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Nutritive Evaluation of Alfalfa, Panicum Maximum and Its Mixture By Sheep In Reclaimed Sandy Soil In Egypt

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Abstract

THE objective of this study was to evaluate the nutritive value of alfalfa, *Panicum maximum*, and their mixture when fed to sheep in reclaimed sandy soil of Suez Governorate, Egypt. The two forages and its mixture were evaluated in three groups as follows: Alfalfa, 100%, Alfalfa 50% + *Panicum maximum*50% and *Panicum maximum*,100%. Digestibility trials were conducted to evaluate the experimental forages using 9 rams averaged 45kg LBW (3 in each). The rumen parameters were measured. Results showed that alfalfa had higher crude protein and mineral content (Ca, P, K, Cu) but lower crude fiber and nitrogen-free extract compared to *Panicum maximum*. No significant differences were observed in dry matter intake or digestibility coefficients among treatments, except for higher digestible crude protein (DCP) in alfalfa and the mixed group. The ruminal pH of *Panicum maximum* at 2h was significantly higher than other forages while the differences of pH at 4h among three groups were not significant. Ruminal NH3-N and total volatile fatty acids (VFA) of alfalfa was significantly higher than *Panicum maximum* at 2h and 4h. Microbial protein of group fed *Panicum maximum* was significantly lower than other groups. Values of pH were significantly decreased and NH3-N and VFA were significantly increased at 2h and 4h after feeding.

Keywords: Digestibility, rumen parameters, ruminant nutrition, forages.

Introduction

In newly reclaimed sandy soil regions of Egypt, livestock particularly ruminants suffer from a severe shortage of available feed resources. Moreover, reliance on conventional feed ingredients, especially protein-rich sources like soybean meal, leads to a significant rise in feeding costs, limiting the economic feasibility of livestock production in such environments. Under these circumstances, green forages have emerged as a promising and cost-effective alternative for ruminant feeding, due to their relatively low cost and seasonal availability. In Egypt, the most widely used winter forage is Berseem (Egyptian clover), while during the summer, available green forages include leguminous crops like cowpea and grasses such as Sorghum, Sudan grass, and Millet, which are commonly utilized as roughages. Although grasses generally offer higher green forage yields than legumes, their nutritional value is often lower due to their reduced crude protein content and deficiency in certain essential amino acids. For this reason, many studies have recommended integrating legumes into grass-based forage systems to enhance the overall nutritive value of the feed, achieving better nutrient balance in the ration and improving nutrient utilization efficiency in ruminant animals.

Alfalfa (*Medicago sativa*), a widely recognized leguminous forage, has demonstrated good adaptability and high nutritional value when cultivated under sandy soil conditions, making it a suitable candidate for reclaimed lands [1–2]. On the other hand, *Panicum maximum*, a tropical grass species with high biomass production potential, has shown promising adaptability in sandy soils, and several studies have been conducted to evaluate its performance under such conditions [3]. Various studies have also investigated the effects of mixing legumes with grasses in the diets of ruminants. For example, combinations such as *Sesbania sesban* with Millet or Sorghum [4], and *Sesbania sesban* with Sudan grass, or Cowpea with Millet [5], have been tested in sheep feeding trials, with varying degrees of

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success in improving forage quality and animal performance.

Accordingly, there is a growing need for further research to evaluate the nutritional value and feeding efficiency of alternative legume–grass mixtures under local environmental conditions. Therefore, the present study was conducted to assess the chemical composition, digestibility coefficients, and nutritive value of Alfalfa, Panicum maximum, and their mixture when fed to sheep under reclaimed sandy soil conditions in Egypt.

Material and Methods

This work was carried out at Suez Governorate and Research laboratories of Agriculture Faculty, Ismailia, Suez Canal University, Egypt.

Alfalfa and *Panicum maximum* as a green forage crops were cultivated singly in reclaimed sandy soil of Suez Governorate.

Nine local rams averaged 45kg LBW were divided into three groups (3 rams in each) to evaluate alfalfa (100%), alfalfa 50% + *Panicum maximum* 50 % and *Panicum maximum* (100%). the green forages was fed ad lib, Drinking water was available all time.

