Egypt. J. Vet. Sci., pp. 1-8

Egyptian Journal of Veterinary Sciences

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

Impact of Betaine and Folic Acid Supplementation on Thermoregulatory Responses, Blood Characteristics and Lactation Performance of Baldi Goats, and The Growth Performance of their kids

Ahmed S. H. Soliman[1]*, Belal F. Farag[2] and Amira A. A. Mohamed[3,4]

[1]*Department of Animal Production, Faculty of Agriculture, New Valley University, Al Kharga City, New Valley, Egypt.*

[2] *Animal Production Department, Faculty of Agriculture, Al-Azhar University, Assiut Branch,71524, Egypt*

[3]*Department of Animal Production, Faculty of Environmental Agricultural Sciences, Arish University. Al-Arish, North- Sinai, Egypt.*

[4]*College of Veterinary Medicine, Northwest Agriculture and Forestry University, Yangling, China.*

Abstract

THIS WORK aimed to find the influence of betaine (Bet) and folic acid (FA) on milk production, hemato-biochemical parameters, and total antioxidant capacity (TAC) of goats during heat stress. Goats (N=40) were equally categorized into control, Bet, FA, and Bet-FA groups. The control group was fed a basal diet, whereas the Bet and Bet-FA groups were supplemented with 4 g/h/d Bet, and the FA and Bet-FA groups were supplemented every other day with 500 μg/animal folic acid. Pulse rate (PR), respiration rate (RR), skin temperature (ST), and rectal temperature (RT) were recorded. Blood samples were collected to estimate hemato-biochemical parameters, hormonal profile, and total antioxidant capacity (TAC). Results showed that BT and FA led to a significant decrease (P<0.05) in RT, ST, RR, and PR. While the concentration of hemoglobin (HB) increased (P<0.05) in all treated groups. BT and FA increased significantly total proteins (TP), while decreasing (P<0.05) alanine aminotransaminase (ALT) levels. The levels of aspartate aminotransaminase (AST) exhibited a significant reduction (P<0.05) in Bet, FA, and Bet-FA groups. Total antioxidant capacity (TAC) in Bet, FA, and Bet-FA groups was higher (P<0.05) than the control group. Additionally, Bet, FA, and Bet-FA have increased (P<0.05) milk yield, milk fat% and milk protein% % compared to control. In conclusion, Bet, FA, and Bet-FA supplementation in the goats' diet significantly improved their performance and better mitigating the heat stress during the hot season.

Keywords: Folic acid, Betaine, Heat stress, Blood biochemical, Goats.

Introduction

Humans and animals are eukaryotic organisms, their bodies contain cells and organs with multiple functions. Changes in the environment lead to disorder in their vital functions. So, alleviating this stress is important for keeping or improving the animals' productivity of meat and milk production, and improving female and male fertility to achieve environmental balance and increase the food sources for human consumption. Several dietary supplementations were used to reduce the mortality rate from infectious diseases for humans and animals[1]. Adherence to healthy diets during the last period of pregnancy in women and animals preserves and improves post-parturient fertility, health, and offspring. Dietary supplementations during the last trimester of pregnancy advanced newborn litter size, growth performance, live birth rates, and milk yield and maternal health after giving birth [2]. Betaine, trimethyl glycine, plays an essential role in homocysteine synthesis by providing methyl groups necessary for methionine production [3]. With its multiple actions, Bet offers potential benefits in mitigating heat stress and enhancing milk production [4, 5].

Folic acid (FA) is responsible for the transport of one-carbon units in the methionine cycle and is an essential nutrient for rumen microorganisms. As

*Corresponding authors: Ahmed S. H. Soliman, ahmed.soliman@agr.nvu.edu.eg Tel.: 0201025815119
(Received 26 April 2025, accepted 26 May 2025)
DOI: 10.21608/ejvs.2025.371384.2803

much as 97% of dietary fatty acids are broken down or utilized by rumen microbes, and thus, rumen-protected folic acid (RPFA) supplements have been used in ruminants [6]. FA is converted to tetrahydrofolate (THF), which accepts one-carbon units to produce 5,10-methylene-THF, 10-formyl-THF, and 5-methyl-THF, facilitating the manufacture of thymidylate, purine, and methionine, respectively. FA is substantial for growth and development, especially in fetal stages. It is standard practice to administer FA to mothers during the preconception phase and late pregnancy [7]. Folic acid is necessary for tissue growth and cell division, being a key cofactor in one-carbon metabolism. It is also necessary for amino acid metabolism, nucleotide synthesis, and many methylation reactions in the body [8, 9].

