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ORIGINAL ARTICLE

Effect of prepartum dietary energy source on goat maternal metabolic profile, neonatal performance, and economic profitability

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ABSTRACT

Objective: This work aimed at studying dietary energy supplementation effects during late pregnancy upon the metabolic status of does, as well as on the birth weight (BW), body temperature, and metabolic profile for their kids and the net economic profit.

Materials and Methods: Eighty pregnant does (Egyptian Nubian) were equally split into four dietary treatments; the control (CON) receiving basal diet, the basal diet with 200 gm corn starch and 100 gm of molasses /h/d added (MS), the basal diet with 300 gm/h/d of corn grains added (CG), and the basal diet with 300 gm/h/d of barley grains added (BG).

Results: Body weight and temperature of kids were significantly higher in MS and BG groups, respectively. The serum concentration of albumin (Alb), aspartate aminotransferase (AST), and alanine aminotransferase (ALT) levels are significantly decreased. At the same time, urea and vitamin A increased dramatically in the BG group before giving birth. After birth, conversely, the serum concentration of albumin, AST, ALT, cholesterol, and vitamin A significantly increased with energy supplementation. Kids in the BG group show the most high level of albumin. Furthermore, all supplemented groups increased dramatically in vitamin A. The economic efficiency of the MS group, followed by the BG group, was significantly higher compared to the other treatments.

Conclusion: It is beneficial for Egyptian farmers to feed extra concentrate (especially barley) to the does during late gestation stages to produce healthy kids with optimal BW and body temperature, as well as to avoid metabolic disorders that may affect the does at this critical stage. Finally, it can be said that this dietary supplementation may also increases the profit margins of the farmers.

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Introduction

Indigenous Egyptian goats make up a significant proportion of domestic meat and milk supplies, which accrues substantial economic benefits. The local production of goat meat and fresh milk increased from 25,000 and 15,000 MT (million tons) in 2001 to 53,608 and 18,000 MT in 2011, respectively [1]. However, production indices are still lower than the global average. In Egypt, feed is the major limitation in improving goat productivity, as it relies on grazing pasture of fluctuating nutritional value, which may affect their nutritional status, particularly when concerning energy supply. As the grazing only may not be adequate for probable goat body weight gain and so goat production can be improved throughout nutritional management by grain supplementation [1]. In recent years, feed shortage and increasing feed prices have contributed to the frequent occurrence of nutritional stress. It is well-known that kids' birth weight (BW), mortality, and viability are all related to the dietary management of does during late pregnancy. Hence, neonatal death and low BW may be contributing factors in the low production values of Egyptian goat products. Adequate nutrition during late pregnancy in goats has a significant impact on animal performance, the viability of neonatal kids [2], and economic efficiency

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as the reproductive problems in livestock are of substantial financial concern. However, in the last 2 weeks of gestation, feed intake is reduced, which can lead to lower BW, mammary development, and milk production [3]. It has been shown that restricting nutrition in goats during pregnancy induces various physiological, endocrinological, and behavioral abnormalities in both do and kids [4,5]. Maternal malnutrition, especially during-late gestation, has bad effect on the of energy sources available for neonate during cold thermogenesis and can subsequently cause neonatal hypothermia, which considered the main cause of neonatal kids and lamb mortality, as well as metabolic disorders linked to reduced energy in dams as pregnancy toxemia [6].

Considering the above evidence, goats grazed or fed on roughage should benefit from a diet supplementation with a high level of nutrients during late gestation. Of particular concern are the energy substrates (mainly glucose) required to metabolize the mammary gland and gravid uterus tissues [7]. Grain starch is often used to substitute forage in the goat diet to increase the energy intake. The benefits of concentrate supplementation upon growth performance and productive traits of the goat is well known [8]. Compared with cattle and sheep, there has been only a little research focused on goats, especially Egyptian Nubian goats that may suffer from marked energy deficiency due to high incidence of twin birth, large body size, high milk production, longer breeding season than other dairy goats, and high butterfat yield in milk about 5% even in desert condition [9]. Furthermore, no data found in the literature to represent whether the different breeds of goat that have the same productive characters can use the same nutrient metabolism under low level of energy availability. The genotypes differences might indicate different physiological mechanisms although no differences in nutritional conditions, especially during late gestation [10]. Therefore, it is essential to understand the metabolism of nutrients in the dam and how it transfers transfer to their kids. Therefore, this study was carried out to evaluate the effects of diet supplementation through late goat gestation with different energy sources and focus on comparing different type of energy supplements that results in the possible improvement of reproductive performance for dam and its kids and maintaining normal range for most serum biochemical parameters with the lowest cost in Egypt environment. The variable investigated included the does' body condition and metabolic status, the kids and body temperature, as well as the profitability of different treatment on final production outputs. The results of this study can help to advise adequate feeding management practices to help goat farmers in Egypt increase their healthy stock and maximize their profits with the least costly type of energy and maximum benefit.