Three digestibility trials were conducted in metabolic cages to evaluate the digestion coefficients and rumen parameters. Adaptation and preliminary period was 21 days, and a collection period was 5 days, followed 3 days for rumen fermentation parameters studies.

Samples of different forages (alfalfa and *Panicum maximum*) were taken and cuttings, then dried at 60ºc for 24 h. Samples of daily feces were collected and dried in oven at 60ºc for 24 h. Forages and feces samples were milling to pass through a 1 mm screen and stored for chemical analysis. Composite samples of daily urine containing 10 % H2SO4 solution were collected for each animal for determining Nitrogen. Chemical composition of forages, feces and urine were determined according to [6]. procedures.

Rumen fluid samples were taken from 9 rams (3 rams in each) using a stomach tube at 0 time, 2h and 4h post feeding for determining rumen fermentation parameters. The samples were filtered through four layers of surgical gauze. Ruminal pH was immediately estimated by digital pH meter. Rumen ammonia-N (NH3-N) was determined according to [7]. Total volatile fatty acids (VFA) were measured as described by[8] . Microbial protein was determined by sodium tungstate method according to [9]

The experiment design was completely randomized design. The data were statistical analysis using[10] . Means were separated using Duncan Multiple range test [11] . Data were analyzed using the following mathematical model: $Yij= \mu + Ti + eij$. Where: Yij= Individual observation, μ= The overall mean for the trial under consideration, Ti= The effect of the ith treatment and eij= Random residual error.

Results

The chemical composition of alfalfa and *Panicum maximum* as fresh and on dry matter (DM) basis is presented in table 1. Organic matter (OM) content of alfalfa and *Panicum maximum* was nearly similar (88.74% and 90.39%, on DM basis). As expected, the crude protein (CP) on DM basis of alfalfa (21.75%) as legume forage was higher than Panicum maximum grass (9.81%) because the CP of legumes was higher than grasses. While, Crude fiber (CF%) of alfalfa were lower than *Panicum maximum*. Nitrogen free extract (NFE%) of alfalfa were lower than *Panicum maximum*. The ether extract (EE%) and Ash% in alfalfa and *Panicum maximum* were nearly similar (Table 1).

The Mineral elements of Alfalfa and Panicum maximum as shown in Tables 2 as fresh and on dry matter (DM) basis explained that calcium (Ca), phosphorus (P), potassium (K) and cupper (Cu) in alfalfa was higher than in Panicum maximum, while sodium (Na) and Iron (Fe) of two forages was nearly similar. In contrast, the manganese (Mn) in Panicum maximum was higher than alfalfa (Table 2).

The data in Table 3 showed the Intake and feed units' intake of Alfalfa (100%), mixture of 50% Alfalfa + 50% *Panicum maximum* and Panicum maximum (100%). The green forage intake as Kg/h/d in 100% alfalfa was a significantly increased than mixture of 50% alfalfa and 50% *Panicum maximum* and insignificantly increased than 100% *Panicum maximum*, whereas there are no significant differences among the three diets in green forage intake as %LBW. There are no significant differences in DM intake (Kg/h/d), DM intake (% LBW) and DM intake (gm/kg W0.75) among the three groups. The DM intake of two forages and its mixture less than 2% of LBW.

Table 4 presents the results of digestion coefficients and nutritive values of alfalfa, *Panicum maximum* and its mixture. The digestion coefficients of DM, OM, CP, CF and NFE among alfalfa, *Panicum maximum* and its mixture were not significant. The EE digestibility increased significantly in mixture of alfalfa + *Panicum maximum* than alfalfa or *Panicum maximum* alone.

Table 5 presents the data about Rumen fermentation parameters of rams fed Alfalfa (100%), mixture of Alfalfa 50% + *Panicum maximum* 50% and *Panicum maximum* (100%). The differences of ruminal pH, ammonia-N (NH3-N) and VFA,s at zero time among the three forages were not significant. The ruminal pH of *Panicum maximum* at 2h was significantly higher than other forages while the differences of pH at 4h among three groups were not significant.