Therefore, this work aimed to evaluate the impact of Bet and/or RPFA on thermoregulatory response, feed intake, lactation performance, and blood metabolites in Baldi goats and the growth performance of their kids**.**

Material and Methods

The work was performed on a traditional farm in the El-Kharga oasis (25°27'36.0"N 30°32'49.8" E), this area is a part of the New Valley governorate, Egypt.

Animals' feeding system and experimental design:

Forty pregnant local goats (during the late pregnancy), aged 2–4 years, 2–3 parities, and weighing 22.64 ± 0.38 kg, were randomly assigned to 4 equal treatments (10 goats each). Goats in the control group (CG) were offered a basal diet of 60% concentrate mixture and as roughage, 40% pearl millet and wheat straw. The contents of CFM were 54% yellow corn, 15 % soybean meal, 28% wheat bran, 2% limestone, and 1% NaCl. The Folic acid (FA) was supplemented to the FA and Betane-FA groups every other day as a single bolus of FA (soft gelatin capsules; 500 µg/animal; Pharco Pharmaceuticals, Egypt). The other experimental groups of betaine (Bet) o and Bet-FA provided 4 g Betane/kg diet mixed with concentrated diet and supplemented daily before feeding. Table (1) shows the chemical composition of the feed consumed by Baldi goats. Diets were offered at 7.30 am and 3.30 pm. Water was available at all times.

Measurement of temperature and humidity index (THI):

Throughout the heat stress period from June to September 2023, the ambient temperature (AT) and humidity (RH) were recorded every two weeks using automatic AT and RH recorders at 08:00 am and 02:00 pm. THI was calculated as followed: $THI = (0.8 \times T) + [(RH/100) \times (T - 14.4)] + 46.4$ **[**10**]** Where; T is the temperature (°C), and RH is the relative humidity.

Experimental procedures:

Body temperature measurements:

The thermoregulatory responses, respiration rate (RR), and pulse rate (PR) were determined every two weeks before determining the rectal temperature (RT). RT°C was recorded using a digital thermometer with a range of 32–43.9 °C. Skin temperature °C was measured by portable infrared thermometer.

Sample collection:

Two blood samples were collected from goats before the morning feeding via the jugular vein. Three millilitres of blood were extracted into EDTA tubes, and the complete blood counts were analysed. Six millilitres of blood were collected in clean tubes and centrifuged at 3,500 rpm for 10 min at 5 °C for harvesting serum. The collected samples were stored in refrigerator at -20 °C till biochemical analysis.

Hematological parameters:

The haematological profile included white blood cell (WBC) count, red blood cell (RBC) count, hematocrit (HCT), hemoglobin (HGB), platelets (PLT), mean corpuscular hemoglobin (MCH), mean corpuscular volume (MCV), and mean corpuscular hemoglobin concentration (MCHC) was analysed using automatic hematology analyser (*Dirui Bcc-3600).*

Analytical procedures:

Sera were analyzed for concentrations of total proteins (TP), albumin (Alb), urea, creatinine, aspartate aminotransferase (AST), alanine aminotransferase (ALT), glucose, and total cholesterol. While the concentration of globulin (Glob) was computed by subtracting albumin from TP. The serum total antioxidant capacity (TAC) was determined. Blood biochemical analyses were performed by spectro-photometer commercial kits (Bio Diagnostics, Cairo, Egypt). Triiodothyronine (T3) and thyroxine (T4) concentrations were determined by using ELISA kits

Milk samples:

Milk yield was estimated using the kid suckling weight differential technique [11]. The milk yield was daily recorded for each goat individually and fat-corrected milk (FCM 4%) was calculated by the following equation of [12]:

$$FCM\ \% = actual\ milk\ yield\ (kg)\ x\ 0.4 + 15\ x\ fat\ yield\ (kg).$$

Milk samples were collected and their composition was determined using *(Lactoscan MCC, Lactoscan Milktronic)*

Kids' growth performance:

All goats included in the experiment gave kids after normal kidding. All newborns were weighed and recorded at birth, and every two weeks thereafter (2, 4, 6, and 8 weeks). The average daily gain (ADG) and total weight gain (TWG) of kids were calculated.