Materials and Methods

Animals, experimental design, and dietary treatments

This study was conducted following the animal care guidelines of the Animal Care Committee at a farm of the faculty of Veterinary Medicine at the University of Sadat City in Egypt (Approval number: VUSC-008-1-17). A total of 80 pregnant Egyptian Nubian goats of similar parity and weight (40 ± 3 kg BW) were randomly but equally assigned into four dietary treatments with four replicates (five does/replicate). The basal diet consisted of *Trifolium alexandrium* (2 kg/h/d) with a concentrate mix (1.0 kg/h/d). The chemical composition and analysis of the concentrate mixture and green berseem are presented in Table 1. Dry matter (DM), crude protein (CP), ether extract, crude fiber (CF), and ashes were measured following the Association of Official Analytical Chemists methods [11]. acid detergent fiber (ADF), neutral detergent fiber (NDF) were measured according to Nancy [12]. Compared to the requirements proposed by the National Research Council (NRC), USA [13], the basal diet was 18% higher in CP (0.193 *vs.* 0.164 gm/d of CP) and 20% lower in energy (0.781 *vs.* 0.97 gm/d of TDN). The four treatments were as follows: basal diet (control, CON), basal diet with100 gm of molasses and 200 gm corn starch/h/d (MS), basal diet with300 gm/head/d of corn grains (CG), and basal diet with 300 gm/h/d of barley grains (BG). The supplemental energy sources provided 0.232 gm/h of TDN daily, covering the 20% shortage in energy requirements during the late gestation of non-dairy mature does with twin kids [13]. The experimental diets covered 80%, 104%, 105%, and 105% of TDN, and 112%, 125%, 137%, and 134% of CP requirements

Table 1. Ingredients and nutrients chemical composition of diets.

Ingredient%	Concentrate Mix	*Trifolium alexandrium*
Corn grain	45	
Decorticated cotton seed meal	12	
Soya bean meal	11	
Wheat bran	29	
Lime stone	2	
Sod. Bicarbonate	0.22	
Common salt	0.5	
Mineral mixture	0.28	
Chemical composition as % of DM		
DM	91.547	12.8
CP	16.51	18.8
EE	2.87	3.1
CF	5.84	21.2
Ash	14.455	14.3
NDF	23.689	42.7
ADF	11.52	23.6
TDN	65	65.8

DM = Dry matter, CP = Crude protein, EE = Ether extract, CF = Crude fiber, NDF = Neutral detergent fibre, ADF = Acid detergent fibre; TDN = Total digestible nutrients.

throughout late pregnancy for CON, MS, CG, and BG, respectively. Animals were housed in individual pens and were fed twice a day for 21 days before parturition. Before the start of the experiment by 1 week, goats were weighed and randomly distributed to the four groups and fed with the basal diet. Bodyweight was measured at the end of this week, just before the start of the experiment. This period was used as the basis to determine subsequent changes that occur within each dietary treatment group. Water and mineral mixture block were provided *ad libitum* during the experiment.

Goat and kids' performance

The body weight of dams was determined before the beginning of the experiment and at parturition. Kids' body weight and rectal temperatures were recorded immediately after kidding.

