Egypt. J. Vet. Sci. **Vol. 55,** No. 2, pp. 531-542 (2024)

Egyptian Journal of Veterinary Sciences

https://ejvs.journals.ekb.eg/

Feeding Management of Small Ruminants as A Strategic Tool to Mitigate the Negative Impact of Climate Changes in Arid Regions of Egypt: A Case Study of Assaf Sheep

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THIS study was carried out to suggest the potential of applying some feeding strategies to reduce the effect of climate change on sheep productivity in desert areas of Egypt. The feeding programs contained several ration formulations. Three experimental groups of sheep were studied: Traditional, cut-&-carry, and Complete ration. Ewes in the second group (G2) consumed higher amounts of Atriplex (1.1kg) than those fed at pre-lambing (0.912 kg). Also, ewes in G2 were significantly heavier ($P<0.05$) (67.28 kg) than the first group (G1) and the third group (G3) at the lambing which was (66.57 and 65.23 kg). The overall mean value of body height for ewes was 78.44 cm, whereas the body length value was 97.48 cm. While, the overall mean value of paunch girth was 114.49 cm, whereas heart girth for sheep was 95.65 cm, respectively. We noticed that the body weight of lambs at birth was of a higher value in G2 (4.06 kg) than that found in G3 and G1, respectively. However, the total weights of lambs at birth, kg and total weights of lambs at weaning, kg higher for G2 (20.30 and 123.35 kg) compared with both the other two groups i.e. G1 (18.45 and 115.6 kg) and G3 (15.52 and 98.19 kg), respectively. It can be concluded from the above that applying some feeding programs to sheep, especially in arid regions such as Sinai, is a new strategy to mitigate the harmful effects of climate change in the coming years.

Keywords: Atriplex, Feeding, Climate Changes, Assaf Sheep, desert, Sinai

Introduction

The application of some convenient feeding programs is a necessity to maximize the significant advantages of small ruminant breeding programs [1]. Sheep are from important red meat and animal genetic resources in Egypt. Under the Egyptian desert conditions, sheep already suffer heat stress periods in summer. During this period, sheep are unable to meet their nutrient needs for different physiological stages [2]. On the other hand, the degradation of the rangeland is clearly seen in many parts of the Egyptian desert due to overgrazing, low erratic rainfall and long drought periods [3]. Defining feed strategies that authorize the mitigation of the negative impact of climate change can have beneficial consequences for the sheep production chain. it is speculated that improving the feeding that reaches the animals tends to increase the efficiency of sheep-raising, contributing to supporting the activity in desert areas of Egypt. South Sinai is an arid region with salt-influenced natural resources and its main water resources are generated from groundwater [4]. So, the feeds in the area represent one of the main obstacles to animal production increasing. The performance of sheep depends on the sufficiency and availability of both major large and small elements from pastures. Therefore, Bedouins currently cope with some of the shortage in pasture feed by feeding grain, hay, or silage but this has great feed and labor costs. Due to climatic conditions in South Sinai, the amount of vegetation produced in an average year will not keep large local sheep productivity.

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(Received 14/09/2023, accepted 02/11/2023
DOI: 10.21608/EJVS.2023.235044.1606

Climate change may negatively affect the reproductive success of sheep because species of different trophic levels are likely to respond at different rates to climate warming. Major constraints in desert areas have been identified, where the ewes do not come into estrus and so do not breed, or pregnant ewes may generate very weak animals. Our previous studies revealed that conditions in Egypt are favorable for raising Assaf sheep due to the higher potential for reproductive performance and meat production [5]. During long dry periods, sheep will be lost with the youngest, weakest and oldest dying first. And therefore, no single strategy will be sufficient to solve this problem, each status will demand a special group of strategies. [6] reported an increase in early embryonic mortality and a decrease in fecundity in ewes subjected to heat stress. Studying crossbred ewes of Targhee x Suffolk under heat stress conditions for a short and long duration of 25 days and 53 days respectively. The ewes exposed to a hot condition during the first 3 days after artificial insemination were shown to affect the oocyte and/or embryo quality [7]. So, several strategies have been done to increase the feed resources available for animals on ranges. Such approaches will supply an adequate number of roughages during drought emergencies, including growing shrubs and agreeable trees (such as Atriplex spp.) that retain their leaves into the dry season and so can be lopped for fodder [8]. The utilization of range plants could be considered as a trial to reduce feed shortage and feeding costs and to enhance the economical feed efficiency in the arid and saline conditions that prevailed in Southern Sinai, Egypt [9]. Concentrate feed mixtures (CFM) are preferred to roughages for drought feeding because of higher nutrient density and ease of transport. It is possible to make complete feeds for use during droughts by adding some concentrate ingredients. The majority of sheep owners in semi-arid regions do not give concentrated feed to their animals even in critical physiological stages. Concentrates feed mixtures in addition to free grazing on community rangeland substantially improve the production performance of ewes [10]. Biologically, using CFM with a sufficient mix of roughage can help sheep better use locally available crop residues and agricultural by-products. Good quality olive leaves can be produced by the pruning and harvesting of olive trees and can be utilized in sheep feeding but a lot of them are missing in the study area. Therefore, the objective of this study is to identify the best strategies that if comprehensively applied, it possible to make a rapid and important contribution to improving the productive and reproductive performance of sheep. Accordingly, a strategy will be applied dependent on improving the practices and technologies such as supplementary feeding and improving the diet quality by implementing proper feeding programs, as such strategies can improve sheep productivity and mitigate the negative impact of climate change in dry areas in Egypt.

