American-Eurasian J. Agric. & Environ. Sci., 22 (2): 69-78, 2022
ISSN 1818-6769
© IDOSI Publications, 2022
DOI: 10.5829/idosi.aejaes.2022.69.78

Growth Performance of Barki Kids Fed Salt Tolerant Plants under Semi-Arid Conditions in North West Coast, Egypt

[1]M.M. Eissa, [1]E.A. El-Wakeel, [1]A.M. Saber, [1]Fatma E. Saba and [2]M.M. El-Deeb

[1]Sheep and Goat Research Department, Animal and Poultry Production Research Institute (APRI), Agricultural Research Center (ARC), Dokki, Giza, Egypt
[2]Animal Nutrition Research Department, APRI, ARC, Dokki, Giza, Egypt

Abstract: This work was carried out on 24 male Barki kids to investigate the effect of substituting berseem hay (Egyptian clover hay) with fresh Kochia (Bassia scoparia) and fresh Athel (*Tamarix aphylla*), on nutrient utilization, rumen activity, some blood constituents, growth performance and economic efficiency. The used kids, aged 5-6 months with average live body weight (LBW) of 20±0.52 Kg, were selected from the herd of Borg El-Arab Station, Alexandria governorate, Egypt, Animal and Poultry Production Research Institute (APRI), Agricultural Research Center (ARC). Kids were randomly divided into 3 similar groups (8 animals for each group). The 1st group (T1) was fed the control diet which consisted of 60% Concentrate Feed Mixture (CFM) plus 40% berseem hay (BH). For the 2nd (T2) and 3rd (T3) groups berseem hay was replaced by fresh Kochia and fresh Athel, respectively. The data indicated that the highest value of DM intake (944 g/h/d and 83g/Kg $W^{0.75}$) was recorded with the control diet. The digestibility coefficients of most nutrients (DM, OM, CP, EE and NFE) and nutritive values measured as TDN and DCP were lower in Athel group than those in both control and Kochia groups. During the whole experimental period (four months), daily body gain was 100, 95.8 and 83.3 g/d in T1, T2 and T3, respectively. The obtained results detected significant ($P<0.05$) differences between the two substitution groups (T2 & T3) and T1 in rumen ammonia-N, VFAs and microbial protein. The effect of replacing berseem hay with fresh Kochia and fresh Athel on serum total protein and urea-N without affecting liver function was insignificant with T1, T2 and T3. Moreover, replacing fresh Kochia and fresh Athel resulted in a lower feed cost and increased economic efficiency (T2 and T3, respectively) compared with T1. In conclusion, fresh Kochia and fresh Athel instead of berseem hay improved growth performance, some blood constituents, feed utilization and increased profitability of Barki kids.

Key words: Kids · Kochia · Athel · Weight gain · Digestibility · Blood

INTRODUCTION

Sheep and goats are considered one of the most important components of livestock in Egypt. Hence, they gain an economic importance. Their total population in Egypt is about 4.2 million heads [1]. The shortage of animal feeds in Egypt is the main constraint for further development of animal production. Moreover, areas cultivated with clover (berseem) are diminishing due to the state trend (National policy) to replace it with wheat to satisfy human demands [2, 3]. During summer season, when the conventional forage resources are in shortage, utilization of alternative feed resources, e.g. salt-tolerant plants, in animal feeding particularly in the salt affected lands could be an appropriate option [4, 5]. The shortage of animal feeds in Egypt is the main constraint for any further increase in the animal population. There are about 12 million animal units, the need of those animal units of concentrated feeds is about 15.9 million tons, and the available quantity for consumption is about 5.1 million tons [6]. Besides, the fresh forage area is about 3 million feddan [7]. Therefore studies should be oriented towards solving these problems and represent replacers of roughages or concentrates from available and cheaper

Corresponding Author: M.M. Eissa, Sheep and Goat Research Department, Animal and Poultry Production Research Institute (APRI), Agricultural Research Center (ARC), Dokki, Giza, Egypt.
Mob: +201227765233.

ingredients which do not compete with human food. The use of saltbushes is one option available to utilize saline landscapes which can convert it from zero productivity into an asset.

Kochia (Bassia scoparia) plants adapting to extreme environmental factors provide an important part of forage requirements for livestock grazing in arid and semi-arid regions. Many wild Kochia species are undervalued mainly because of insufficient knowledge about their potential feeding value, yields and their effect on animal performance. Therefore this research paper gives knowledge on Kochia plant as salt-tolerant forage for feeding small ruminants' at the Northwestern coast of Egypt. Many studies show that this plant could be used successfully as an alternative feed to replace partially common feedstuff [8]. However, the presence of plant secondary metabolites should be taken into consideration in rations containing Kochia forage for small ruminants feeding.

Athel (*Tamarix aphylla*) is an easily grown plant succeeding in most soils and tolerant of saline conditions. It grows well in heavy clay soils as well as in sands and even shingles. It is usually found near the coast and succeeds inland if given a fairly good deep loam and a sunny position. It is also tolerant of maritime winds and dry soils when grown near the coast plants require a moister soil and shelter from cold drying winds when they are grown inland in non-saline soils because they use the soil salts that are found help them reduce transpiration. These species succeed in the milder areas of the country, tolerating temperatures down to between -5 and -10°C [9].

The present study was conducted to evaluate the effect of using a salt tolerant plant (fresh Koicha & fresh Athel) as a replacement to berseem hay in Barki kids' rations on their growth and economic return.