Blood sampling and biochemical analysis

Samples of the blood were collected from eight does in each treatment group (2/replicate) before and after birthing, as well as from their kids shortly after birth(after suckling colostrum). Blood was collected by puncturing the jugular vein using a vacutainer without anticoagulants in the morning before does were fed and after kids had been allowed to suckle. The serum was separated after collecting 10 ml of blood in sterilized dry centrifuge tubes and keeping them for three hours in a slant position at room temperature, then incubated at 37°C for 30 min and centrifuged at 3,000 rpm for 15 min. Serum samples were collected and stored at −20°C until the analysis of the following parameters; total serum protein (TP), albumin (Alb), urea, creatinine, cholesterol (CHOL), triglycerides (TG), total antioxidants (T.antioxid), aspartate aminotransferase (AST), alanine aminotransferase (ALT), and vitamin A (VitA) concentrations using an ultraviolet spectrophotometer UV4802 (Unico Co., Dayton, OH) in a commercial kit (Biosystem S.A, Costa Brava, 30, Barcelona, Spain), following the manufacturer's instructions. Globulin concentration was calculated, and glucose was determined soon after serum collection using the Stanbio kit (Catalog No. 1075) for the quantitative enzymatic-colorimetric determination of glucose.

Economic analysis

The economic analysis was performed considering the feed intake and feeding costs for each doe during late pregnancy (last 21 days) and after parturition. The weight gain was measured for each doe in the four treatments throughout the experimental period. Weight gain was estimated by multiplying experimental feed intake(in gm) with the feeding cost of each doe, according to toa method described by Sebei et al. [14].

Total variable and fixed costs, including the price of the pregnant does, and the cost of purchased feed (for CON, MS, CG, and BG), labor, veterinary treatment (vaccines, disinfectants, and veterinary supervision), litter, water, fuel, electrolytes, transportation, building, fencing, and equipment depreciation (L.E) were calculated [15]. The rate of depreciation depends on the useful life of the asset, varying from 3 to 40 years. The pens depreciation and equipment were determined, and the net profit was then calculated according to the following formula: Net profit =Total return−Total costs [16].

Statistical analysis

Data were analyzed by PROC MIXED procedure in SAS. The model included the supplemented energy source as a fixed effect and animal as a random effect. The means of supplemented energy sources were separated using the PDIFF Data were represented as least squares means with $p < 0.05$ and $p < 0.01$ set as statistical significance levels.

Results

As presented in Table 2, maternal final body weights indicated no significant difference between the

Table 2. Effect of prenatal supplementation of energy sources on growth performance of does and kids and body temperatures of kids .

Parameters	Dietary treatments[a]				SEM	*p*-value
	CON	MS	CG	BG		
Doe initial weight (kg)	37.33	43.00	38.14	41.08	1.50	0.525
Doe final weight (kg)	33.33	36.00	33.86	36.83	1.60	0.842
Change (kg)	−4.00	−7.00	−4.29	−4.25	0.729	0.433
Kid BW (kg)	2.01[b]	3.16[a]	3.04[ab]	3.01[ab]	0.159	0.021
Kid body temperature	38.51[b]	38.77[ab]	38.87[ab]	38.99[a]	0.055	0.006

Means within the same row carrying different small superscripts are significantly different at $p < 0.05$.
[a]CON = control; MS = 200 gm corn starch and 100 gm of molasses /h/d; CG = 300 gm/head/d of corn grains;
BG = 300 gm/h/d of barley grains.
SEM = Standard error of means.

energy-supplemented groups and CON. BW and temperatures of kids were significantly increased in the MS- and BG-supplemented groups, respectively. In the BG-supplemented group, the serum concentrations of Alb, AST, and ALT prior to birthing were significantly lower than in the other treatments, while urea and Vit A were both considerably higher. On the other hand, TP, globulin, glucose, creatinine, TG, CHOL, and Total antioxidants did not indicate a significant difference with the other treatment groups (Table 3). Conversely, after birthing, the serum concentration of Alb, AST, ALT, CHOL, and Vit A significantly increased with energy supplementation. Still, no significant changes were recorded in TP, globulin, urea, creatinine, TG, glucose, and T. antioxid (Table 4).

In kids, the serum analysis revealed a significant increase in Albin the BG group and Vit A of all supplemented groups, while TP, globulin, and glucose did not show a significant change (Table 5). The economic assessment is shown in Table 6, showing a significant difference ($p < 0.001$) in the value of total costs between CON group and the other groups. The largest level of significance ($p < 0.001$) appeared in the BG group (2,761.1 LE/doe), while CON group had the lowest value of total costs (2,700.95 LE/doe) followed by the MS group (2,749.3LE/doe). There was also some variation in the total return value between CON and other treatment groups. The highest total return was found in the BG group (3,970 LE/doe) followed by the MS group (3,960 LE/doe), while the lowest total return was3633.50 LE/doe in CON group, followed by the CG group (3,940.02 LE/doe). Moreover, the net profit of all groups was significantly different ($p < 0.001$): the highest net profit was found in the MS group (1,210.70 LE/doe), while CON group had the lowest net profit value (932.55 LE/doe).