Materials and Methods

Experimental Site and Duration:

This study was carried out during the period between 2020 and 2021 at a special unit for producing improved sheep and goats and economically high-quality rations under the authority of the Agricultural Directorate in El-Tor City, South Sinai Governorate with the National Research Centre as shown in Figure 1.

Fig.1. Location of the study *The yellow spot indicates the area under study.

Environmental conditions

South Sinai is characterized by a dry to extremely arid climate and irregular rainfall. The drought of Sinai has existed for millennia and will continue. Sheep lived in this study in two major seasons, from the start of summer to the end autumn of with high temperatures and long days. At the start of this season, there was an increase in temperature (31.06ºC) that produced heat stress. The second seasonal period began at the start of winter to the end of spring with short days. At the start of this season, there was a decrease in temperature (12.83ºC) that produced cold weather. The feed intake from Acacia and olive cake was available at different seasons of study as seen in Figure 2.

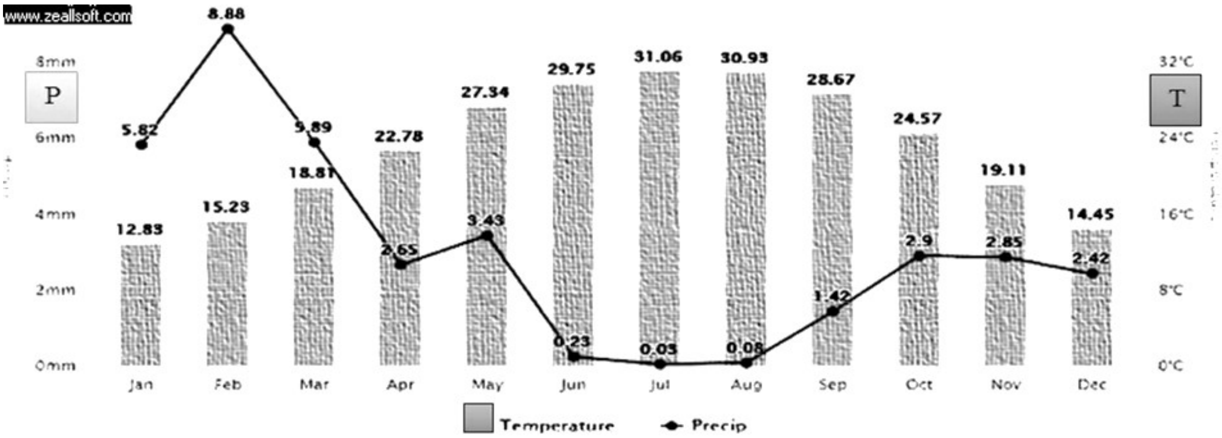

Fig.2. The mean monthly temperature and precipitation of South Sinai in recent years.

Experimental design

Twelve ewes of sheep in their late gestation were raised in a semi-closed farm system, aged 3-4 years were randomly distributed into three groups, 4 females each, all experimental females were mated by the same buck aged 3-5 years on average. The experiment was conducted during two physiological stages; the first stage covered the first 4 weeks of the end of pregnancy, and the second covered the time from lambing to weaning 90 days later. The ewes were ear-tagged and weighed, and the mean live body weight (LBW) of the ewes at the start of the breeding season was 62.03, 61.85, and 61.10 kg for G1, G2 and G3, respectively.

Breeding program

At the start of the breeding season (from the mid of July), a mating plan for experimental ewes was designed. Teaser ram was used to detect ewes in estrus twice daily (at 8 a.m. and 5 p.m.) for 30 minutes. Ewe that stood and permitted the teaser ram to mount her was considered in heat. Ewe showing heat signs in the morning were mated at the same time and repeated in the evening also with the same buck and vice versa. The births occurred from January to February.

Supplemental diets and animal management:

The groups of sheep at two physiological stages were allocated to three different feeding programs as follows: Group-I/ Traditional feeding program: Consists of the provision of feed at 4% of body weight. The feed resources are 30% of barley grain, 30% of wheat bran and 40% of Alfalfa hay, rations were given separately. Group- II/ Cut-and-carry feeding program: Fresh grass is cut daily and fed directly to experimental sheep. Consists of the provision of feed at 4% of body weight. The feed resources are 40% of Atriplex as a cut and carried fodder, with 60% of concentrate feed mixture CFM. Group III/ Complete feeding program: Consists of the provision of feed at 4% of body weight. The feed resources are 60% of concentrate feed mixture CFM and 40% of olive leaves in a mesh form diet. All groups were fed at 4 and 5% of body weight at pre- and post-lambing, respectively. Amount of concentrate feed mixture (CFM), which is formed from (17% wheat bran, 25% cottonseed meal, 50% yellow corn, 5% bean peels, 1.7% limestone, 0.3 Vit. & Minerals and 1% salt.), olive leaves and Atriplex was kept constant for all the three groups subject to equal increment in accordance with their physiological stages. Experimental rations were offered to animals and have been presented in Table (1). Atriplex was collected daily from the experimental farm in El-Tor City, South Sinai. These trees (Atriplex) were planted in 2015 through a project entitled (Technology Transfer for the Development of Small Ruminants in Southern Sinai).