MATERIALS AND METHODS

The experiment was conducted at Borg El-Arab Research Station (West of Alexandria city, latitudes 21° and 31° North and longitudes 25° and 35° East), belongs to Animal Production Research Institute (APRI), Agricultural Research Center (ARC), Egypt. This study was carried out using Twenty four growing male Barki kids. The animals were divided into three treatment groups (Eight heads each). The present work aimed at studying the effect of fresh Kochia and/or fresh Athel (Leaves and Twigs) on growth performance, rumen parameters, blood metabolites and feeding efficiency.

Sample Collection, Preparation and Chemical Analysis: The tested plants (Kochia and Athel) from each ingredient in forms of leaves and twigs were collected and fed to the experimental animals as fresh. Samples from both plants were chopped into small pieces and dried in an oven at 55°C for 48 h prior to being milled. Feed samples were analyzed for dry matter (DM) and total ash using the method of A.O.A.C [10]. Acid detergent fiber (ADF) and neutral detergent fiber (NDF) were analyzed by the Van Soest, [11]. Non fibrous carbohydrates % (NFC) was calculated according to the equation of Calsamiglia *et al.* [12]. Determinations of phenol compounds were determined by Makkar [13].

Feeding Management: This study was carried out on Twenty four growing Barki males, selected from a herd of Borg El-Arab Station, Alexandria governorate, Egypt, APRI, ARC. The average age of these males about 5-6 months and the average body weight is 20±0.52 Kg. The animals were divided into three groups (eight males each) to study the effect of the tested rations on growth performance, blood metabolites and feed efficiency. Feeding requirements for the three studied groups were adjusted according to NRC [14], comprises 40% roughage + 60% Concentrate Feed Mixture (CFM). The used CFM composed of 25% cottonseed cake, 38% maize, 25% wheat, 5% soybean, 3% molasses, 2.5% limestone and 1.5% salt & mineral mixture. The rations were offered once a day in the morning and water was made available all the day time. The three studied rations were formed as follows:

T1: 40% barseem hay + 60% CFM.
T2: 40% Kochia + 60% CFM.
T3: 40 % Athel + 60% CFM.

Rumen Fluid Parameters: Rumen fluid samples were taken from 3 animals of the experimental groups using stomach tube before feeding (0 times) and at 4 hrs post-feeding. The samples were filtered through 3 layers of gauze and immediately subjected to the determination of pH value by pH meter. Ammonia nitrogen (NH_3-N) concentration was measured according to method Conway [15] and total volatile fatty acids (TVFAs) were determined according to the technique described by Warner [16]. Microbial protein was determined according to Shultz and Shultz [17].

Digestibility Trial: Three animals form each group were used for digestibility trial to evaluate the three studied

rations. Proximate chemical analysis of the feeds and feces was calculated according to A.O.A.C. [10]. The rations were offered twice daily at 8 am and 3 pm and drinking water was available all the time. Digestibility coefficients, nutritive value (total digestible nutrients; TDN & digestible crude protein; DCP), feed conversion (Kg DM / Kg gain, Kg TDN / Kg gain and Kg DCP / Kg gain), relative feeding value (RFV), digestible energy (DE; Mcal/Kg DM) and effective neutral detergent fiber (eNDF) were calculated using the equations of Moore and Coleman [18], NRC [19] and Fox *et al.* [20], respectively.

Kid's Growth Performance: Kids were weighed at the beginning of the experiment and then biweekly during the four months experimental period. Average daily weight gain was calculated. Total dry matter intake (g/head/day), DM intake as % of body weight (% BW) and DM intake (g/Kg metabolic body weight) were recorded. Feed conversion ratio was calculated using the following equation:

FCR = Feed consumed (g) during a certain period / Body weight gain (g) during the same period

Blood Analysis: Blood samples were collected from the jugular vein once before feeding from the three experimental groups (3 animals each) at the end of growing period. Samples were centrifuged at 4000 rpm for 20 min. Part of the separated serum was directed to enzymes activity determination, while the other part was stored frozen at -20°C till the biochemical analysis. Commercial kits were used for all colorimetric biochemical determination.

Economic Indicator: The economic indicator was calculated as a return of Kg gain of sold kids minus feeding cost during the four months according to the Egyptian local prices, where one ton of berseem hay = 1800 Egyptian pound (LE), CFM = 4000 LE and the cost of one ton of fresh Kochia forage cultivation, harvesting and any other cost = 350 LE while one Kg live body weight of kids sold for 60 LE.

Statistical Analysis: Data were statistically analyzed by the GLM procedure of SAS [21] using the following model:

$Yij = \mu + Ti + eijk$

where: Y_{ij} = an observations, μ = Overall mean, T_i = Effect of using different kinds of dried forage (i = Berseem hay, Kochia and *Tamarix aphylla*) and e_{ijk} = Residual (Random error).

Differences among means were determined by Duncan's New Multiple Range Test [22].

RESULTS AND DISCUSSION

The chemical compositions of the tested forages are presented in Table (1). It was observed that CP content was noticeably higher with fresh Athel (14.75%) than fresh Kochia (12.8%), or berseem hay (10.63%). While, the highest value of CF (38.54) was recorded with berseem hay and the lowest values (17.19%) were detected with fresh Athel. The differences in DM and OM were higher values between fresh Kochia & fresh Athel. The chemical composition obtained in the present study is nearly similar to that obtained by Ben Salem *et al.* [23] Fulkerson *et al.* [24] and Shaker *et al.* [25] on some salt-tolerant fodder shrubs. The results showed that CP, EE, antioxidant activity, phenolic compounds and condensed tannin contents were higher in fresh Kochia than fresh Athel. The salt-tolerant fodder shrubs had higher CP, CF, NFE, antioxidant activity and OM% which could be a safe cover for the important nutrient requirements of animals [5]. Also, Salem *et al.* [26] suggested that browse is potential as nitrogen supplements for ruminants fed low-quality fodders through the dry season in semi-arid regions. El Shereef [27] noted that fresh fodder *Kochia indica Wight* had high crude protein content (18.6%). Moreover, shrubs and multipurpose trees have become a useful alternative ruminant feed in the harsh semi-arid regions [28-30]. The NFC of the formulated rations is in the range of minimum above 20-25% and maximum below 40-45% reported by Wheeler [31].