Discussion

This study did not detect any significant difference in maternal final body weight, but a numerical reduction in net weight in all groups was found. This reduction may be a result of fetal development and growth during the last phases of gestation, throughout which the maternal framework needs to meet the prerequisites of the developing and growing fetuses and development of mammary glands by maternal tissue reserve mobilization. As a result, the doe body weight was reduced [17]. However, this additional energy reserve led to higher kids‘ BWin all energy-supplemented groups (particularly in the MS group). These findings concur with those of Murniati et al. [18] who correlated high kid performance and BW with energy supplementation of the dam during late gestation. Moreover, Mahfuz et al. [1] record a positive effect for concentrate supplementation for the pregnant goat on their kids‘ BW. This suggests that nutrition assumes an especially significant role during the late gestation time of does. The nutritional requirements of does

Table 3. Effect of prenatal supplementation of energy sources on metabolic profiles of does before kidding.

Parameters	Dietary treatments[a]				SEM	*p*-value
	CON	MS	CG	BG		
TP (gm/dl)	6.05	5.65	5.86	5.68	0.125	0.634
Alb (gm/dl)	2.94^{a}	2.42^{ab}	2.85^{ab}	2.23^{b}	0.094	0.008
Glob (gm/dl)	3.11	3.23	3.02	3.45	0.135	0.742
Glucose (mg/dl)	58.47	53.89	54.53	53.18	2.33	0.854
Urea (mg/dl)	39.80^{b}	40.31^{ab}	43.36^{ab}	51.72^{a}	1.82	0.047
Creatinine (mg/dl)	0.538	0.660	0.659	0.680	0.036	0.473
AST (IU/L)	72.71^{a}	61.83^{ab}	61.40^{ab}	55.50^{b}	2.57	0.042
ALT (IU/L)	32.29^{a}	24.17^{ab}	24.00^{ab}	21.17^{b}	1.45	0.017
VitA (µg/dl)	23.59^{b}	22.46^{b}	27.18^{ab}	32.99^{a}	1.22	0.003
TG (mg/dl)	127.77	134.13	125.84	125.4	3.24	0.791
CHOL (mg/dl)	100.52	115.24	114.79	115.44	3.11	0.208
T. antioxid (mmol/l)	0.478	0.489	0.548	0.459	0.066	0.976

Means within the same row carrying different small superscripts are significantly different at $p < 0.05$.
[a]CON = control; MS = 200 gm corn starch and 100 gm of molasses /h/d; CG = 300 gm/head/d of corn grains; BG= 300 gm/h/d of barley grains.
TP = Total protein; Alb = Albumin; Glob = Globulin; AST = Aspartate aminotransferase; ALT = Alanine aminotransferase; VitA = Vitamin A; TG = Total glycerides; CHOL = Cholesterol; T.antioxid = Total antioxident; SEM = Standard error of means.

Table 4. Effect of prenatal supplementation of energy sources on metabolic profiles of does after kidding.

Parameters	Dietary treatments[a]				SEM	*p*-value
	CON	MS	CG	BG		
TP (gm/dl)	5.51	6.44	5.63	6.29	0.173	0.134
Alb (gm/dl)	2.81[b]	3.49[a]	2.76[b]	3.05[ab]	0.106	0.042
Glob (gm/dl)	2.70	2.94	2.87	3.24	0.132	0.542
Glucose (mg/dl)	50.07	68.78	64.61	56.02	2.92	0.076
Urea (mg/dl)	49.99	47.88	58.05	49.78	2.17	0.440
Creatinine (mg/dl)	0.630	0.731	0.660	0.702	0.029	0.635
AST (IU/L)	59.17[b]	97.17[a]	66.40[b]	93.20[a]	4.46	0.001
ALT (IU/L)	24.67[b]	32.17[a]	29.40[ab]	32.20[a]	1.01	0.009
Vit A (µg/dl)	18.32[c]	44.15[b]	39.35[b]	60.37[a]	3.60	<0.001
TG (mg/dl)	35.12	47.45	35.63	41.78	1.93	0.063
CHO (mg/dl)	68.23[b]	65.56[b]	67.30[b]	92.66[a]	4.16	0.054
T.antioxid (mmol/l)	0.504	0.522	0.431	0.791	0.060	0.169