Statistical analysis:

Data were statistically analyzed using SAS v.9.1**.** The among-groups were tested by Duncan's multiple range test [**13**]**.**

The statistical model was $Y_{ij} = \mu + A_j + £_{ij}$

Y_{ij} = observation traits, μ = overall means, A_j = treatments group, $£_{ij}$ = standerd error

Results

Climatic conditions:

Ambient temperature °C, RH percent, and THI through the experimental periods are presented in Table (2). The average AT °C through the trial periods ranged from 24.3°C to 28.2 °C at 08:00 am and from 39.8°C to 45.7°C at 02:00 pm. Moreover, the average RH% was 18% and 22% at 08:00 am and from 12% to 15% at 02:00 pm. Furthermore, the THI values were 68.02 to 71.44 at 08:00 am and 78.37 to 83.08 at 02:00 pm through the last two months of pregnancy and lactation period. The observed values of THI clear that all experimental goats were suffered from moderate stress at 02:00 pm during the entire study period because it exceeded the upper critical limit for farm animals according to Armstrong [14].

Thermoregulatory response:

Figure (1) shows that at 08:00 am Bet, FA, and Bet-FA groups led to a decrease in ST and RR. While, RT and PR were low (P<0.05) in treated goats compared with controls. At 02:00 pm, Bet, FA, and Bet-FA groups had reduced (P<0.05) RT, ST, RR, and PR compared to the control one. Our results show that Bet, FA, and Bet-FA improved thermoregulation in goats subjected to heat stress.

Blood hematological parameters:

The impacts of the Bet, FA, and Bet-FA on goats' haematological parameters are presented in Table 3. RBCs, HGB concentration, and HCT increased (P<0.05) in goats treated with Bet, FA, and Bet*FA. While, WBCs , platelets, MCV, MCH, and MCHC were not affected.

Serum enzymes

Data in Table (4) show that supplementation of Bet, FA, and Bet-FA had no significant effect on albumin, globulin, urea-N, creatinine, ALT, glucose, and cholesterol concentrations. However, the concentrations of AST declined (P < 0.0 in Bet, FA, and Bet-FA groups compared to the control. While goats fed Bet (7.49 g/dl) or Bet-FA (7.51 g/dl) had higher (P < 0.05) total protein with no significant difference between those fed FA (7.36 g/dl) and control (7.17 g/dl). The serum concentration of TAC in Bet, FA and Bet-FA groups was significantly high (P<0.05). Meanwhile, increased (P<0.05) T3 and T4 levels can be observed with both Bet, FA, and Bet-FA groups (Table 4).

Lactation performance:

The impacts of Bet, FA, and Bet-FA on milk yield, FCM, milk quality, and total dry matter intake (TDMI) are shown in Table (5). It was observed that there was no difference in TDMI among groups. Milk yield, FCM, fat, and protein significantly increased (P< 0.05) with supplementing Bet, FA, and Bet-FA.

Kid's growth performance:

Data in Table (6) revealed that the average birth weight of kids was 1.65 kg, 1.76 kg, 1,78 kg, and 1.81 kg, in control, Bet, FA, and Bet-FA groups, respectively. Betaine and FA supplementation revealed an increase (P < 0.05) in LBW at 2, 4, 6, and 8 weeks of age in comparison with the control groups. Concerning ADG, results showed that ADG during the suckling period in Bet, FA, and Bet-FA supplemented groups was significantly greater (P <0.05) than in the control group.

Discussion

During pregnant especially the last months of pregnancy and lactation period synthesis of milk are a critical stage of mother health and new born viability therefore; add some supplements pharmaceutical perhaps improving mother and kids' health during summer season in the desert Egypt. Our research start from June to September were high AT and RH and we recorded meteorological measures during the experimental doing. The THI values that were recorded in our study are in conformity with [15] who found that THI values ranged between 67.4 to 71.1 at 08:00 am and from 76.5 to 80.53 at 10:00 pm during hot season in New Valley. Under the same conditions in New Valley, The mean THI values were found from 67.4 to 71.1 at 08:00 am and from 76.5 to 80.53 at 02:00 pm during summer season in the New Valley [16]. Recently, [5] found that the THI values were ranged from 67.42 to 71.98 at 08:00 am and 79.20 to 82.77 at 02:00 pm indicating that the animals in New Valley were under HS, especially at 02:00 pm. The observed THI values indicate that all experimental goats experienced stress during the research period, since they surpassed the highest critical threshold for goats, particularly in the evening. Thermal stress induces significant physiological changes that adversely affect growth, reproductive function, and milk supply [3]. Furthermore, stress may induce apoptosis in certain cells [17].