Yi *et al.* [32] stated that the antioxidant activity of plants containing phenolic compounds referred back to their capacity in acting as donors of hydrogen atoms or electrons and capturing the free radicals. Several investigations revealed that the overall antioxidant activity of plants to large extent results from the amount of total phenolics and total flavonoids constituents [33, 34]. The natural antioxidants that are ingested by fed animals are believed to contribute towards an improved antioxidant status of the animal. Therefore, more efficient

utilization from feeds' protein (T2) might be attributed to glutathione peroxidase, since it is the most powerful antioxidant enzyme that protects cellular proteins against reactive oxygen species (stress products) in the body [35].

The current results in Table (2) showed that kids consumed approximately a similar daily amount of dry matter (DM) from the three understudied experimental rations. The highest value of DM intake was obtained for T1 during the four months (944 g/h/d and 83 g/Kg $W^{0.75}$) in comparison with fresh Kochia and fresh Athel, being 915 g/h/d; 81 g/Kg $W^{0.75}$ and 903 g/h/d; 80 g/Kg $W^{0.75}$, respectively, but without significant differences among the three groups. Generally, it is clear that with increasing the level of NFC, DMI increased, but this was accompanied by a reduction in NDF content (T1 & T2 compared to T3). An opposite trend was observed with T3, since DMI decreased, while NFC increased with the decreased level of NDF% in comparison to the other two tested groups.

These results agree with Alsheikh [36] who found that DM intake from Kochia ration was lower ($P<0.05$) than that of clover hay ration. Also, Hanafy *et al.* [37] found that DM intake of lactating goats from Kochia hay ration was lower ($P<0.05$) than that of clover hay (10.12 *Vs.* 28.6 g/Kg BW). Energy requirements of the animals negatively related to NDF content, which limits the intake from diets with low NDF level. Condensed tannin as a polyphenol macromolecule was the highest in Kochia may play additive role in reducing feed intake and relative feeding value compared to BH ration. These results are similar to the studies of Hanafy *et al.* [37] and Youssef *et al.* [8] where goats and sheep consumed diets contained Kochia had lower DM intake.

On the other hand, Fahmy and Fayed [38] observed that DM intake by sheep from both Kochia hay and clover hay was almost similar (20.1 *Vs.* 21.3 g/Kg BW). Moreover, Gihad *et al.* [39], during their studies for the palatability of eight desert plants, found that DM intake/Kg $BW^{0.75}$ from fresh Kochia by both sheep and goats was higher than other tested plants with corresponding values of 55.7 g/Kg $BW^{0.75}$ for sheep and 57.8 g/Kg $BW^{0.75}$ for goats. Similar trend was obtained by Youssef *et al.* [8] during a palatability trial when they tested pearl millet and Kochia with sheep (785 pearl millet hay *Vs.* 688 g DM/h/d of Kochia hay).

Results of the digestibility trial (Table 3) showed that digestibility coefficients of most nutrients (DM, OM, CP, EE and NFE) were lower in T3 than those of T1 and T2. The nutritive values of T3, measured as TDN and DCP were also lower (65.8 & 9.9) than those of T1 and T2 (72.4 & 12.5 and 70.3 & 11.8, respectively). This may be attributed to the increase in ash percentage in Athel.

Alsheikh [36] reported that the nutritive values of TDN and DCP were higher ($P<0.05$) in Shami kids fed 40% Kochia and 60% concentrate mixture, than those fed 40% berseem hay and 60% concentrate mixture, (64.3 and 9.9%, respectively). The improvement in digestibility of all nutrients and nutritive values for fresh Kochia and Athel, according to Hashemi and Davoodi [40], may be due to the mechanism of phenolic compounds that may act as growth promoters for the farm animals, by enhancing digestive enzyme secretions (endogenous digestive enzymes, saliva, bile, and mucus). Digestible energy in the form of easily fermentable carbohydrates provides a source of energy for the reproduction and growth of the microorganisms. This may explain the increased relative feeding value of T1& T2 compared to that of T3.

These results are similar to those obtained by Mehrez *et al.* [41] on Rahmani lambs and Ahmed [42] on Zaraibi kids. Abd El-Rahman [43] observed that DM, OM, CP, CF, EE and NFE digestibility coefficients of fresh Kochia were comparable between sheep and goats and reported also higher organic matter digestibility than that reported by Fahmy and Fayed [38] for fresh Kochia (76.5 *Vs.* 52.0%). Besides, the feed conversion (Table 3) of both DM and TDN and DCP in T2, T3 (16.00 & 9.50 and 14.51 & 9.20), respectively was better than that in T1 (13.30 & 8.76). This may be attributed to the phenolic compounds and antioxidant activity may have additional benefits [44]. Generally, nutrient digestibility of Kochia hay for both sheep and goats and feed conversation was better in fresh forage than its hay without significant differences [38, 45].