While the olive leaves are produced by the pruning and harvesting of olive trees in the study area. Freshwater was available continuously during the experimental period.

Measurements

The measurements included the following three linear body measurements; namely, body height (BH), body length (BL), and heart girth (HG). The live body weight of the ewe was recorded monthly at different physiological stages (from breeding to weaning). Lambs were weighed within 24 h. after birth and thereafter at biweekly intervals up to weaning (90 days of age). The conception rate, Prolificacy, fertility rate, fecundity and twining rate were also recorded

Biological evaluation

Biological criteria considered were kilograms of lambs born/ewes lambing, kilograms of lambs weaned/ewes lambing, percentage of lambs weaned/ewes joined, and percentage of lambs weaned/ewes lambing.

Proximate chemical analysis

Before the implementation of the feeding programs was conducted, Rations were collected and ground through a 1-mm sieve screen to evaluate dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE), crude fiber (CF) and ash contents according to A.O.A.C. [11]. The chemical composition of feed ingredients and tested diets are shown in Table (1).

Statistical analysis

Data were expressed in means ± SE or percentages and analyzed using the SPSS program, version 17.0 [12]. One-way ANOVA was used to compare the means of different factors in sheep of the different groups. Differences among means were ranked using Duncan's New Multiple Range Test [13]. All analyses were carried out in triplicates and the differences were considered significant at ($p<0.05$).

Results and Discussion

Chemical composition of range and diet

Results revealed in Table (1) show that barley grain and wheat bran are rich in energy (as NFE %) content (79.55 and 69.35%) but barley grain was slightly lower in protein content (9.56%), ash (2.69%) and ether extract (2.45%) and crude fiber content (5.75%). Olive leaves as an agro by-product, it was highly cheaper than barley grains. It was noticeable that fresh Atriplex had lower CP than alfalfa hay and higher ash content (28.95%), it was deficient in available carbohydrates as NFE content (32.31%).

TABLE 1. Chemical composition of the experimental rations used (DM basis %).

Content	DM	OM	CP	CF	EE	NFE	Ash
CFM*	85.40	93.33	13.75	9.39	5.40	64.79	6.67
Barley grain	89.43	97.31	9.56	5.75	2.45	79.55	2.69
Wheat bran	90.40	94.66	11.84	10.80	2.67	69.35	5.34
Atriplex	92.51	71.05	8.51	27.75	2.48	32.31	28.95
Olive leaves	92.85	87.10	5.98	26.33	4.18	50.61	12.90
Alfalfa hay	92.87	88.39	10.23	37.98	1.19	38.99	11.61
Diet1**	91.10	92.93	11.85	19.80	2.02	59.26	7.07
Diet2**	88.24	84.82	11.65	16.73	4.23	52.21	15.18
Diet3**	88.48	90.84	10.64	16.16	4.91	62.13	9.16

DM: Dry matter; OM= Organic matter; CP= Crud protein; EE= Ether extract; CF= Crud fiber; NFE= Nitrogen Free Extract; * CFM: Concentrate feed mixture consisted of 17% wheat bran, 25% cottonseed meal, 50% yellow corn, 5% bean peels, 1.7% limestone, 0.3 Vit. & Minerals and 1% salt. ** The tested diets: G1: (30% barley grain + 30% wheat bran + 40% Alfalfa hay", on DM basis), G 2: 60% CFM + 40% Atriplex leaves and G 3: 60% CFM + 40% Olive leaves.

Sheep had free choice to consume Atriplex besides being supplemented with CFM at the rate of 60% aiming to overcome the poor energy content of Atripliex. The traditional rations contained a reasonable level of crude protein (11.85%) while the second group (CFM at 60 percent and Atriplex at 40 percent) recorded a level of crude protein (11.65%). However, the level of CP in G2 which contains CFM plus Atriplex was at the same ratio in G1 and was slightly decreased (10.64%) as those observed in G3. So, the feeding programs were not significantly different in quality values of protein, due to low variations in the protein content of the experimental diets. It was observed that olive leaves had lower contents of CP than Atriplex. Animals fed on range plants tended to consume comparable amounts of total DMI, but in general lower than that fed on the control rations [9]. The chemical composition of a range of plants may be different from period to period according to various factors.