Thermoregulatory reactions associated with physiological indicators, including RT, RR, PR, and ST, constitute the principal adaptive mechanisms to the intensity and duration of HS. Prior research has shown that the vulnerability of ewes to HS may be confirmed by elevated RR, RT, or ST, when subjected to HS [18, 19]. In consistent, our results showed that HS-related physiological abnormalities may be the source of the increase in RT, RR, PR, and ST, which may trigger inflammation [20]. Interestingly, the rise in RT, PR, RR, and ST caused by HS was clearly decreased by the addition of FA and BT, suggesting that they may be crucial in preventing inflammation.

During the experiment period blood hematological parameters were analysis to identify the effect of supplementary FA or/and Bet on mother health. The Fe saturation of plasma transferrin is the most often used screening metric for Fe deficient anaemia, which was high in goats treated with Bet and FA in our results. Recently, the MCV became the most important red cell marker for detecting Fe deficiency anaemia in circulating RBCs [21]. On the other hand, HGB, HCT, and RBCs were highest in rats which received riboflavin and FA [22]. However, blood metabolites show no negative impact on the health of the goats, as the blood parameters values were within the normal limits [23].

Resently, other data showed supplemented vitamins as L-ascorbic acid and FA alone and (or) in combination on broiler chickens under HS conditionseither increased ($P < 0.01$) insulin growth factor1, T3 and T4 levels, TP, Alb, Glob, heat shock protein70, catalase enzyme activity, superoxide dismutase, and TAC [24]. The functional role of FA is essential for water-soluble and a cofactor in one-carbon metabolism that can organize some different pathways as cell growth, differentiation, DNA repair, apoptosis, and carcinogenesis prevention [25]. Several biochemical roles can be proposed as plausible mechanisms for this protective activity in addition to the known biochemical role, the most important of which to date are free radical scavenging and antioxidant activity [26] our data showed total antioxidant capacity in blood serum increased significantly in the bet and folic acid vitamins, comparable to the control groups.

Milk yield in this study was increased by 8.4%, 7.8%, and 13% with Bet, FA, and Bet-FA, respectively. Likewise, adding 4 g Bet/kg DM either in goats and cows' ration [4-6, 27, 28] increased milk yield. Similarly, FA supplementation increased milk yield by up to 22.1% without affecting milk composition in Zaraibi goats [29] . Numerous researches on dairy cows have demonstrated that supplementing with Bet and FA increases milk yield [6, 30-32]. The positive impact of Bet supplementation on the mammary gland has been confirmed by several studies, which can be attributed to a decrease in the number of somatic milk cells, a decrease in oxidative damage to mammary epithelial cells under HS conditions, and an alleviation of the severity of HS [4, 5]. Furthermore, FA supplementation can positively impact milk production and overall animal health, potentially through its role in cellular processes and antioxidant defense mechanisms.

Finally, during the mid to late lactation stage, supplementation of rumen-protected betaine increased the cow's milk yield and led to increased body weight of their calf [33, 34]. The data above agrees with our data reported that Bet and FA supplements increased the milk yield of Baldi Goats and caused an increase in birth weight, weaning weight, total body weight, and average body weight of growing kids' performance. Our current findings are consistent with [6] who noted that various amounts of Bet affect growth, digestibility, and intestinal health of rabbits under HS.

Conclusion

Results from the present study showed that dry matter intake, thermoregulatory response, blood constituents, milk yield, and composition of goats were improved as a result of BeT and FA inclusion during late pregnancy and lactation periods. Improvement in the milk production performance of goats increased the weight of kids and average daily gain during the suckling period. Improvement in milk production and growth of young goats receiving Bet-FA was higher than in those receiving Bet or FA alone.

Acknowledgments

Not applicable.

Funding statement

This study didn't receive any funding support

Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical of approval

The goats involved in this study underwent evaluation and approval by the Research Ethics Committee of New Valley University, Egypt. The Ethical Committee protocol number is provided: (*NVREC 0337-2024-14*).

TABLE 1. Chemical composition of feedstuffs

Item	CFM	Pearl millet	Wheat straw
Dry matter	89.33	18.88	91.85
Organic matter	91.45	90.1	94.2
Crude protein	14.62	10.25	2.6
Crude fiber	6.86	30.49	44.6
Ether extract	3.76	3.14	1.8
Ash	8.55	9.9	5.8
Nitrogen free extract	66.21	46.22	45.2

TABLE 2. Means of AT °C, RH % and THI during the experimental period.