El-Adawy *et al.* [46] found that feed conversion ratio of dried Kochia inclusion diets increased ($P<0.05$) in groups fed diets contained 25, 50, 75 and 100% compared to the control which had the lowest. The overall feed conversion ratio of the control and 25% diet were similar but higher ($P<0.05$) in those fed 50, 75 and 100% Kochia. From practical point of view, they concluded that dietary berseem hay could be replaced up to 25% by dried Kochia in the growing rabbit diets without obvious negative effects on growth performance, nutrients evaluation, digestibility and productivity.

Table 1: Chemical analysis of feed ingredients and the tested rations

	Chemical composition, % DM basis												
Item	DM	OM	CP	CF	EE	NEF	Ash	NDF	ADF	NFC*	Anti-oxidant activity	Phenolic compounds	CT
CFM	91.20	93.90	15.70	16.45	3.13	58.62	6.10	43.00	17.30	32.07	-	-	
Berseem hay	95.12	89.50	10.63	38.54	1.03	39.30	10.50	55.89	43.27	21.95	-	-	
Fresh Kochia	91.60	82.37	19.07	33.40	1.48	26.42	17.63	53.37	41.09	8.45	60.12	60.33	4.83
Fresh Athel	58.67	86.83	10.52	21.46	1.00	53.85	13.17	43.21	31.26	32.10	37.26	53.51	1.60
Calculated chemical composition of rations:													
T1	92.77	92.14	13.67	25.29	2.29	50.89	7.86	48.16	27.69	28.02	-	-	
T2	91.36	89.29	17.05	23.23	2.47	45.74	10.71	47.15	26.82	22.62	35.40	30.50	2.83
T3	78.19	91.07	13.63	18.45	2.28	56.71	8.93	43.08	22.88	32.08	20.50	30.25	0.70

CFM = Concentrate feed mixture.

* Non fibrous carbohydrates% (NFC) = OM% - (CP%+NDF%+EE %).

DM, dry matter; OM, organic matter; CP, crude protein; EE, ether extract; NFC, non-fibrous carbohydrates; NDF, neutral detergent fiber and ADF, acid detergent fiber.

Table 2: Dry matter intake of Barki kids from the three experimental rations

Item	T1	T2	T3
Concentrate (g/h/d)	560	550	540
Roughage (g/h/d)	384	365	363
Total DM intake (g/h/d)	944	915	903
DM intake, % BW	3.30	3.40	3.25
DM intake, g/Kg $W^{0.75}$	83	81	80

Table 3: Digestibility coefficients, nutritive values and feed conversion of the three experimental rations fed to Barki kids

Item	T1	T2	T3
Digestion coefficient (%)			
DM	70.1 ± 1.22^a	69.3 ± 1.33^a	64.53 ± 1.33^b
OM	75.2 ± 1.40^a	74.5 ± 0.88^a	66.22 ± 1.54^b
CF	66.5 ± 0.80^a	65.2 ± 0.45^a	62.46 ± 0.77^b
CP	78.8 ± 0.42^a	77.5 ± 0.31^a	70.54 ± 1.65^b
EE	80.2 ± 0.45^a	79.8 ± 0.35^a	74.59 ± 1.45^b
NFE	75.0 ± 1.46^a	74.8 ± 1.25^a	68.64 ± 144^b
Nutritive value (%)			
TDN	72.4 ± 0.58^a	71.5 ± 0.74^a	65.8 ± 1.20^b
DCP	12.5 ± 0.11^a	11.8 ± 0.62^a	9.9 ± 0.12^b
Feed conversion			
Kg DM/kg gain	13.30	16.00	14.51
Kg TDN/kg gain	8.76	9.50	9.20
Kg DCP/kg gain	1.26	1.35	1.32
eNDF	32.04	32.04	30.15
RFV	48.45^a	51.30^a	44.15^b
DE (Mcal/Kg DM)	3.01^a	3.19^a	2.46^b

TDN = Total digestible nutrients. DCP = Digestible crude protein.

RFV (Relative feeding value) = DMI x DDM / 1.29

DE (Digestible energy, Mcal/Kg DM) = % TDN x 0.04409

eNDF (Effective neutral detergent fiber) = (pH - 5.425) / 0.04229

Means in the same row with different superscripts differ significantly at ($P<0.05$)

Rumen parameters are presented in Table (4) and showed that, except pH values, the differences among treatments respecting all other tested parameters were not significant at zero sampling time, while at 4 hrs post-feeding the concentration of ammonia-N with animals fed fresh Kochia and fresh Athel rations was significantly ($P<0.05$) higher than those for animals fed berseem hay ration. Rumen total VFAs concentrations during the 4 hrs post-feeding was significantly ($P<0.05$) higher with fresh Kochia and fresh Athel rations (12.43 &12.95 mEq/100 ml rumen liquor) compared with berseem hay (11.80 mEq/100 ml rumen liquor). The superiority in total VFAs in fresh Kochia and fresh Athel rations is mostly attributed to their high content of NFE compared to berseem hay.

Generally, ruminal total VFAs found to be higher with increasing Kochia forage in goat rations [42, 3]. Also, it could be observed an opposite relationship between ammonia-N concentration values and the microbial protein content values over 4 hrs sampling time, overall dietary treatments. In this respect, Varel *et al.* [47] reported that rumen microorganisms have the ability to degrade low concentration of phenolics and use it as an energy source without negative effects on rumen fermentation. Fulkerson *et al.* [24] showed that the dietary fibrous fractions, possibly induce positive effects on rumen microflora activity. Moreover, Papatsiros *et al.* [48] reported that the pungent substances that induce modification in the gut microflora are found to function throughout increasing blood circulation, leading to faster detoxification of the whole metabolism. Najmul Haque [49] found that low structural fiber diet disturbs rumen function causing a reduction in the rumen fermentation and accordingly feed utilization, on the long term. The increased level of microbial protein synthesized in the rumen of groups received either Kochia or Athel instead of BH may be attributed to the utilization of ruminal ammonia-N. In addition, the high level of CP in Kochia may participate in improving microbial protein synthesis throughout its protection from degradation in the rumen by tannin.