Discussion

In this study, the chemical composition of alfalfa and *Panicum maximum* was compared to identify differences in their crude protein, crude fiber, and ash contents, and to evaluate their nutritional suitability in ruminant feeding systems. The CP of alfalfa in this study (21.75%) was nearly similar with the CP obtained by Doran et al., (2007) (21.1%), [1] (2001) (21.7%) and [12] (21.1%), and was higher than [2] (18.6 to 19.7%) and was lower than [13] (2002) (29.8%) and [14] (28.2%). The CF of alfalfa in this study (24.86%) was nearly similar with the CF obtained by [15] (26.21%), [16],[1] and [2] (26.5%). The Ash content of alfalfa in this study (8.09%) was nearly similar with the Ash content obtained by [17]) (8.7%),[2] (8.7 %) and [12] (8.3%). The CP of *Panicum maximum* in this study (9.81%) was nearly similar with the CP obtained by [18], [19] (9.3%), [20] (9.42%),[21] (9.45%) and [22] (10.4%). However, [23] found that CP ranged from 10.09 to 25.86% in different cultivars of *Panicum maximum*, [24] found that CP ranged from 5.3 to 20.5% in different growing stages and [3] found that CP ranged from 8.36to 16.0% in different cuts of *Panicum maximum*. The CF of *Panicum maximum* in this study (35.55%) was nearly similar with the CF obtained by [22] (38.5%). [24] found that CF ranged from 24.10 to 39.60% in *Panicum maximum* at different growing stages. Ash content of *Panicum maximum* in this study (7.25%) was nearly similar with the Ash obtained by [25] and [22] (7.45%).

The mineral composition of alfalfa and *Panicum maximum* was evaluated to compare their contents of essential elements and assess their variability in relation to previous studies. The P in alfalfa in this study agreed with [26] while, Ca was higher and K was lower than the same author. The Ca, K and Zn of alfalfa in this study were nearly similar with [27] while Na, Cu, Fe were higher than data obtained by the same author. The K in *Panicum maximum* in this study was similar with [28] . While Ca and Na were higher and P was lower than data obtained by the same author. The Ca and K was higher and P was lower in *Panicum maximum* in this study than data obtained by[29] .

Generally, the wide range of chemical composition of green forages may be due to many reasons as kinds and varieties of plants, plant age, different cuts, cultivation regions, soil fertility and agricultural processes which applied, climatic conditions, sampling site, and vegetative stage.

The data in Table 3 showed the Intake and feed units' intake of Alfalfa (100%), mixture of 50%Alfalfa + 50% *Panicum maximum* and *Panicum maximum* (100%). The DM intake of two forages and its mixture less than 2% of LBW. However, DM intake of *Panicum maximum* in this study was nearly similar with[3] . As expected the CP intake and DCP intake as Kg/h/d and gm/kg W0.75 in 100% alfalfa was significantly higher than mixture of 50% alfalfa + 50% *Panicum maximum* and 100% *Panicum maximum*. Also, CP and DCP intakes as Kg/h/d and gm/kg W0.75 of 50% alfalfa and 50% *Panicum maximum* was significantly higher than 100% *Panicum maximum* due to the high percent of CP in alfalfa than *Panicum maximum*. There are no significant differences in TDN intake as Kg/h/d) and gm/kg W0.75 among the three groups.

The digestibility of DM, OM, CF, EE and NFE of alfalfa (Table 4) in this study were higher than the data obtained by [2] while the CP digestibility agreed with the same author, on the other side, the digestion coefficients of all nutrients in alfalfa in this study were lower than the data obtained by [1] and [30].

The digestibility of DM, OM and CF in *Panicum maximum* in this study agreed with data obtained by [3] while CP and NFE digestibilities were slightly higher than the same author. Also, the DM digestibility of *Panicum maximum* was higher than the results reported by [31], the CP and EE digestibilities were lower than the values reported by the same authors. There were no significant differences in TDN among the all forages, meanwhile, the DCP value in alfalfa and mixture of alfalfa + *Panicum maximum* were significantly higher than *Panicum maximum* alone. The TDN and DCP of alfalfa in this study was nearly similar with data obtained by[2] of alfalfa and[3] of *Panicum maximum* and lower than [1] of alfalfa.

