطع أعلى قيم لمحتوى CP و EE ومحتوى الرماد (17.9 و 2.1 و 12.7) على التوالي ، وسجل محتوى CF أقل 24.6. أظهرت نتائج التجربه الأولي و هي عملية التخمر بالكرش معمليا ، و مسار تكوين الميثان للعينات التي تم جمعها من أيام القطع المختلفة والوجبات الغذائية التجريبية للماعز الحلابه أن أدنى GP بفاصل قطع 90 (يوم). بينما كانت التجربة الثانية عبارة عن أداء ماعز االحلابه ، حيث تم تقسيم 24 ماعزًا بلديًا إلى مجموعة كنترول (T1) ومجموعات تتغذى على البونيكام موميساسا الإسباني بنسبة 25 و 50 ٪ كبديل من دريس البرسيم ، تمثلت في T2 و T3 .أظهرت مجموعة 50٪ من البونيكام موميساسا الإسباني (T3) أعلى إنتاجية للحليب (P <0.05) تليها مجموعة البونيكام موميساسا الإسباني (T2) بنسبة 25٪. هذا و قد كانت الاختلافات معنوية في محتوى البروتين والدهون و TS والرماد في الحليب ، في الأشهر الأولى والثانية والثالثة من الرضاعة. أظهرت تحاليل الدم الكولستيرول AST و ALT و TG والألبيومين واليوريا والكرياتين ومحتويات MDA في الدم اختلافات معنوية أقل (P> 0.05) بين النظام الغذائي (T3) والكنترول (T1) ، بينما سجلت مجموعة النظام الغذائي (P <0.05) T3 قيم أعلى لـ GPX مقارنة بالكنترول . و نستنتج من هذه الدراسه ان التغذيه علي نبات البونيكام موميساسا الأسباني بنسبه 25 ، 50٪ من الدريس كانت الأفضل من الناحيه الغذائيه و الإنتاجيه و الأقتصاديه و علي صحه الحيوان تحت الظروف المصريه