Data in Table (5) showed that animals fed rations contained Kochia and Athel had higher ($P<0.05$) glucose concentrations than control. These results may be due to the improvements that occurred in the metabolic process as a response to the experimental additives. The concentrations of glucose were in the normal range for healthy animals and were higher in both Kochia and Athel groups than control. These results are parallel with values obtained by Ali *et al.* [50] who found that chamomile supplemented goats ration increased ($P<0.05$) blood glucose values. Stella *et al.* [51] found no significant effect of yeast culture supplementation on the plasma glucose of lactating goats indicting that tested additives to lactating goat's rations did not negatively affect the liver activity or animal health. Moreover, serum total protein values increased while serum albumin, globulin and A/G ratio showed no significant increase with fresh Kochia and fresh Athel rations compared to the control. These results may be due to the improvements in ruminal microbial protein synthesis [52].

Moreover, the results (Table 5) showed no significant changes in Aspartate aminotransferase (AST) and Alanine aminotransferase (ALT) activities, also creatinine and urea levels, which indicated the healthy effect of fresh Kochia and fresh Athel in kids rations. This may be attributed to phenolic compounds and antioxidant activity as natural feed molecules that may have additional beneficial properties such as immunity, anti-inflammatory, gut health and antimicrobial activity, consequently reflected on health criteria [53].

The obtained results in Table (6) indicated that replacing hay with fresh Kochia and fresh Athel during the experimental period maintained the average daily gain (ADG) of kids significantly ($P<0.05$) different in favor of feeding Koicha (T2) than Athel (T3). The ADG values were 100, 95.8, and 83.3 g/h/d, for T1, T2 and T3, respectively. The differences between T1 and T2 were insignificant, while the ADG in T3 (83.3 g/h/d) was significantly ($P<0.05$) lower than those of T1 and T2 (100 and 95.8 g/h/d, respectively). The same trend was obtained in the final body weight which was significantly ($P<0.05$) lower in T3 (30 Kg) than those of T1 and T2 (32 and 31.5 kg, respectively). These results indicate that the positive improvement in production performance may be due to the consumption of fresh herbage by ruminants can improve several quality traits of digestibility as compared with concentrate-based diets, with the increased production of TVFAs, the main source of energy. These results can be explained by the fact that the tested shrubs able to modify the diet fermentability and energy availability for ruminants and might increase energy-efficiency to be utilized in forms of live body weight. In particular, the positive effect is attributed to the high content of antioxidant compounds in fresh herbage and to their deposition in the animal tissues, and the improvement in the digestibility of all nutrients and nutritive values, consequently the growth performance [44]. Similar results were obtained by Ahmed [41] and Sadek *et al.* [52]. El-Adawy *et al.* [46] found that rabbits fed on Kochia diets showed a decrease ($P<0.05$) in daily weight gain and daily feed consumption was numerically lower by 2.9 and 5.1% with increasing Kochia level in the rations compared to the control. They added that feeding growing rabbits with diets contained 50, 75 and 100% Kochia decreased ($P<0.05$) the final live body weight at 13 weeks of age by 4.5, 10.3 and 13.1%, respectively, than those fed the control diet (Kochia free). They attributed this decrease in live body weight to the lower feeding values and digestibility of nutrients compared with those fed 0 and 25% Kochia. Similar trend was recorded by Hanafy *et al.* [37] when Kochia fed to goats, since it had low birth and weaning weights.

Table 4: Effect of experimental rations on the rumen liquor parameters and microbial protein synthesis

Item	hrs	T1	T2	T3	±SEM
pH	0	6.80	6.95	6.90	0.06
	4	6.75	6.60	6.50	0.05
Ammonia-N (mg/100 ml)	0	17.20	17.90	17.85	0.30
	4	21.70[b]	23.60[a]	22.50[a]	0.25
TVFA's (mEq/100 ml)	0	9.00	9.05	8.85	0.15
	4	11.80[b]	12.90[a]	12.95[a]	022
Microbial protein (g/100 ml)	0	0.355	0.349	0.341	0.02
	4	0.570[b]	0.600[a]	0.595[a]	0.013

a, b Means in the same row with different superscript differ significantly at P<0.05

Table 5: Effect of feeding experimental rations for Barki kids on some blood serum parameters

Item	T1	T2	T3
Glucose (mg/dl)	44.84±0.60	45.60±0.56	45.22±0.43
Total protein (g/dl)	6.57±0.35[b]	7.57±0.78[a]	7.37±0.44[ab]
Albumin (A; g/dl)	3.06±0.07	3.61±0.17	3.50±0.35
Globulin (G; g/dl)	3.41±0.44	3.96±0.84	3.87±0.78
A/G ratio	0.90±0.13	0.91±0.20	0.90±0.45
Urea (g/dl)	33.10±0.64	33.80±0.45	33.70±0.41
Creatinine (mg/dl)	1.27±0.09	1.17±0.09	1.47±0.12
AST (IU/L)	33.67±1.20	32.63±1.23	34.07±1.16
ALT, (IU/L)	18.33±1.67	18.33±1.76	18.88±1.69

a, b, c: Means in the same row with different superscripts differ significantly at P<0.05.