Generally, the feed intake and digestibility coefficient and consequently nutritive values as TDN and DCP of animals are affected by many factors such as animal species, animal health, animal production, feed availability, feed quality, drinking water availability and heat stress.

Table 5 summarizes the effects of different forages on rumen pH, NH_3-N, VFAs, and microbial protein, highlighting changes in fermentation activity after feeding. . The values of pH in this study agreed with [3] of *Panicum maximum*. Ruminal NH3-N of alfalfa was significantly higher than *Panicum maximum* at 2h and 4h. These increased may be due to the high percent of CP in alfalfa than *Panicum maximum*. The NH3-N value of mixture of alfalfa and *Panicum maximum* lie between values obtained from the two forages. Ruminal NH3-N values concentration in this study were higher than that the concentration is required for maximum fermentation (20-24 mg NH3-N/100ml rumen fluid) as mentioned by[32] . The higher values of NH3-N in this study may be the high degradability of forage CP as noticed by [33] and low soluble carbohydrate which require to convert NH3-N to microbial protein by micro-organisms. The VFA of group fed alfalfa was significantly higher than other groups at 2 and 4 h

post feeding while the differences between the other two groups were not significant. The VFA in this study was higher than [3] and lower than [34] . Microbial protein of group fed alfalfa was significantly higher than other groups and microbial protein of group fed *Panicum maximum* was significantly lower than other groups. However, Microbial protein in this study was lower than the values obtained by some authors which utilizing green forage with concentrates [3-4] On the other side, the values of pH were significantly decreased and NH3-N and VFA were significantly increased at 2 and 4h after feeding. The same trend was recorded by [4-5].

Conclusion

Based on the results obtained from this study, and given the absence of significant differences in the digestion coefficients among alfalfa, *Panicum maximum*, and their mixture, it can be concluded that *Panicum maximum* can partially replace alfalfa in sheep feeding. Furthermore, a mixture of both forages may be used without adverse effects on animal health, while ensuring comparable nutritional performance.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

TABLE 1. Chemical composition of Alfalfa and *Panicum maximum* as fresh and DM basis

Items	DM	OM	CP	CF	NFE	EE	Ash
	On fresh basis (%)						
Alfalfa	18.01	15.98	3.91	4.47	6.30	0.39	1.45
Panicum maximum	22.44	20.28	2.20	7.97	8.53	0.47	1.62
	On DM basis(%)						
Alfalfa	100	88.74	21.75	24.86	34.99	2.21	8.09
Panicum maximum	100	90.39	9.81	35.55	38.02	2.11	7.25

DM= Dry Matter OM= Organic matter CP=Crude Protein CF= Crude Fiber NFE= Nitrogen Free Extract EE=Ether Extract Ash = Total Mineral Content

TABLE 2. Contents of mineral elements of Alfalfa and Panicum maximum as fresh and DM basis

Items	macro elements				micro elements			
	Ca%	P%	Na%	K%	Fe, ppm	Cu ppm	Mn ppm	Zn ppm
	On fresh basis							
Alfalfa	0.648	0,09	0.360	0.306	19.919	14.199	1.244	3.627
Panicum maximum	0.471	0.022	0.410	0.168	22.347	5.547	2.324	
	On DM basis							
Alfalfa	3.6	0.5	2.0	1.7	110.6	78.84	6.91	20.13
Panicum maximum	2.1	0.1	1.83	0.75	108.5	24.72	10.36	

Ca=Calcium, P= Phosphorus, Na= Sodium, K= Potassium, Fe= Iron, Cu= Copper, Mn= Manganese, Zn= Zinc.