Month	Time of day					
	08:00 am			02:00 pm		
	AT,°C	RH, %	THI	AT,°C	RH, %	THI
June	26.4	18	69.68	44.2	14	81.90
	27.8	19	71.17	45.7	12	83.08
July	28.2	18	71.44	42.3	15	80.39
	25.7	17	68.88	42.4	15	80.47
August	26.7	18	69.97	44.8	13	82.37
	24.3	22	68.02	40.5	12	78.92
September	25.8	18	69.09	41.2	14	79.50
	25.8	18	69.09	39.8	13	78.37

$\boldsymbol{THI} = (\mathbf{0.8} \times \boldsymbol{Ta}) + [(\boldsymbol{RH}/\mathbf{100}) \times (\boldsymbol{Ta} - \mathbf{14.4})] + \mathbf{46.4}$.

TABLE 3. Effects of Bet, FA, and Bet-FA on hematological parameters

Parameter	Experimental rations				SEM	P-values
	Control	Bet	FA	Bet-FA		
RBC (10^6/µl)	6.746^b	7.490^a	7.456^a	7.674^a	0.142	**0.048**
HB (g/dl)	10.39^b	11.88^a	11.74^a	12.14^a	0.230	**0.025**
HCT %	31.09^b	34.10^a	34.74^a	35.26^a	0.636	**0.026**
MCV (fl)	44.20	47.65	45.14	48.14	0.795	0.258
MCH (pg)	16.32	16.86	17.30	16.70	0.357	0.844
MCHC (g/dl)	36.92	35.48	36.44	34.72	0.533	0.522
WBC (10^3/µl)	12.96	11.51	10.52	10.78	0.423	0.190
PLT	336.20	340.40	336.60	341.00	16.155	0.999

^{a,b} Means in the same row lacking a common superscript differ at P<0.05. RBC, red blood cell ;HB, hemoglobin concentration ; HCT, hematocrit ; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin ; MCHC, mean corpuscular hemoglobin concentration; WBC, White blood cell ; PLT, Platelets

TABLE 4. Effects of Bet, FA, and Bet-FA on blood biochmical parameters.

Parameter	Experimental rations				SEM	P-values
	Control	Bet	FA	Bet-FA		
Total protein (g/dL)	7.17^b	7.49^a	7.36^{ab}	7.51^a	0.045	**0.022**
Albumin (g/dL)	3.27	3.48	3.47	3.61	0.046	0.072
Globulin (g/dL)	3.90	4.01	3.89	3.90	0.048	0.809
Glucose (mg/dL)	55.80	57.60	58.00	57.40	1.293	0.950
Total Cholesterol (mg/dL)	173.57	164.00	174.07	176.74	2.844	0.464
AST (U/L)	48.02^a	44.60^b	44.01^b	42.60^b	0.631	**0.010**
ALT (U/L)	19.80	18.21	17.63	18,81	0.349	0.158
Urea-N (mg/dL)	24.82	25.86	25.61	24.34	0.514	0.754
Creatinine (mg/dL)	1.931	1.848	1.738	1.676	0.051	0.331
TAC mM/L)	0.673^b	0.805^a	0.778^a	0.824^a	0.020	**0.029**
T3 (µg/dl)	1.62^b	1.86 ^{a}	1.85 ^{a}	1.81 ^{a}	0.034	**0.025**
T4 (µg/dl)	4.88^b	5.54^a	5.60^a	5.72^a	0.118	**0.048**

^{a,b} Means in the same row lacking a common superscript differ at P<0.05. TAC; total antioxidant capacity, T3; triiodothyronine, T4; thyroxine, AST; aspartates aminotransferase, ALT; alanine aminotransferase.

TABLE 5. Effects of Bet, FA, and Bet-FA supplementation on milk yield and constituents.

Parameter	Experimental rations				SEM	P-values
	Control	Bet	FA	Bet-FA		
Total number of goats	10	10	10	10		
Average body weight, kg	22.89	23.25	21.84	22.58	0.375	0.6459
Average daily DM intake, g/h/d						
CFM	600	600	600	600		
Pearl millet	300	300	300	300		
Wheat straw	136	144	159	164	7.867	0.6669
TDMI	1036	1044	1059	1064	7.867	0.6669
Milk yield and Milk composition						
Milk yield, g	664^{b}	720^{a}	715^{a}	751^{a}	9.946	**0.0109**
4% FCM, g	606.54^{b}	691.89^{a}	691.26^{a}	723.26^{a}	12.021	**0.0006**
Total Solids, %	11.36^{b}	12.58^{a}	12.20^{a}	12.62^{a}	0.149	**0.0027**
Fat, %	3.42^{b}	3.74^{a}	3.78^{a}	3.76^{a}	0.050	**0.0261**
Solids not fat, %	7.94^{b}	8.84^{a}	8.42^{a}	8.86^{a}	0.112	**0.0040**
Protein, %	2.78^{b}	3.22^{a}	3.02^{a}	3.34^{a}	0.074	**0.0336**
Lactose, %	4.28	4.60	4.44	4.48	0.048	0.1331
Ash, %	0.88	1.02	0.96	1.04	0.037	0.4635