Total dry matter intake

Data in Figure 3 shows that the ewes at the post-lambing stage in G2 consume higher amounts of CFM (2.525 kg) than those fed at pre-lambing (2.282 kg) as a result of the increase in body weight (67.28 kg). Also, ewes in G2 consumed higher amounts of Atriplex (1.1kg) than those fed at pre-lambing (0.912 kg) as a result of the increase in body weight (67.28 kg). During pre-lambing, providing adequate nutrients through a proper feeding program is very important in preparation for lambing purposes. DMI drastically increased when the ewes moved from the pre- to the lambing-post stage. Sheep under the pre-lambing stage consumed about (1.370 and 1.350 kg) from CFM for G2 and G3, respectively.

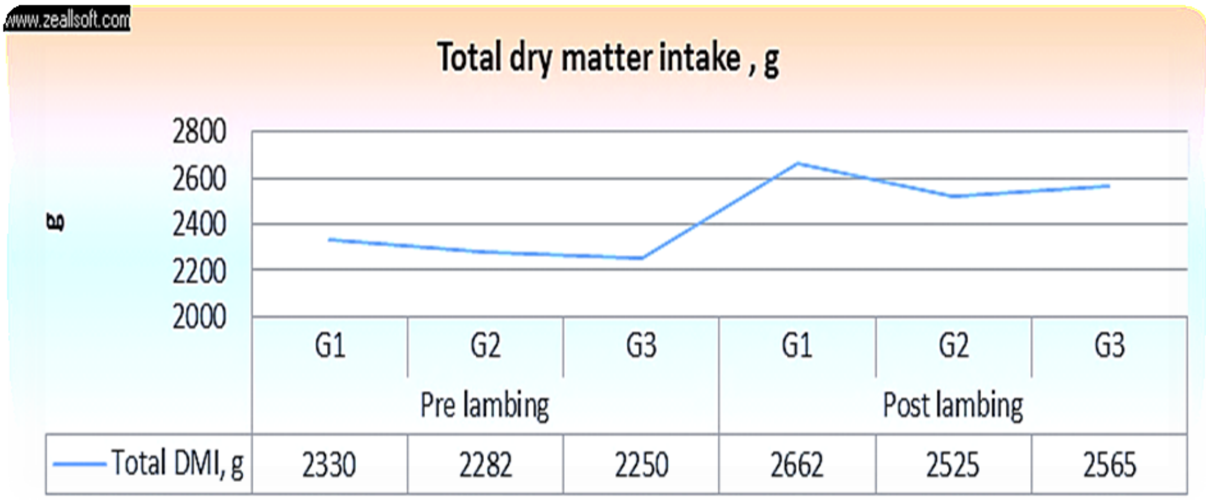

Fig.3. Means of total dry matter intake at different physiological stages.

As already discussed on Boer goats, a mother's requirements in late pregnancy depend on the number of animals she carries, proximity to lambing, and body weight [14]. Within the pre-lambing stage, protein is one of the most important nutrients needed by pregnant sheep. Similar results were obtained by some authors [15-17], in which they concluded that additional concentrates provided to ewes at the time of feeding roughage may enhance the growth of rumen bacteria, digestion rate and digest passage. The current data are in the same tendency as those reported by other researchers [18 , 19], who decided little importance differences among various experimental dites (Acacia, Atriplex and Cassava vs. berseem hay) in LBW of Barki ewes during the two weeks prepartum, at lambing and at 60 days post-partum. Likewise, Abu-Zanat and Tabbaa [8] and [20] found insignificant differences due to adding Atriplex and Acacia in rations of ewes and Shami goats. These obtained results revealed that these forage shrubs can be used for maintaining the growth and body weight of sheep as berseem hay (BH) without negative impacts, although these plants have high ash and low energy contents, especially Acacia and Cassava. Also, all sheep under study increased their DMI at the post-lambing stage of the study, this indicated that ewes increased their intake to achieve their metabolic needs. Several researchers have indicated that concentrate ration supplementation during the weaning period had an impact on growth and improved lamb productivity [21,22]. On the other hand, Sheep in G3 consumed different amounts of olive leaf rations at different physiological stages. The effect of feeding level could be related to higher nutrient reserve during late gestation and or higher intake of concentrate post lambing. A diet becomes richer and more diverse, the high-value crude protein that the concentrates offer in G2 and G3 improves the nutrition of the vast majority of the sheep. On the other hand, ewes could not consume the total quantity of olive leaves offered in the third program because the leaves easily mixed with the dirt in the soil. While the animals in the second program consumed the total amount of supplements offered to them.

Body weight

All management practices in this study were the same for the animals except for feeding programs which is the only factor that can affect the sheep body weight differences. Results presented in Table (2) indicated that ewes from all groups started the experimental study with body weight above 60 kg. There was a significant ($p<0.05$) effect on the overall mean live weight of ewes at different physiological stages. Although live weight among the groups G1, G2 and

G3 did not differ significantly. On the other hand, ewes lost body weight during milking in all groups. G2 was significantly heavier (p<0.05) (67.28 kg) than G1 and G3 at the lambing stage which was (66.57 and 65.23 kg) (Table, 2).

TABLE 2. Means of body weight of ewes (kg) at different physiological stages.