Means within the same row carrying different small superscripts are significantly different at $p < 0.05$.
[a]CON = control; MS = 200 gm corn starch and 100 gm of molasses /h/d; CG = 300 gm/head/d of corn grains;
BG= 300 gm/h/d of barley grains.
TP = Total protein;Alb = Albumin; Glob = Globulin; AST = Aspartate aminotransferase; ALT = Alanine aminotransferase;
VitA = Vitamin A; TG = Totalglycerides; CHOL = Cholesterol; T.antioxid = Total antioxident; SEM = Standard error of means.

Table 5. Effect of prenatal supplementation of energy sources on metabolic profiles of kids.

Parameters	Dietary treatments[a]				SEM	*p*-value
	CON	MS	CG	BG		
TP (gm/dl)	5.69	6.05	6.40	5.81	0.144	0.379
Alb (gm/dl)	2.30[b]	2.39[ab]	1.95[b]	2.69[a]	0.058	0.001
Glob (gm/dl)	3.39	3.66	4.45	3.11	0.163	0.076
Glucose (mg/dl)	99.00[ab]	97.10[ab]	103.65[a]	82.41[b]	2.74	0.020
VitA (µg/dl)	17.60[c]	39.75[b]	37.62[b]	56.75[a]	2.28	<0.001

Means within the same row carrying different small superscripts are significantly different at $p < 0.05$.
[a]CON = control; MS = 200 gm corn starch and 100 g of molasses /h/d; CG = 300 gm/head/d of corn grains; BG= 300 gm/h/d of barley grains.
TP = Total protein; Alb = Albumin; Glob = Globulin; VitA = Vitamin A; SEM = Standard error of means.

during this period are influenced by the balance of blood metabolism and nutrients [19]. However, Sultana et al. [8] found no significant differences in kids' BW in black Bengal goats after concentrate diet supplementation of dams.

Kid temperature was significantly different during the first 2 h after birth in energy-supplemented groups compared to CON. This is due to higher energy intake during the neonatal period, which promoted the development of brown adipose tissue (BAT), which is considered the primary source of non-shivering heat creation [20]. BAT is influenced by many factors, including thermal, nutritional, and environmental Stimuli. Nutrition and energy can profoundly affect postnatal sheep and goat survival. Directly after birth, kids show continuous breathing and activated non-shivering thermogenesis; it is important that feeding is started to prevent excessive exhaustion of its endogenous energy storage in the form of both lipid and glycogen. Moreover, in the neonatal sheep, the continuing loss of BAT is accompanied by a lowering in energy intake of the dam [21].

Blood biochemical parameters reflect the health status of pregnant does and can help to diagnose metabolic disorders early and provide preventive treatment. Subsequently, this study endeavored to investigate the impact of concentrate feeding supplementation for does during late pregnancy on serum biochemical profiles before and after birthing and in young kids.

In this study, the low Alb value in the energy-supplemented groups before birthing is related to enhanced

Table 6. Effect of prenatal supplementation of energy sources on the economic profitability of goats.

Parameters[3]	Dietary treatment[2]	Mean[1]	SEM[4]	*p*-value
TC	CON	2700.95^{bc}	10.670^{b}	<0.001
	MS	2749.3^{b}	11.134^{ab}	
	CG	2751.8^{b}	11.277^{ab}	
	BG	2761.1^{a}	12.960^{a}	
TR	CON	3633.50^{bc}	13.422^{c}	<0.001
	MS	3960.00^{ab}	21.643^{ab}	
	CG	3940.02^{b}	18.173^{b}	
	BG	3970.00^{a}	22.478^{a}	
NP	CON	932.55^{c}	16.780^{b}	<0.001
	MS	1210.70^{a}	22.586^{ab}	
	CG	1188.40^{b}	17.634^{b}	
	BG	1208.90^{ab}	22.751^{a}	

Means within the same column carrying different small superscripts are significantly different at $p < 0.001$.
[a]CON = control; MS = 200 gm corn starch and 100 gm of molasses /h/d; CG = 300 gm/head/d of corn grains; BG = 300 gm/h/d of barley grains.
TC = Total cost; TR = Total return; NP = Net profit; SEM = Standard error of means.

protein catabolism during the last third of the gestation [22]. Additionally, as birthing approaches, serum Alb is known to exponentially increase the growth of fetal tissue [10]. Increasing estrogen concentration during this stage also causes TP to decrease. This decrease is because of fetal growth, which prompts the utilization of enormous amounts of amino acids from the mother to keep fetal protein and muscles improvement [23].