TABLE 3. Intake and feed units intake of Alfalfa (100%), mixture of Alfalfa 50% + Panicum maximum 50% and Panicum maximum (100%)

Items	Alfalfa,100%	Alfalfa50%+Panicum maximum50%	Panicum maximum,100%
No. of animals	**3 rams**	**3 rams**	**3 rams**
Average LBW, kg	46.25 ^{a} ±3.52	44.60 ^{a} ±1.65	44.25 ^{a} ±1.75
Average $W^{0.75}$	17.71 ^{a} ±1.00	17.25 ^{a} ±0.47	17.14 ^{a} ±0.50
Green forage intake, Kg/h/d	4.83^{a}±0.16	3.93^{b}±0.29	4.03^{ab}±0.24
Green forage intake, %LBW	10.54 ^{a} ±0.73	8.80^{a} ±0.44	9.15 ^{a} ±0.76
DM intake, Kg/h/d	840.28 ^{a} ±28.97	764.06 ^{a} ±56.44	880.4 ^{a} ±52.46
DM intake % LBW	1.83 ^{a} ±0.12	1.71 ^{a} ±0.08	1.99 ^{a} ±0.16
DM intake, gm/kg $W^{0.75}$	47.67 ^{a} ±2.59	44.21 ^{a} ±2.44	51.50 ^{a} ±3.94
CP intake, Kg/h/d	206.04^{a}±7.10	130.52^{b}±9.64	95.74^{c}±5.70
CP intake, gm/kg $W^{0.75}$	11.69 ^{a} ±0.63	7.55 ^{b} ±0.41	5.60 ^{c} ±0.42
TDN intake, Kg/h/d	439.53 ^{a} ±10.55	398.49 ^{a} ±29.13	461.80 ^{a} ±22.80
TDN intake, gm/kg $W^{0.75}$	24.92 ^{a} ±1.05	23.05 ^{a} ±1.21	27.01 ^{a} ±1.82
DCP intake, Kg/h/d	121.88^{a}±2.88	80.82^{b}±5.70	57.93^{c}±3.99
DCP intake, gm/kg $W^{0.75}$	6.91 ^{a}±0.35	4.67 ^{b}±0.24	3.38 ^{c}±0.28

* DM= Dry Matter CP=Crude Protein TDN== Total Digestible Nutrients DCP = Digestible Crude Protein

** a,b and c means in the same row with different superscripts are significantly different (P<0.05).

TABLE 4. Digestion coefficients and Nutritive values of Alfalfa (100%), mixture of Alfalfa 50% + Panicum maximum 50% and *Panicum maximum* (100%)

Items	Alfalfa,100%	Alfalfa50%+*Panicum maximum* 50%	*Panicum maximum*,100%
	Digestion coefficients (%)		
D M	59.17 ^{a} ±1.44	58.56 ^{a} ±0.60	59.06 ^{a} ±0.53
O M	61.04 ^{a} ±1.05	60.05 ^{a} ±0.40	60.30 ^{a} ±0.68
C P	66.74 ^{a} ±0.75	67.05 ^{a} ±0.37	67.00 ^{a} ±0.60
CF	51.19 ^{a} ±0.91	50.88 ^{a} ±0.27	50.52 ^{a} ±0.10
E E	52.62^{c}±0.15	57.52^{a}±0.44	54.27^{b}±0.56
N F E	64.28 ^{a} ±1.81	64.15 ^{a}±0.70	66.81 ^{a} ±1.57
	Nutritive values		
T D N	52.35 ^{a} ±0.82	52.16 ^{a} ±0.33	52.51 ^{a} ±0.53
D C P	14.51^{a}±0.16	10.58^{b}±0.05	6.57^{c}±0.05

* DM= Dry Matter OM= Organic matter CP=Crude Protein CF= Crude Fiber NFE= Nitrogen Free Extract EE=Ether Extract Ash = Total Mineral Content TDN== Total Digestible Nutrients DCP = Digestible Crude Protein

** a,b and c means in the same row with different superscripts are significantly different (P<0.05).

TABLE 5. Rumen fermentation parameters of Rams fed Alfalfa (100%), mixture of Alfalfa 50% + Panicum maximum 50% and Panicum maximum (100%)