S. No.	Physiological stages	G1	G2	G3	M±SE	Sig
1	At beginning of the experiment (kg)	62.03	61.85	61.10	61.66^{b} ±0.28	Ns
2	Pre-lambing (kg)	63.98	64.77	63.59	$64.11a^{b}$ ±0.26	Ns
3	At lambing (kg)	66.57	67.28	65.23	66.36^{a} ±0.38	*
4	Post lambing (kg)	58.45	57.25	57.98	57.89^{c}±0.14	Ns

a and b values in the same column with different superscripts are different (P < 0.05)., NS: Not significant, * (p<0.05)

The obtained lambing weight of sheep was higher than sheep at different physiological stages (66.36kg) and this could be explained due to the rapid growth rate of fetal during the final six weeks of pregnancy. Which increases the challenges imposed on the ewe to meet these physiological changes [23]. A slight increase in body weight of the experimental ewes through post-lambing recorded in this study (57.89 kg) may be translated into higher milk secretion. Higher ewes body weight in the last period of pregnancy is associated with higher fetal weight and increased fetal fluid volume, especially in the four weeks before giving birth, which is consistent with what was stated by Ivey *et al.* [24]. The apparent decrease in body weight during the period between birth and weaning may be due to the fact that sheep do not meet their production needs to the required extent and thus tend to mobilize body tissues for maintenance and production to obtain energy from them. This is consistent with what was stated by many previous authors, [25, 36, 27,28]. Consequently, it was concluded that the application of convenient feeding programs as shown in the second and third groups give promising result because adequate feeding prevents large losses in sheep body weight at different pregnancy stages, which is reflected in the productivity of Assaf sheep, which can be adopted by the Bedouins in breeding programs to improve their animal's productivity.

Body weight changes of experimental groups at different physiological stages

It was found in this study that the body weight changes of all sheep at the lambing stage were the highest in G2 which was (5.43 kg), followed by G1 which was (4.54 kg). While sheep in G3 recorded also the lowest value of body weight change at the lambing stage (4.13 kg). This confirms that sufficient feeding decreased great losses in live weight at the time of lambing. Sheep in G2 recorded also the highest negative value of body weight change at the post-lambing stage (10.03 kg) followed by G1 which was (8.12 kg).

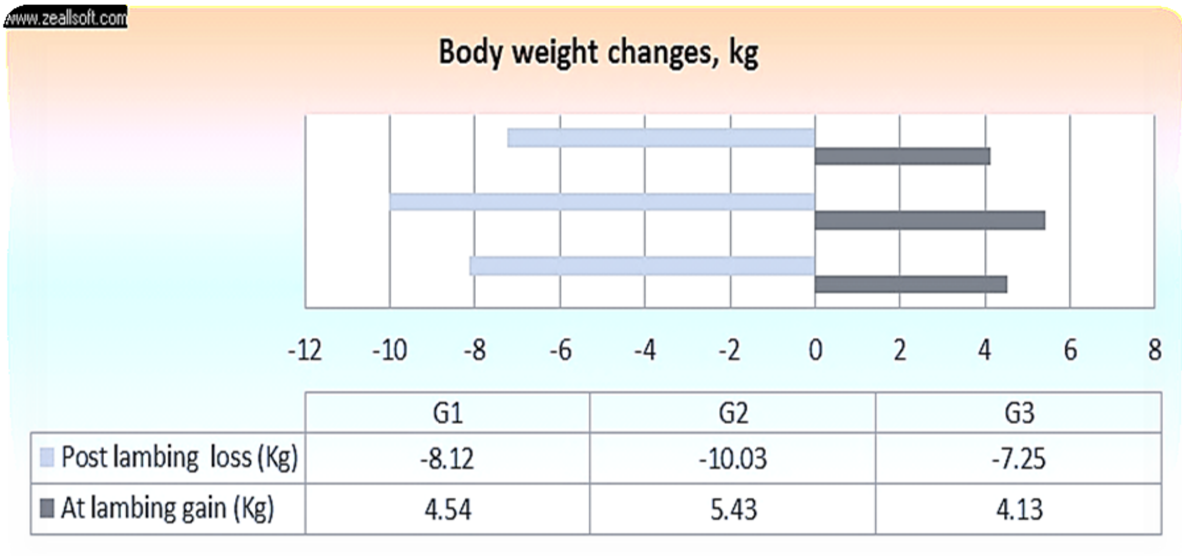

Fig.4. Means of body weight changes of ewes at different physiological stages, kg.

These findings of body weight changes of the ewes without and with concentrate supplementation are in harmonization with results reported by some authors [29-31]. Non-supplemented sheep showed that sufficient supplements prevent great losses in live weight at the time of the birth of lambs and for that reason reduce the time to reinitiate ovarian activity. These results were incompatible with those reported by many studies [32-34]. The effect of different feeding programs on body weight changes of the ewes is presented in (Figure 4). Similar results were reported by some studies [35,36] who reported that the lowered according to pregnant dam feed condition. These results also are in line with the findings of some authors [37, 21] on Shami goats. Our significant results showed that adequate feeding prevents large losses in body weight at the time of kidding and therefore reduces losses of body weight of ewes as a result of an increased level of dietary supplementation. Body weight changes at different periods of gestation and during the pre-weaning period were affected by feeding programs. This is because good BCS of the ewe during pre-lambing has positive effects on milk yield in the early lactation stage [38]. Assaf ewes size affected twin fetuses in late pregnancy, but not in early or mid-pregnancy. likewise, maternal feeding had a slight effect on foetal development in early- and mid-pregnancy, however, foetal growth was more affected in late pregnancy, suggesting that the twin fetuses were nutrient in need in this late period only.

