

## **EFFECT OF GRAZING ACTIVITY AND SUPPLEMENTARY FEEDING ON ENERGY UTILIZATION BY GOATS**

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### **SUMMARY**

**T**hirty non-productive female Shami goats were employed in a 60-day experiment to study the effect of grazing activity and supplementary feeding on energy expenditure (EE) and balance (EB). Goats were divided into three treatments, 10 per each. Animals were grazing a limited area of alfalfa with (GS) or without (G) a limited concentrate supplement, while animals in control treatment were in confinement (in-door, I) in which the same amount of supplement was given with alfalfa hay depending on their recommended requirements. The concentrate feed mixture, as supplementary feeding, was given to cover approximately 50% of the metabolisable energy used for maintenance requirements ( $ME_m$ ). Total EE was estimated by a heart rate (HR) monitor for 48h after individual calibration by oxygen consumption with a face mask open-circuit respiratory system. The internal marker technique was used to estimate the individual intake and digestibility for 6 animals per each treatment in which bags was used for total fecal collection. Animals in control group were consumed significantly less roughage ( $g/kg BW^{0.75}$ ) in comparison with those in grazing treatments. Digestible energy was affected by grazing activity and supplementary feeding. Total EE was greater for grazing vs. in-door and reduced with supplementary feeding. As a result, the EB was positive and similar between animals in control (I) and GS groups, while a negative EB associated with body weight loss were observed when animals grazing without supplementation (G). In conclusion, grazing activity has a significant effect on the EE and consequently the  $ME_m$  and supplementary feeding is essential to maintain grazing animals without deterioration.

**Keywords.** *Shami goats, grazing activity, supplementation and energy expenditure.*

### **INTRODUCTION**

Goats are very important to the world's food security and supply because of their ability to utilize fibrous materials not of immediate nutritional value to people. Feed accounts for about 70% of the cost of the livestock production, approximately one-half of the production cost for ruminants is in feed used for body weight and maintenance requirements. However, one of the most important factors affecting the energy requirement for maintenance ( $ME_m$ ) is an animal's activity (NRC, 2007). The energy cost for grazing activity has been quite difficult to study (Goetsch *et al.*, 2010); therefore, in most pastoral production systems the magnitude of energy loss is unknown. By gaining few understanding of factors influencing the energy cost for grazing activity, it will be possible to employ management practices that minimize this energy loss, thereby increasing the level of production by elevating efficiencies of feed utilization. This will help to take a correct decision and facilitate changes in management such as stocking rate, alternative pasture access, adding supplementary feeding, etc. without deterioration of our pastoral's system. On the other hand, supplementary feeding may be necessary to cover the nutrients requirements of grazing animals and to maintain them during the dry season (Pimentel *et al.*, 2011 and Askar *et al.*, 2014). It decreases the grazing time and the associated energy cost for grazing activity (Beker *et al.*, 2009). The objective of this study was to determine the the effect of grazing activity and supplementary feeding on energy utilization by Shami goats under different production system settings.

## MATERIAL AND METHODS

The study was carried out in the Ras Surd region at the South Sinai research station of the Desert Research Center, some 200 km from Cairo, the capital of Egypt. It is considered a desert area. There is practically no rainfall during the year. However, the average annual temperature is 22.2 °C, while the average rainfall is 15 mm/year, most of the precipitation falls in January, averaging 3 mm.

### *Animals and treatments:*

Thirty adult non-productive female Shami goats were employed in a 60-day experiment to study the effect of grazing activity and supplementary feeding on energy expenditure (EE) and balance (EB). Goats were divided into three treatments, 10 per each. Animals were grazing a limited area of alfalfa with (GS) or without (G) a limited concentrate supplement, while animals in control treatment were in confinement (in-door, I) in which the same amount of supplement was given with alfalfa hay depending on their recommended requirements. The concentrate feed mixture, as a supplementary feeding, was given to cover approximately 50% of ME<sub>m</sub>.

### *Experimental procedures:*

The experiment started in August and lasted for 60 days (during the dry season), followed by a 2-week period for the measurements of feed intake, digestibility and energy utilization. Concentrate supplement were given in the morning (before grazing for GS group). Water was available free choice twice daily, at 08:00 and 14:00 h.

**Intake and digestibility:** The internal marker technique was used to estimate the individual intake and digestibility for 6 animals per each treatment in which bags was used for total fecal collection.

### *Energy expenditure:*

The calorimetry system and its usage were described previously by Askar (2016) in which the same six animals per treatment were fitted with a face mask facilitating open-circuit respiratory system for measuring O<sub>2</sub> consumption (Sable Systems, Las Vegas, NV). Heart rate (HR) was simultaneously measured to determine the individual energy expenditure (EE)/HR ratio. Energy expenditure was estimated assuming a constant thermal equivalent of 20.47 kJ per liter O<sub>2</sub>. Human S610 HR (Polar, Lake Success, NY) monitors with infrared connections to the transmitters were used to collect HR data at a 1-min interval. Heart rate data were analyzed using Polar Precision Performance SW software provided by Polar. Heart rate was measured, for each animal, while they were grazing for at least 48 h. The daily HR and EE were determined from the EE: HR ratio for each animal. Furthermore, Gross energy (GE) of feed, orts and feces were measured by bomb calorimeter (IKA, model C 200, Staufen, Germany), using benzoic acid as standard. Metabolizable energy (ME) was estimated as 82% of digestible energy (DE) intake (NRC, 2007). Recovered energy (RE) was calculated as the difference between ME intake (MEI) and total EE.