Table 6: Performance of the growing Barki kids and economic indicators in relation to the tested rations

Item	T1	T2	T3
Growing performance traits:			
Initial BW (Kg)	20 ± 0.45	20± 0.60	20 ± 0.50
Final BW (Kg)	32 ± 0.93[a]	31.5 ± 0.82[a]	30 ± 0.70[b]
Total gain (Kg)	12 ± 0.54[a]	11.5 ± 0.22[a]	10± 0.28[b]
Daily gain (g/h/d)	100 ± 2.40[a]	95.8 ± 1.35[a]	83.3 ± 1.69[b]
Economic indicators:			
Total feed intake (g/h/d)	944	915	903
CFM	560	550	540
BH	384		
Kochia		365	
Athel			363
Price of total feed intake (LE./h/d):			
CFM	308	303	297
BH	0.96		
Kochia		0.20	
Athel			0.19
Total feeding cost (LE)	4.04	3.23	3.16
Average daily gain (g/h/d)	100	95.8	83.3
Price of daily gain (LE)	7.00	6.44	5.25
Net profit (LE/h/d)[1]	2.96	3.21	3.09
Economic efficiency[2]	73.26	99.38	88.14
Relative improvement[3]	100	135.36	102.28

Total price for feeds was calculated according to the price of different ingredients available in Egypt.

The price was calculated due to the local market where one-ton of CFM, BH, Kochia, Athel and Kg BW/kids were 5500, 2500, 550, 550 & 70 LE, respectively).

1. Net profit = Price of daily gain (LE) - Total feeding cost (LE).

2. Economic efficiency (EE)= Net profit / total feeding cost (LE).

3. Relative improvement from the control, assuming that the EE relative to the control (100)

On the other hand, Abd El-Hamid [54] studied the effect of feeding Kochia with two levels of concentrate on growth performance of lambs. They found that the average daily gain of lambs fed Kochia ration either with 40 or 60% concentrate mixture was higher by 4.02 and 13.8% than those fed clover hay with concentrate mixture.

Results of feed cost and economic indicator in Table (6) showed that although kids in T3 had the lowest feed cost, T2 gave the highest net profit compared with T1. Replacing berseem hay with fresh Kochia and fresh Athel tended to be more economic and leading to increase the return [52].

CONCLUSION

It could be concluded that fresh Kochia and fresh Athel could be considered as promising forage by smallholder crop-livestock farmers and agro pastoralists in arid and semi-arid areas. Moreover, these plants can provide relatively high forage yield under soil and water salinity conditions, improve animal growth performance, nutrients utilization, digestibility and animal productivity thus participating in increasing farmer's income.

REFERENCES

1. FAO, Food and Agriculture Organization, 2010. Site in: http://faostat.fao.org/site/573/DesktopDefault.aspx?PageID=573#ancor. Food and Agriculture Organization, United Nations, Rome.
2. Ahmed, M.M.M., F.M. El-Hag, F.S. Wahab and S.F. Salih, 2001. Feeding strategies during dry summer for lactating desert goats in a rainfed area under tropical conditions. Small Rumin. Res., 39: 161-166.
3. Shehata, E.I., M.E. Ahmed, A.M. Abdehamid, F.F. Abou Ammou and M.H. Haggag, 2001. Comparative nutritive values of silage rations containing different levels of Teosinte and Kochia. Egyptian J. Nutrition and Feeds, 4(Special Issue):129.
4. Fahmy, A.A., K.M. Youssef and H.M. El-Shaer, 2009. Intake and nutritive value of some salt tolerant fodder grasses fed to sheep under saline conditions of South Sinai. Egyptian J. Nutrition and Feeds, 12(1): 89-97.
5. El-Shaer, H.M., 2010. Halophytes and salttolerant plants as potential forage for ruminants in the Near East region. Small Ruminant Research, 91: 3-12.
6. Mousa, M.R.M. and H.M. El-Shabrawy, 2011. Growth performance of Damascus kids as affected by feeding system under Semi-arid conditions of North Sinai. J. Agric. Sci. Mansoura Univ., 28(7): 5224-5237.
7. FAO, Food and Agriculture Organization, 2009. The State of Food And Agriculture 2009 - Livestock in the balance ISBN 978-92-5-106215-9; available at: http://www.fao.org/publications/sofa/en/ (in Arabic, Chinese , English, French, Russian and Spanish).
8. Youssef, K.M., A.A. Fahmy, A.M. EL-Essawy and H.M. El-Shaer, 2009. Nutritional studies on Pennisetum americanum and Kochia indica fed to sheep under saline conditions of Sinai, Egypt. American-Eurasian J. Agric. and Environ. Sci., 5: 63-68.
9. Kennedy, T.A., J.C. Finlay and S.E. Hobbie, 2005. Eradication of invasive *Tamarix ramosissima* along a desert stream increases native fish density. Ecological Applications, 15: 2072-2083.
10. A.O.A.C., Association of Official Analytical Chemists, 1995. Official Methods of Analysis (16th edn), Washington, D.C., USA.
11. Van Soest, P.J., J.B. Robertson and B.A. Lewis, 1991. Methods for dietary fiber, neutral detergent fiber, and non-starch polysaccharides in relation to animal nutrition. J. Dairy Sci., 74: 3583-3597.
12. Calsamiglia, S., M.D. Stern and J.L. Firkins, 1995. Effects of protein source on nitrogen metabolism in continuous culture and intestinal digestion *in vitro*. J. Anim. Sci., 73: 1819.
13. Makkar, H.P.S., 2003. Effects and fate of tannins in ruminant animals, adaptation to tannins, and strategies to overcome detrimental effects of feeding tannin-rich feeds. Small Ruminant Research, 49: 241.
14. NRC, National Research Council, 1981. Nutrient Requirements of Domestic Animals. Nutrient Requirement of Goats. National Academy press. Washington D.C., USA.
15. Conway, E.F., 1957. Micro diffusion Analysis and Volumetric Error. Rev. Ed. Lock Wood, London.
16. Warner. A.C.I., 1964. Production of volatile fatty acids in the rumen Methods of measurements. Nutr. Abst. Rev., 34: 339 digestibility. J. Anim. Sci., 24: 834.
17. Shultz, T.A. and E. Shultz, 1970. Estimation of rumen microbial nitrogen by three analytical methods. J. Dairy Sci., 53: 781.