Body measurements:

Data recorded in Table (3) and Figure, 5 indicated that the overall mean value of body height for ewes was (78.44 cm), whereas for body length value was (97.48 cm). While, the overall mean value of paunch girth value was (114.49 cm), whereas heart girth for sheep was (95.65 cm). The overall mean values of body height in ewes fed on different feeding diets were not significantly affected. The mean value of body height in (G1) was (77.8 cm) and in (G2) was (78.77 cm), while in (G3) was (78.75cm). It is important to point out that the ewes fed on fresh Atriplex and supplemented with commercially formulated CFM (G2) indicated similar body length compared to other groups (G1 and G3). The overall mean values of body length in ewes fed on different feeding diets were not significantly (P <0.05) affected. The mean value of body length in ewes of (G1) was found to be (97.77 cm) and in ewes of (G2) was found to be (96.98 cm), while in ewes of (G3) was found to be (97.70 cm). The overall mean values of paunch girth in ewes fed on different feeding diets were significantly (P < 0.05) affected. The average paunch girth in ewes was found to be (113.66 cm) in (G1) and was found to be (115.78 cm) in (G2), while it was found to be (114.05 cm) in (G3). The average heart girth in ewes of feeding programs under study was found to be (95.48 cm) in (G1) and was found to be (95.95 cm) in (G2), while was found to be (95.53 cm) in (G3). In some studies[8]they reported that BH (73.25), BL (88.90), PG (123.35) and HG (103.20) of Assaf sheep.

TABLE 3. Means of body measurements of ewes at different physiological stages.

Item		Experimental groups			Means	SEM	Sig
Body conformation (cm)	**Stages**	**G1**	**G2**	**G3**			
Body height (BH)	Pre-lambing (cm)	77.45	78.45	78.08	77.99 ^{a}	0.76	Ns
	Post lambing (cm)	78.15	79.09	79.43	78.89^{a}	0.64	Ns
Means		77.8	78.77	78.755	78.44		
Body length (BL)	Pre-lambing (cm)	97.12	96.58	97.04	96.91^{b}	0.35	Ns
	Post lambing (cm)	98.43	97.39	98.37	98.06^{a}	1.07	Ns
Means		97.77	96.98	97.70	97.48		
Paunch girth (PG)	Pre-lambing (cm)	117.34	121.18	119.53	119.35^{a}	0.67	*
	Post lambing (cm)	109.98	110.39	108.57	109.64^{b}	0,47	Ns
Means		113.66	115.78	114.05	114.49		
Heart girth (HG)	Pre-lambing (cm)	95.74	96.04	95.89	95.89 ^{a}	0.36	Ns
	Post lambing (cm)	95.22	95.87	95.16	95.41^{a}	1.07	Ns
Means		95.48	95.95	95.53	95.65		

a and b values in the same column with different superscripts are different (P < 0.05)., NS: Not significant, * (p<0.05)

Notwithstanding the aforementioned, the small number of sheep used in this study was not enough to test the effect of the best strategies under study on the morphological measurements.