### *Statistical analyses:*

Data were analyzed by the GLM procedure of the SAS statistical package (SAS, 2000) in which the effect of treatment was considered (one way analysis of variance). The least significant difference (LSD) was used to compare the means, and differences with P<0.05 were accepted as statistically significant.

## RESULTS AND DISCUSSION

### *Energy intake and digestibility:*

Although a similar GE (kJ/kg MBW) intake between animals in confinement (I) and those in grazing (GS) groups, animals in GS group had a greater DE (kJ/kg MBM and %) than those in confinement (Table 1). Grazing animals were reported to have higher intake and digestibility than those in confinement (Askar *et al.*, 2013 and 2014). On the other hand, Supplementary feeding increased the intake and digestibility for grazed animals. Concentrate supplement was reported to increase intake and utilization as a result of increasing dry matter digestibility (Gekara *et al.*, 2005 and Askar *et al.*, 2014). It was expected that adding concentrate supplement might reduce the forage intake (Garcés-Yépez *et al.*, 1997) but in the current study the forage intake was similar for animals grazing with or without supplementation. The effect of concentrate supplement on forage intake varied depending on the forage quality and the supplement composition (Moore *et al.*, 1999). In

agreement with the current findings, it was reported that supplementation did not affect forage intake when the forage quality was high (Smith *et al.*, 2006), while it had a positive effect on the intake of the low quality forage (Kartchner, 1980).

**Table (1). Energy intake and digestibility by Shami goats grazing a limited area of alfalfa with (GS) or without (G) concentrate supplement in comparison with the in-door (I) treatment.**

Item	Treatment			SEM	Significant Treatment
	In-door	Grazing			
	Concentrate supplement (50% ME <sub>m</sub> )				
	With	With	Without		
	I	GS	G		
Dry matter intake, g/kg BW <sup>0.75</sup> /day					
Forage	59.6 <sup>b</sup>	65.5 <sup>ab</sup>	71.2 <sup>a</sup>	3.33	t
Total	83.6 <sup>ab</sup>	89.6 <sup>a</sup>	71.2 <sup>b</sup>	3.37	**
Energy utilization, kJ/ BW <sup>0.75</sup> /day					
Gross energy	1446 <sup>a</sup>	1542 <sup>a</sup>	1203 <sup>b</sup>	57.1	**
Digestible energy	927 <sup>b</sup>	1067 <sup>a</sup>	692 <sup>c</sup>	39.4	***
Metabolizable energy	760 <sup>b</sup>	875 <sup>a</sup>	568 <sup>c</sup>	32.3	***
Digestible energy, %	64.0 <sup>b</sup>	69.2 <sup>a</sup>	57.5 <sup>c</sup>	1.01	***

t = P<0.10; \*\* = P<0.01; \*\*\* = P<0.001; SEM = Standard error of means.

**Energy expenditure and balance:**

Heart rate and EE were significantly (P<0.001) greater for grazing vs. in-door treatments. These values of energy loss are much greater for G vs. GS in which a lower HR and EE were observed for animals grazing with vs. without concentrate supplement (Table 2). In addition, Figure (1) showed the effect of grazing activity and supplementary feeding on EE throughout the 24 hours of the day that supported the findings reported in Table (2). Grazing activity was expected to increase the energy requirements for grazing animals compared to those in the confinement (Brosh *et al.*, 2006).

**Table (2). Heart rate (HR), and energy expenditure (EE) and balance (EB) by Shami goats grazing a limited area of alfalfa with (GS) or without (G) concentrate supplement in comparison with the in-door (I) treatment.**

Item	Treatment			SEM	Significant Treatment
	In-door	Grazing			
	Concentrate supplement (50% ME <sub>m</sub> )				
	With	With	Without		
	I	GS	G		
HR, beat/minute	106 <sup>c</sup>	121 <sup>b</sup>	131 <sup>a</sup>	3.18	***
EE:HR, kJ/BW <sup>0.75</sup> /beat	6.25	6.20	6.22	0.088	ns
EE, kJ/kg BW <sup>0.75</sup> /day	660 <sup>c</sup>	751 <sup>b</sup>	819 <sup>a</sup>	18.24	***
EB, kJ/kg BW <sup>0.75</sup> /day	96.4 <sup>a</sup>	120.0 <sup>a</sup>	-251.1 <sup>b</sup>	19.56	***

ns = non-significant; \* = P<0.05; \*\*\* = P<0.001; SEM = Standard error of means.