Items	Time	Alfalfa,100%	Alfalfa50%+*Panicum maximum* 50%	*Panicum maximum*,100%
pH	0	7.41^{Aa} ±0.06	7.18^{Aa}±0.08	7.15^{Ab}±0.05
	2	6.70^{Bb} ±0.05	6.73^{Bb}±0.01	6.88^{Ba}±0.01
	4	6.70^{Ba} ±0.15	6.80^{Ba}±0.05	6.81^{Ba}±0.10
NH_3-N, mg/100ml rumen liquor	0	46.66^{Ba}±0.18	46.65 ^{Ba} ±0.12	46.20 ^{Ba} ±0.16
	2	51.42 ^{Aa} ±0.40	49.46 ^{Ab} ±0.18	49.37 ^{Ab} ±0.09
	4	50.86 ^{Aa} ±0.49	49.49 ^{Aa} ±0.09	48.53 ^{Ab} ±0.76
VFA,s, mEq/100ml rumen liquor	0	5.75 ^{Ba} ±0.13	5.83 ^{ca} ±0.12	5.61^{ca}±0.09
	2	10.35 ^{Aa} ±0.47	7.13 ^{Bb} ±0.04	7.43^{Bb}±0.56
	4	10.81 ^{Aa} ±0.45	9.03 ^{Ab} ±0.14	8.78 ^{Ab} ±0.14
Microbial Protein, g/100ml rumen liquor	4	0.13^{a}±0.002	0.08^{b}±0.002	0.07^{c}±0.003

*VFA= Volatile Fatty Acids

** a,b and c means in the same row with different superscripts are significantly different (P<0.05).

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التقييم الغذائي للبرسيم الحجازي و البنيكام و خليطهما بإستخدام الأغنام في الأراضي الرملية المستصلحة في مصر

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الملخص

هدف هذا البحث هو دراسة زراعة البرسيم والبانكم ماكسمم في الأراضي الرملية المستصلحة بمحافظة السويس، مصر . تم تقييم العلفين كل على حدة، بالإضافة إلى خليط منهما، من خلال ثلاث مجموعات تجريبية كما يلي: برسيم بنسبة 100%، خليط من برسيم 50% + بانكم ماكسمم 50%، وبانكم ماكسمم بنسبة 100 %. أجريت تجارب الهضم لتقييم هذه الأعلاف باستخدام 9 كباش بمتوسط وزن حي 45 كجم (3 كباش في كل مجموعة). كما تم قياس بعض معايير الكرش. أظهرت النتائج أن البرسيم احتوى على نسبة أعلى من البروتين الخام والعناصر المعدنية (الكالسيوم، الفوسفور، البوتاسيوم، النحاس)، بينما كانت نسبة الألياف الخام والمستخلص الخالي من النيتروجين أقل مقارنةً بالبانكم ماكسمم. لم تُسجل فروق معنوية في استهلاك المادة الجافة أو معاملات الهضم بين المعاملات المختلفة، باستثناء زيادة معنوية في البروتين الخام المهضوم (DCP) في مجموعتي البرسيم والخليط. سجّل بانكم ماكسمم قيمة pH أعلى في الكرش بعد ساعتين من التغذية مقارنة ببقية المعاملات، بينما لم تكن هناك فروق معنوية في قيمة pH بعد أربع ساعات بين المجموعات الثلاث. كما كانت تراكيز الأمونيا-نيتروجين (NH_3-N) والأحماض الدهنية الطيارة الكلية (VFA) في الكرش لدى مجموعة البرسيم أعلى معنوياً من مجموعة البانكم ماكسمم بعد ساعتين وأربع ساعات. كذلك، كانت كمية البروتين الميكروبي في مجموعة البانكم ماكسمم أقل معنوياً من باقي المجموعات. وقد لوحظ انخفاض معنوي في pH الكرش، وزيادة معنوية في تركيز NH_3-N و VFAبعد ساعتين وأربع ساعات من التغذية.

الكلمات الدالة : معامل الهضم، مقاييس الكرش، تغذية المجترات، الاعلاف.