[a,b] Means in the same row lacking a common superscript differ (P<0.05). CFM; concentrate feed mixture, TDMI; total dry matter intake, FCM; fat corrected milk

TABLE 6. Effect of Bet, FA, and Bet-FA on the growth performance of newborn kids during the suckling period

Parameter	Experimental rations				SEM	P-values
	Control	Bet	FA	Bet-FA		
Birth weight	1.65^{b}	1.76^{a}	1.78^{a}	1.81^{a}	0.021	**0.023**
Weight at 2nd week	2.50^{b}	2.66^{a}	2.70^{a}	2.73^{a}	0.027	**0.004**
Weight at 4th week	3.30^{b}	3.52^{a}	3.56^{a}	3.59^{a}	0.032	**0.000**
Weight at 6th week	4.05^{b}	4.29^{a}	4.40^{a}	4.42^{a}	0.044	**0.004**
Weaning weight at 8th week	4.95^{b}	5.28^{a}	5.35^{a}	5.36^{a}	0.048	**0.004**
Total weight gain	3.30^{b}	3.53^{a}	3.58^{a}	3.55^{a}	0.037	**0.022**
Average daily weight gain, g	58.92^{b}	62.95^{a}	63.83^{a}	63.39^{a}	0.667	**0.022**

[a,b] Means in the same row lacking a common superscript differ *(P<0.05).*

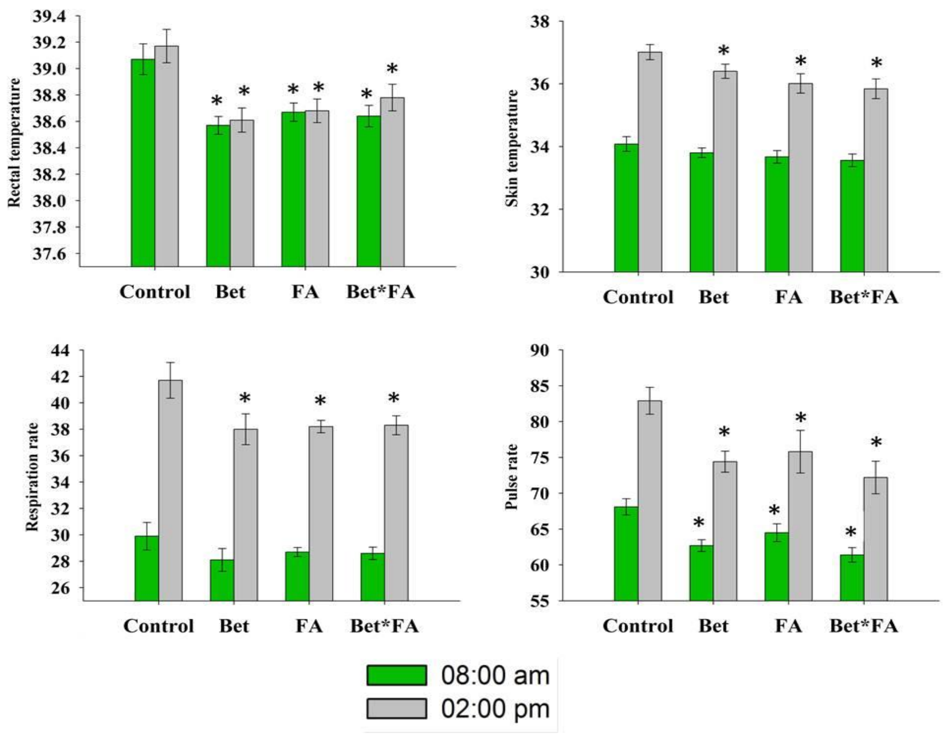

Fig. 1. Thermoregulatory responses of Baldi goats after treatment with Bet, FA, and Bet*FA. * means significant at P<0.05.