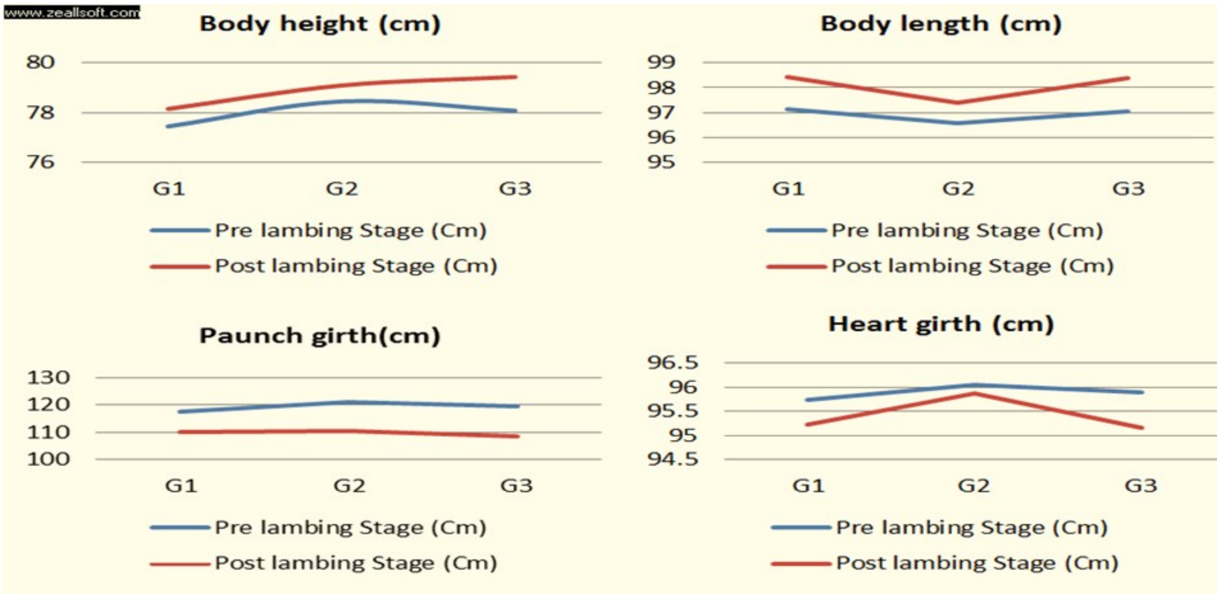

Fig.5. Means of body measurements of ewes experimental groups at different physiological stages.

Reproductive performance

The effect of the feeding strategy on the reproductive performance of Assaf ewes in the current study is presented in Table (4). No clear impact was shown in the lambing rate as a result of supplementation. However, the supplementation drastically improved reproductive ability. The percentage of lambing in different groups was not affected by feeding programs. Data in Table (4) showed that prolificacy rates were different in all experimental groups. The prolificacy rate increased in the supplemented group (G2) compared with the supplemented group (G3). The prolificacy ratio estimated in the present study for G1 (125%) was lower than those reported for other groups (175% and 150%) of G2 and G3, respectively.

TABLE 4. Effect of feeding programs on some reproductive traits of experimental ewes groups.

Item	Experimental groups		
	G1	G2	G3
No. of ewes mated	5	5	5
No. of ewes conceived	4	4	4
No. of ewes lambed	4	4	4
Conception rate,%	80	80	80
Lambing rate,%	80	80	80
Prolificacy rate, %	125	175	150
Twinning rate, %	25	25	0

These findings were in agreement with that of [29] who noticed that high fertility and prolificacy were shown in the highly supplemented. The positive impacts of the type of concentrate ration be inverted the significance of the plane of nutrition on sheep reproduction, especially prolificacy. The level of supplemental feeding sheep affects prolificacy [39]. Small ruminates are the most prolific animals under tropical and subtropical conditions, and can breed in every part of the year [14,40]. A higher percentage of ewes lambed was also reported [41] in ewes that weighed heavier at breeding (92.86 %) than in ewes that weighed less at breeding (86.36%). The responses of the twinning rate of Assaf sheep to a different feeding program in either G1 and G2 or G3 are shown in Table (4). The twinning rate of three experimental feeding programs were (25, 25 and 0%) for G1, G2 and G3, respectively.

Biological evaluation for ewes fed different feeding programs

The ability of the ewes to conceive and deliver live lamb represents the first measurable component of ewe reproductive performance. Differences in lambs' live body weight at birth and at weaning were observed among different groups. In the first group, the average number of alive lambs after one day of birth (5) was in line with reported in the second group (5) and was (4) for G3, respectively. Usually, the weaning weight is the most important parameter associated with the efficiency of sheep productivity. The importance of the weaning weight lies in the fact that it evaluates the reproductive efficiency of the group for each feeding program by considering: fertility, prolificacy, and mortality of the lambs until weaning. Differences in lamb's live body weight at birth and at weaning were observed among different groups. The lambs' weights at birth and weaning were different significantly ($p<0.05$) of ewes experimental groups at the different physiological stages as presented in Table (5).

TABLE 5. Biological evaluation for ewes fed different feeding programs.

Item	Experimental groups		
	G1	G2	G3
No. of alive lambs after 1 day of birth	5	5	4
No. of alive lambs at weaning	5	5	4
No. of lambs weaned / ewes lambing	1.25	1.25	1.0
Live weight of lambs at birth, kg	3.69^{b}	4.06^{a}	3.88^{a}
Live weight of lambs at weaning, kg	23.12^{b}	24.67^{a}	24.54^{a}
Total weights of lambs at birth, kg	18.45^{ab}	20.30^{a}	15.52^{b}
Total weights of lambs at weaning, kg	115.6^{b}	123.35^{a}	98.19^{c}

a, b, c values in the same row with different superscripts are different ($P < 0.05$).

Lambs of G2 showed heavier live body weight at birth and weaning. Also, lambs weaned/ ewes lambing follows the same trend. The live weight of lambs at birth, kg was of higher values in G2 (4.06 kg) than that found in G3 and G1, respectively. This result might be referred to as feed differences since G2 is considered a heavier group in comparison with other groups. However, the total weights of lambs at birth, kg and total weights of lambs at weaning, kg higher for G2 (20.30 and 123.35 kg) compared with both the other two groups i.e. G1 (18.45 and 115.6 kg) and G3 (15.52 and 98.19 kg), respectively. In this study, the superiority of the supplemented group (G2) related to the total weights of lambs at weaning obtained during the study is derived from the higher prolificacy ratio to this group. There is no clear explanation for the higher weaning weight of lambs in G2, which may be due to the mothers being fed the experimental diets enriched with protein because the CFM is higher in nutrients compared with traditional rations. The concentrate diets stimulated the rumen microbial environment which led to the liberation of nutrients from the forages [42]. However, these values especially in G1 indicated that sheep are adapted to the harsh environment of the area of study because it indicated intermediated values and favored reproduction as a biological tool to improve live body weight and management compared with other groups. These average values suggest that by improving feeding management, it is possible to substantially improve the level of productivity of sheep.