18. Moore, J.E. and S.W. Coleman, 2001. Forage intake, digestibility, NDF and ADF: How well are they related? pp: 238-242. In: C. Terrill (Ed.) Proc. Am. For GRSLD Coun., Springdale, A.R. AFGC Georgetown, TX.
19. NRC, National Research Council, 1978. Nutrient Requirements of Dairy Cattle. 5th Rev. ed., Nat. Acad. Sci., Washington, DC.
20. Fox, D.G., C.P. Tylutki, M.E. Van Amburgh, L.E. Chase, A.N. Pell, C.R. Overton, L.O. Cedeschi, C.N. Rasmussen and V.M. Durbal, 2000. The net carbohydrate and protein system for evaluating herd nutrition and nutrient execration. Anim. Sci. Mimeo 213, Department of Anim. Sci., Cornell Univ. 130 Morrison Hall Ithaca, NY.
21. SAS, Statistical Analysis Software, 2003. SAS. ISTATR User Guide: Statistics. Ver. 6.04; Fourt "Edition SAS Institute Inc; Cary; Nc.
22. Duncan, D.B., 1955. Multiple Range's and Multiple Ftest. Biometrics, 11: 1-42.Ver. 8.0 Edit., SAS Inst., Inc., Cary, NC.
23. Ben Salem, H., A. Nefzaoui, H.P.S. Makkar, H. Hochlef, I. Ben Salem and L. Ben Salem, 2006. Effect of early experience and adaptation period on voluntary intake, digestion and growth in Barbarine lambs given tannin - containing (*Acacia cyanophylla* Lindl. foliage) or tannin - free (Oaten hay) diets. Anim. Feed Sci. and Tech., 122: 59-77.
24. Fulkerson, W.J., A. Horadagoda, J.S. Neal, I. Barchia and K.S. Nandra, 2008. Nutritive value of forage species grown in the warm temperate climate of Australia for dairy cows: Herbs and grain crops. Livest. Sci., 114: 75- 83.
25. Shaker, Y.M., N.H. Ibrahim, F.E. Younis and H.M. El-Shaer, 2014. Effect of Feeding Some Salt Tolerant Fodder Shrubs Mixture on Physiological Performance of Shami Goats in Southern Sinai, Egypt. Journal of American Science, 10(2s): 66-77.
26. Salem, A.Z.M., M.Z.M. Salem, M.M. El-Adawy and P.H. Robinson, 2006. Nutritive evaluations of some browse tree foliages during the dry season: Secondary compounds, feed intake and *in vivo* digestibility in sheep and goats. Anim. Feed Sci. Technol., 127(3-4): 251-267
27. El Shereef, A.A., 2006. Nutritional studies on the use of some fodder plant for ruminant in Sinai. Dissertation, Cairo University.
28. FAO, Food Agriculture Organization, 1992. Legume trees and other fodder trees as protein sources for livestock In: Speedy, A., Pugliese, P.L. (Eds.), Proceedings of the FAO Expert Consultation.
29. Eissa, M.M., EL.A. EL-Wakeel, A.M. Saber, A.R. Khattab and W.M.A. Sadek, 2015a. Response of Barki lambs to diets containing Cassava and Treated wheat straw with Prosopis or *Acacia saligna* (leaves & twigs) under semi-arid area in Egypt. Egyptian J. Anim. Prod., 52(4): 79.
30. Eissa, M.M., W.M.A. Sadek, A.R. Khattab, A. EL-Wakeel and A.M. Saber, 2015b. Impact of feeding different combination of some fodder trees and treated crop residues on Barki lambs performance under semi-arid area in Egypt. Egyptian J. Anim. Prod., 52(4): 69.
31. Wheeler, B., 2003. Guidelines for feeding dairy cows. Ministry of Agriculture and Food, Government of Ontario, Canada. https://en.engormix.com/dairy-cattle/articles/feeding-dairy-cows-t33333.htm.
32. Yi, L., C.Y. Chen, X. Jin, M.T. Mi, B. Yu and H. Chang, 2010. Structural requirements of anthocyanins in relation to inhibition of endothelial injury induced by oxidized low-density lipoprotein and correlation with radical scavenging activity. FEBS Lett, 584: 583-590.
33. Li, H.Y., Z.B. Hao and X.L. Wang, 2009. Antioxidant activities of extracts and fractions from *Lysimachia foenum-graecum* Hance. Bioresour. Technol., 100: 970-974.
34. Negro, C., L. Tommasi and A. Miceli, 2003. Phenolic compounds and antioxidant activity from red grape marc extracts. Bioresour. Technol., 87: 41-44.
35. Arivazhagan, S., S. Balesenthil and S. Nagini, 2000. Garlic and neem leaf extracts enhance hepatic glutathione and glutathione dependent enzymes during N-methyl- N nitrosoguanidine (MNNG)-induced gastric carcinogenesis. Phytotherapy Research, 14: 291-293.
36. Alsheikh, S.M., 2012. Growth performance of shami kids fed a salt tolerant plant under semi-arid conditions in Sinai. Egypt. Egyptian J. Anim. Prod., 49(Suppl. Issue): 105-110.
37. Hanafy, M.A., A.A. Fahmy, M.S. Farghaly and A.A. El Shereef, 2007. Effect of using some fodder plants in diets on goats performance under desert conditions of Sinai. Egypt. J. Nutr. and Feeds, 10(1): 151-163.
38. Fahmy, A.A. and A.M. Fayed, 2000. Nutritional evaluation of Kochia indica hay as animal feed in Sinai. Egypt. J. Nutr. and Feeds, 3: 97-106.
39. Gihad, E.A., M.M. Shoukry, M.A. Hanafy, A.F. Mansour and H.H. Abd El-Rahman, 2005. Secondary compounds affect intake by range sheep and goats. Egypt. J. Nutr. and Feeds, 6: 1301-1310.