A similar finding was obtained by Sahu et al. [24] and Soares et al. [25]. However, Krisnan et al. [26] recorded an elevation of serum Alb in pregnant does; the level of concentrate feeding increased between the 17th and 20th weeks.

After birthing, however, serum Alb does significantly increases in the groups supplemented with the energy in comparison with CON, possibly due to increasing Alb synthesis by the liver, which attempts to decrease plasma volume [27,28].

The mean estimations of serum glucose concentration will lead to an increase in the treatment groups after birthing; this might be because of the high concentration of glucocorticoid hormones (e.g., cortisol), which instigate an expansion in hepatic gluconeogenesis. A positive relationship between energy supplementation and serum glucose concentration was found by O'Doherty and Crosby [29]. Some studies reported an elevation in glucose concentration during late pregnancy and directly after parturition [30,31]. Other researchers reported hypoglycemia at the onset of lactation, especially in high-producing dairy goats, which are related to increasing milk lactose synthesis [32,33]. However, in diets containing high levels of fermentable starch, Wang et al. [34] indicated high glucose concentration and a positive relationship between energy supplementation and serum glucose concentration. However, in our experiment, this relationship was not detected, possibly impaired by physiological variations, breed, or environmental conditions. Accordingly, a recent study by Zarrin et al. [35] reported that glucose hemostasis varies with physiological stages and that the high levels of beta-hydroxybutyrate produced during this stage may be behind the changing in glucose concentration in early lactation in dairy cows.

Blood urea concentration is an essential indicator of TP and energy levels in the feed rations [36]. In this study, urea concentration in serum was higher in the energy-supplemented groups, which was expected due to the high protein levels used in the treatments, suggesting an increase in protein degradation and amino acid deamination, as urea responds more quickly in relation to changes admission of the diet and its blood concentration straightforwardly mirrors the amount of protein ingested through the diet [37]. Increasing urea in blood with high protein and the relative amount of energy in the diet was also reported by Radovic et al. [38].

Creatinine is a normal metabolic residue during the maternal mobilization of proteins for fetal tissue building and the elimination of organic residues [39]. Although many researchers have reported that creatinine concentration in does during late pregnancy is higher than normal [17,23,40] our results concur with those of Cepeda-Palacios et al. [40] who found that nutrition and physiological status did not affect creatinine concentration. Therefore, this suggests that nutritional supplementation of does in late pregnancy did not affect creatinine levels [41].

The activity of two transaminases enzymes (GOT and GPT) is a pointer of liver function in pregnant animals [42]. Both enzymes are involved in gluconeogenesis [43]. During late pregnancy, as energy demand increases, this leads to higher gluconeogenesis, which in turn results in higher GOT and GPT activity as a consequence of higher hepatic metabolism [43,44]. In this research, the decreasing concentration of these enzymes in the supplemented groups before birthing can be explained by the concentrated energy supplementation, which conserves energy and inhibits the hepatic metabolism, thereby decreasing GOT and GPT serum concentration. This result concurs with that of Sajadian et al. [31] and Elzein et al. [39] in desert goats. After birthing, however, we observed an elevation in the activity of these two enzymes, suggesting an increase in lipid metabolism and gluconeogenesis for milk production, despite energy supplementation. This is similar to the results of Mohammadi et al. [42] in Makouei sheep and Soares et al. [25] in Brazilian goats.