References

1. Zinder, R., Cooley, R., Vlad, L. G. and Molnar, J. A.. Vitamin A and wound healing. *Nutrition in Clinical Practice*, **34**(6), 839-849 (2019).
2. Gaskins, A. J. and Chavarro, J. E.. Diet and fertility: a review. *American Journal Of Obstetrics And Gynecology*, **218**(4), 379-389 (2018).
3. Kassab, A., Hamdon, H., Daghash, H. and Soliman, A.. Impact of betaine supplementation as anti stress on some hematological parameters and thermoregulatory responses of aberdeen angus cows in arid subtropical regions. *New Valley Journal of Agricultural Science*, **1**(2), 89-97 (2021).
4. Ghoneem, W. M. A. and El-Tanany, R. R. A. Impact of natural betaine supplementation on rumen fermentation and productive performance of lactating Damascus goats. *Tropical Animal Health and Production*, **55**(2), 123 (2023).
5. Soliman, A., Daghash, M. W. H., Hamdon, H. and Mohamed, A. A. A. Influence of betaine and zinc supplementation on milk production and its components thermoregulatory responses, blood characteristics and reproductive performance of lactating cows in arid subtropical regions. *Egyptian Journal of Animal Production*, **61**(2), 73-81(2024).
6. Cheng, K. F., Wang, C., Zhang, G. W., Du, H. S., Wu, Z. Z., Liu, Q. and Pei, C. X. Effects of betaine and rumen-protected folic acid supplementation on lactation performance, nutrient digestion, rumen fermentation and blood metabolites in dairy cows. *Animal Feed Science and Technology*, **262**, 114445 (2020).
7. Ferrazzi, E., Tiso, G. and Di Martino, D. Folic acid versus 5-methyl tetrahydrofolate supplementation in pregnancy. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, **253**, 312-319 (2020).
8. Bailey, L. B., Stover, P. J., McNulty, H., Fenech, M. F., Gregory III, J. F., Mills, J. L. and Raiten, D. J. Biomarkers of nutrition for development—folate review. *The Journal of Nutrition*, **145**(7), 1636S-1680S (2015).
9. McNulty, H., Rollins, M., Cassidy, T., Caffrey, A., Marshall, B., Dornan, J. and Pentieva, K. Effect of continued folic acid supplementation beyond the first trimester of pregnancy on cognitive performance in the child: a follow-up study from a randomized controlled trial (FASSTT Offspring Trial). *BMC Medicine*, **17**, 1-11(2019).
10. Mader, T. L., Davis, M. S. and Brown-Brandl, T. Environmental factors influencing heat stress in feedlot cattle. *Journal of Animal Science*, **84**(3), 712-719 (2006).
11. Economides, S. Comparative studies of sheep and goats: milk yield and composition and growth rate of lambs and kids. *The Journal of Agricultural Science*, **106**(3), 477-484 (1986).
12. Gaines, W. L. An efficiency formula for dairy cows. *Science*, **67**(1735), 353-354 (1928).
13. Duncan, D., Multiple range and multiple F test. Biometrics, **11**, 1-42 (1955).
14. Armstrong, D. V. Heat stress interaction with shade and cooling. *Journal of Dairy Science*, **77**(7), 2044-2050 (1994).
15. Soliman, A., Ayman, K., Hamdon, H., Senosy, W. and Daghash, H. Effect of antioxidant supplementation on some hematological parameters and thermoregulatory responses of Aberdeen Angus cows during hot season in arid subtropical regions. *New Valley Journal of Agricultural Science*, **2**(6), 544-551 (2022).
16. Kassab, A., Hamdon, H., Senosy, W. and Wardy, E. M. Impact of Chlorella vulgaris Microalgae as Anti Stress on Hematological Parameters and Thermoregulation of Boer Goats in Arid Subtropical Regions. *New Valley Journal of Agricultural Science*, **3**(10), 21-27(2023)..
17. Mohamed, A. A. A., Soliman, S. S., Soliman, A. S., Hanafy, A. and Jin, Y. Endoplasmic reticulum stress is involved in mycotoxin zearalenone induced inflammatory response, proliferation, and apoptosis in goat endometrial stromal cells. Reproductive Biology, **24**(4), 100948(2024).
18. Zhang, M., Warner, R. D., Dunshea, F. R., DiGiacomo, K., Joy, A., Abhijith, A. and Chauhan, S. S. Impact of heat stress on the growth performance and retail meat quality of 2nd cross (Poll Dorset×(Border Leicester× Merino)) and Dorper lambs. *Meat Science*, **181**, 108581 (2021).
19. Li, B., Wu, K., Duan, G., Yin, W., Lei, M., Yan, Y. and Zhang, C. Folic acid and taurine alleviate the impairment of redox status, immunity, rumen microbial composition and fermentation of lambs under heat stress. *Animals*, **14**(7), 998 (2024).
20. Bokharaeian, M., Toghdory, A. and Ghoorchi, T. Effects of dietary curcumin nano-micelles on growth performance, blood metabolites, antioxidant status, immune and physiological responses of fattening lambs under heat-stress conditions. *Journal of Thermal Biology*, **114**, 103585 (2023).
21. Cook, J. D. Diagnosis and management of iron-deficiency anaemia. *Best Practice & Research Clinical Haematology*, **18**(2), 319-332 (2005).
22. Dako, D. Y. and Hill, D. C. Effect of riboflavin and folic acid supplementation on some haematopoietic parameters in the rat. *International Journal for Vitamin and Nutrition research. Internationale Zeitschrift fur Vitamin-und Ernahrungsforschung. Journal International de Vitaminologie et de Nutrition*, **50**(3), 254-260 (1980).
23. Mohammed, S. A., Razzaque, M. A., Omar, A. E., Albert, S. and Al-Gallaf, W. M. Biochemical and hematological profile of different breeds of goat maintained under intensive production system. *African Journal of Biotechnology*, **15**(24), 1253-1257 (2016).
24. Gouda, A., Amer, S. A., Gabr, S. and Tolba, S. A. Effect of dietary supplemental ascorbic acid and folic acid on the growth performance, redox status, and immune status of broiler chickens under heat stress. *Tropical Animal Health and Production*, **52**, 2987-2996 (2020).