40. Hashemi, S. and H. Davoodi, 2011. Herbal plants and their derivatives as growth and health promoters in animal nutrition. Vet. Res. Commun, 35: 169-80.
41. Mehrez, A.Z., E.M. Soliman. M.Y. El-Ayek, E.A. El-Ayouty and M.E. El-Kholany, 2001. Influence of roughage to concentrate ratio and type of roughage on digestibility, some rumen parameters and fiber fractions degradability of tested rations with ruminants. Egyptian J. Nutrition and Feeds, 4(special Issue): 193.
42. Ahmed, M.E., 2003. The economic marketing weight of male zaraibi goats. Egyptain J. Nutrition and Feeds, 6(Special Issue): 1311.
43. Abd El-Rahman, H.H., 2003. Constrains and possibilities for their alleviation to improve utilization of desert natural range plants for grazing ruminants. Ph.D. Thesis, Fac. Agric., Cairo Univ., Egypt.
44. Luciano, G., L. Biondi, M. Scerra, V. Vasta, P. López-Andrés, B. Valenti, M. Lanza, A. Priolo and M. Avondo, 2012. The restriction of grazing duration does not compromise lamb meat colour and oxidative stability. Meat Science, 92: 30-35
45. Ahmed, M.E., E.I. Shehata, F.F. Abou Ammou, E.I. Khalifa and O.A. EL-Zolaky, 2009. Productive and reproductive performance of Rahmani sheep fed rations containing reed forage (*Arundo domax* L.) either fresh, hay or silage. Egyptian J. Sheep and Goat Sci., 4(1): 45.
46. El-Adawy, M.M., Zahraa R.Aboelez, A.M. Rashad, Mona M.M.Y. Elghandour, M.J. Adegbeye, M.R. Ashtoy, Moise´s Cipriano-Salazar, Sau´l Rojas Herna´ndez and A.Z.M. Salem, 2020. Effects of dietary inclusion of dried *Kochia indica* Wight tree foliages on growth performance and nutrient digestibility of growing rabbits. Agroforest Syst., 94: 1219-1228. https://doi.org/10.1007/s10457-019-00352-0.
47. Varel, V.H., H.G. Jung and L.R. Krumholz, 1991. Degradation of cellulose and forage fiber fractions by ruminal cellulolytic bacteria alone and in coculture with phenolic monomer degrading bacteria. Journal of Animal Science, 69: 4993-5000.
48. Papatsiros, V.G., P.D. Katsoulos, K.C. Koutoulis, M. Karatzia, A. Dedousi and G. Christodoulopoulos, 2012. Alternatives to antibiotics for farm animals. https://webcache.googleusercontent.com/search?q=cache:njJOxYbhnnkJ:https://www.scribd.com/document/363073220/Alternatives-to-antibiotics-for-farm-animals-Papatsiros-et-al-2012-doc+&cd= 4&hl=ar&ct=clnk&gl=eg.
49. Najmul Haque, Md., 2018. Dietary manipulation: a sustainable way to mitigate methane emissions from ruminants. Journal of Animal Science and Technology, 60: 15.
50. Ali, M.F., M.S. Saleh, N.M. Eweedah and S.A. Mohmoud, 2005. Effect of using chamomile (*Mtricaria chamomilla*) flowers as feed additives on performance of growing lambs under desert farming systems. Egypt. J. Nutr. Feeds, 8: 127-137.
51. Stella, A.V., R. Paratte, L. Valnegri, G. Cigalino and G. Soncini, 2007. Effect of administration of live Saccharomyces cerevisiae on milk production, milk composition, blood metabolites and faecal flora in early lactating dairy goats. Small Rumin. Res., 67: 7-13.
52. Sadek, W.M.A., Elsaeed A. Elwakeel, Adel M. Saber, Lamiaa F. Abdel-Mawla, Mohamed M. Anwar, H. Ghobashy and M.M. Eissa, 2020. Comparative study of tanniniferous shrubs as an alternative source of feed on performance of sheep vs. goats under semi-desert conditions of the north western-coast of Egypt. Int. J. Curr. Res. Biosci. Plant Biol., 7(3): 1-14.
53. Hung, P., 2016. Phenolic compounds of cereals and their antioxidant capacity. Crit. Rev. Food Sci. Nutri., 56(1): 25-35.
54. Abd El-Hamid, A.A., 2003. Studies of some anti-nutritional factors affecting forage utilization by ruminants. Dissertation, Ain Shams University.