On the other hand, the relation between EE and ME intake shows that indoor (I) and supplemented grazing animals (GS) are in a better state with a lower EE/MEI ratio than those grazing without supplementation (G) (EE = 87 and 86 vs. 144% of ME intake, respectively). This is reflected on the EB that was similar and positive for control and supplemented grazing animals, while a negative EB was observed for grazing animals without supplementation. This indicates that concentrate supplement is necessary to maintain grazing animals without deterioration as suggested by Askar *et al.* (2014). Supplementary feeding may cover part of the energy requirements for grazing animals which was expected to reduce the grazing time and the associated energy cost for grazing activity (Beker *et al.*, 2009).

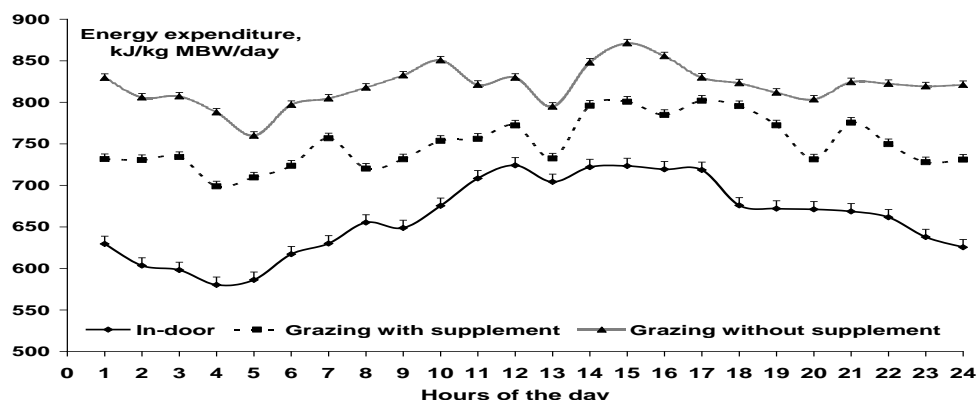


Figure (1). Hourly energy expenditure (kJ/kg MBW) of Shami goat grazing a limited area of alfalfa with or without supplementation compared to the in-door treatment throughout 24-hour period.

## CONCLUSIONS

Grazing animals have higher energy intake and digestibility than those in the confinement and concentrate supplement improved the forage utilization for grazed animals. Grazing activity has a significant effect on the energy expenditure and requirements, while supplementary feeding is essential to maintain grazing animals without deterioration under the experimental condition.

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### تأثير النشاط الرعوي والتغذية التكميلية على استخدامات الطاقة في المعز

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تم استخدام 30 أنثى جافة من الماعز الشامي في تجربة أستمرت 60 يوماً لدراسة تأثير النشاط الرعوي والتغذية التكميلية على الفاقد من الطاقة وميزان الطاقة. تم تقسيم الماعز إلى ثلاثة معاملات، 10 لكل معاملة. وكانت الحيوانات ترعى مساحة من البرسيم الحجازي مع (GS) أو بدون (G) كمية محدودة من مخلوط العلف المركز، بينما كانت حيوانات الكنترول في الحظائر (In-door, I) وتم إعطائها نفس الكمية من العلف المركز مع دريس البرسيم الحجازي تبعاً للاحتياجات الغذائية الموصى بها. تم إعطاء العلف المركز كغذاء مكمل ليغطي حوالي 50% من الأحتياج الحافظ من الطاقة ( $ME_m$ ) وتم تقدير الطاقة المفقودة من خلال جهاز معدل ضربات القلب ولمدة 48 ساعة بعد المعايرة الفردية لكل حيوان عن طريق تقدير إستهلاك الأوكسجين بواسطة جهاز تبادل الغازات (a face mask open-circuit respiratory system). وتم استخدام المرقمات الداخلية لتقدير المأكول والهضم لعدد 6 حيوانات بكل معاملة بينما تم استخدام الشنط لجمع الروث الكلي. كان المأكول من المادة الخشنة ( $g/kg BW^{0.75}$ ) للحيوانات في مجموعة الكنترول أقل بشكل معنوي بالمقارنة بتلك التي ترعى. وكذلك تأثرت الطاقة المهضومة بالنشاط الرعوي والتغذية التكميلية. وكان إجمالي الفاقد من الطاقة أكبر للحيوانات التي ترعى مقارنةً بالتي في الحظائر ويقال الفاقد في الطاقة بأضافة التغذية التكميلية. ونتيجة لذلك فإن ميزان الطاقة كان موجباً ومتشابه بين الحيوانات التي بالحظائر والتي ترعى مع مخلوط العلف المكمل، في حين لوحظ أن ميزان الطاقة كان سالبا ومصاحبا لفقد في وزن الجسم عندما كانت الحيوانات ترعى بدون العلف المكمل (G). توصى الدراسة بأن النشاط الرعوي له تأثير كبير على الفاقد من الطاقة وبالتالي على الطاقة الحافظة وأن التغذية التكميلية ضرورية للحفاظ على الحيوانات التي ترعى دون تدهور.