Vitamin A is an essential nutrient for the proper functioning of the immune system. Bovines can accumulate a high concentration of carotenoids due to lower vitamin A synthesis efficiency in enterocytes [45]. Therefore, Vitamin A deficiency during pregnancy may cause stillbirth, fetal resorption, and malformation [45]. The serum concentration of vitamin A in does of the energy-supplemented groups (BG and CG) was significantly higher than in CON and MS groups. This is possible because barley is an excellent source of Vit A compared to other major cereal grains, according to NRC [46], 3.8 IU/kg versus 1 IU/kg in corn. This result concurs with that of Samad [47] in pregnant dairy cows.

In this study, circulating serum triglycerides were higher in the energy-supplemented groups compared to CON, suggesting a reduction in the risk of metabolic disorders that may occur in multiparous does feeding on a glucogenic diet. Similarly, Abd-allah [48] reported an insignificant increase in triglycerides in plasma of Rhmani ewes, which fed on a high-energy supplemented diet. Conversely, some researchers reported high triglycerides and CHOL levels during late pregnancy [49,50], possibly due to high levels of insulin, which is involved in the metabolism of adipose tissue during pregnancy [51].

The detected increase of CHOL levels in the BG group after birthing and during early lactation might be due to estrogen stimulation [52], which concurs with that reported by Iriadam et al. [53]. Furthermore, Celi et al. [54] reported high CHOL levels in the serum of kids born from dams who received extra concentrate feeding, suggesting higher serum CHOL levels in dams. The absence of significant changes in peripartum CHOL levels in goats was observed by Soares et al. [25]. However, Sajadian et al. [31] and Ismaeel et al. [23] recorded a reduction in serum CHOL concentration in the last week of pregnancy in goats.

Pregnancy and lactation are significant stress factors associated with oxidative changes in sheep and goat [55]. The stability of total antioxidants observed in this study indicates the effect of diet composition in the modification of oxidative hemostasis in the pregnant and lactating ewe, which might be suppressed during late pregnancy and just after parturition; then later returns to the oxidative balance. This outcome is similar to Sgorlon et al. [56].

Serum Alb and globulin concentrations were significantly higher in kids born from dams that fed on high energy-supplemented group comparing to CON. The progressive increase of Alb and globulin concentration may be due to increasing serum immunoglobulin during the first hours of life or transplacental transfer from does, concurring with our findings, Celi et al. [54] observed high levels of plasma Alb and globulin in kids born from dams fed with a high-energy diet, suggesting that kids born from energy-supplemented dams have higher immunity.

Increasing serum glucose levels in kids from the energy-supplemented groups is a result of consuming large amounts of lactose and energy substrates in colostrums, likewise to what was seen by Celi et al. [41]. The only source for vitamin A in the kids is through the colostrum, as this substance does not cross the placenta; therefore, supplementing pregnant does with a good source of vitamin A should be considered, e.g., using barley as a feed source. Indeed, higher levels of Vit. Awerefound in the BG-supplemented group, concurring with Samad [47], who reported that vitamin A in calf plasma from cows fed vitamin A as either ester or alcohol was significantly higher than that of calves from the dams fed on a basal diet or those fed alfalfa leaf meal.

The economic evaluation showed that the addition of a prepartum dietary energy source supplement in pregnant might improve financial efficiency for meat and milk production. The net revenue was higher in the MS and BG groups; however, the goats in CON group fed on the basal diet showed the lowest net profit. This suggests that the energy supplementation in prepartum diets for pregnant does economically beneficial. This result concurs with that of De Souza et al. [16], who found a significant positive economic effect in goats fed with a high dietary energy level. Therefore, our study concludes that the feeding of the high-energy ration is economically beneficial for goat farmers. Else ways, our outcomes were not lined up with those of Rashid et al. [57] who demonstrated that the difference profits between CON and the treatment group were not noteworthy.

Conclusion

Supplementing Egyptian Nubian does with a high-energy diet during late gestation resulted in increased kid BW and body temperature, which can potentially overcome problems of neonatal hypothermia and low BW. Such high-energy diets also lead to changes in the serum concentration of some essential metabolic parameters in dams and kids. The feeding supplementation proposed in this study, particularly that with BG, could be useful in the management of goats during late gestation and in avoiding early metabolic disorders.

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Conflict of interests

No conflict of interest to declare.

Authors' contribution

HDM, RAE designed the work, interpreted data, and drafted the manuscript. KMS and RAE were involved in the collection of data and also contributed to manuscript preparation. SAAK took part in preparing the economic data and critical checking of this manuscript.

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