Conclusions

Many studies aimed at improving sheep productivity through feeding strategies in the arid areas of eastern Egypt reached no firm conclusions simply because there was not enough data to support robust assessments of the productivity of sheep. Careful designing feeding programs is essential to prevent problems from arising, and strategies can help identify when intervention is required, so the flock's productivity in both the short and long term is maximized. These strategies could help increase the profitability and viability of sheep production systems in Eastern Egypt. These strategies could help Bedouins overcome the challenge of managing sheep in arid areas. This improved management could help reverse the falling direction in husbandry and financial gain of Eastern Egypt sheep productivity.

Ethical Approval

Ethical approval for this study was obtained from the Medical Research Ethics Committee, National Research Centre as part of the project entitled "Improving utilization range of animal and plants in Southern Sinai" under registration number (19-451).

Funding details

This study was funded by the National Research Centre through the research plan budget for 2019-

2021 (The project entitled: "Improving utilization range of animal and plants in Southern Sinai" no. 19-451).

Conflict of interest

The authors declare that there is no conflict of interest concerning this article.

Acknowledgments

The authors gratefully acknowledge the support of the National Research Centre for their provision of core and project- specific funding. We also thank the Director of the Agricultural Directorate in El-Tor City, South Sinai Governorate for providing the facilities. The financial assistance provided under the "Improving Utilization Range of Animal and Plants in Southern Sinai" Project is also acknowledged.

Authors contributions:

All authors contributed to the study's conception and design. SA wrote the main manuscript, prepared Figures, drafted, corrected the manuscript and analyzed the data. Data collection and experimental study were performed by SA, HA, and MI. All chemical analyses were performed by AA; FM and MS revised the manuscript. All authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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إدارة تغذية المجترات الصغيرة كأداة استراتيجية للتخفيف من الأثر السلبي للتغيرات المناخية في المناطق القاحلة في مصر: دراسة حالة لأغنام العساف

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أجريت هذه الدراسة لتوضيح إمكانية تطبيق بعض استراتيجيات التغذية للحد من تأثير التغيرات المناخية على إنتاجية الأغنام في المناطق الصحراوية في مصر. تضمنت استراتيجية التغذية تركيبات غذائية مختلفة، حيث تم تقسيم الأغنام إلى ثلاث مجموعات تجريبية: البرنامج الغذائي التقليدي، وبرنامج القطع والحمل، وبرنامج العليقة الكاملة. استهلكت النعاج في المجموعة الثانية (G2) كميات أعلى من الأتريبلكس (١,١ كجم) مقارنة بتلك التي تم تغذيتها في مرحلة ما قبل الولادة (٠,٩١٢ كجم). كما أن نعاج المجموعة الثانية (G2) كانت أثقل معنويا (P<0.05) (٦٧,٢٨ كجم) من المجموعة الأولى (G1) والمجموعة الثالثة (G3) عند الحمل والتي قدرت ب (٦٦,٥٧ و٦٥,٢٣ كجم). قدرت القيمة المتوسطة الإجمالية لارتفاع الجسم عند النعاج ٧٨,٤٤ سم، بينما بلغت قيمة طول الجسم ٩٧,٤٨ سم. في حين بلغ متوسط القيمة الإجمالية لمحيط البطن ١١٤,٤٩ سم، بينما بلغ محيط الصدر للأغنام ٩٥,٦٥ سم على التوالي. لاحظنا أن وزن الحملان عند الولادة كانت له قيمة أعلى في المجموعة الثانية G2 (٤,٠٦ كجم) من تلك الموجودة في المجموعة الثالثة (G٣) والمجموعة الأولى (G1) على التوالي. ومع ذلك، فإن الأوزان الإجمالية للحملان عند الولادة بالكيلوجرام والأوزان الإجمالية للحملان عند الفطام بالكيلوجرام كانت أعلى لحملان المجموعة الثانية (G2) (٢٠,٣٠ و١٢٣,٣٥ كجم) مقارنة بالمجموعتين الأخريين أي المجموعة الأولى (G١) (١٨,٤٥ و١١٥,٦ كجم) والمجموعة الثالثة (G٣) (١٥,٥٢ و٩٨,١٩). كجم)، على التوالي. ويمكن أن نستنتج مما سبق أن تطبيق بعض برامج التغذية على الأغنام، خاصة في المناطق القاحلة مثل سيناء، يعد استراتيجية جديدة للتخفيف من الآثار الضارة للتغير المناخي في السنوات القادمة.

الكلمات الدالة: أتريبليكس، التغذية، التغيرات المناخية، الأغنام العساف، الصحراء، سيناء.