25. Trujillo, E., Davis, C., and Milner, J. Nutrigenomics, proteomics, metabolomics, and the practice of dietetics. *Journal of the American Dietetic Association*, **106**(3), 403-413 (2006).

26. Joshi, R., Adhikari, S., Patro, B. S., Chattopadhyay, S. and Mukherjee, T. Free radical scavenging behavior of folic acid: evidence for possible antioxidant activity. *Free Radical Biology and Medicine*, **30**(12), 1390-1399 (2001).

27. Fernández, C., Sánchez-Seiquer, P., Sánchez, A., Contreras, A. and De La Fuente, J. M. Influence of betaine on milk yield and composition in primiparous lactating dairy goats. *Small Ruminant Research*, **52**(1-2), 37-43 (2004).

28. Fernández, C., Mata, C., Piquer, O., Bacha, F. and de la Fuente, J. M. Influence of betaine on goat milk yield and blood metabolites. *Tropical and Subtropical Agroecosystems*, **11**(1), 209-213 (2009).

29. Ahmed, M., Ibrahim, F. A., Abou Ammou, F. F. and El-Shewy, A. A. Influence of using folic acid on lactating Zaraibi goats performance. *Journal of Animal and Poultry Production*, **26**(11), 6745-6758 (2001).

30. Graulet, B., Matte, J. J., Desrochers, A., Doepel, L., Palin, M. F. and Girard, C. L. Effects of dietary supplements of folic acid and vitamin B12 on metabolism of dairy cows in early lactation. *Journal of Dairy Science*, **90**(7), 3442-3455 (2007).

31. Li, H. Q., Liu, Q., Wang, C., Yang, Z. M., Guo, G., Huo, W. J. and Huang, Y. X. Effects of dietary supplements of rumen-protected folic acid on lactation performance, energy balance, blood parameters and reproductive performance in dairy cows. *Animal Feed Science and Technology*, **213**, 55-63 (2016).

32. Dunshea, F. R., Oluboyede, K., DiGiacomo, K., Leury, B. J. and Cottrell, J. J. Betaine improves milk yield in grazing dairy cows supplemented with concentrates at high temperatures. *Animals*, **9**(2), 57 (2019).

33. Peterson, S. E., Rezamand, P., Williams, J. E., Price, W., Chahine, M. and McGuire, M. A. Effects of dietary betaine on milk yield and milk composition of mid-lactation Holstein dairy cows. *Journal of Dairy Science*, **95**(11), 6557-6562 (2012).

34. Hamdon, H., Ayman, K., Daghash, H. and Soliman, A. Effects of betaine supplementation during late gestation on colostrum and milk quality of Aberdeen Angus cows, and the growth performance of their calves. *New Valley Journal of Agricultural Science*, **5**(1), 50-58 (2025).

تأثير اضافة البيتايين وحمض الفوليك علي التنظيم الحراري وخصائص الدم وانتاج اللبن للماعز البلدي واداء نمو مواليدها

احمد سليمان حسن سليمان[1] ، بلال فراج فرج[2] و أميرة عبد الله عبدالشافي محمد[3,4]

[1] قسم الانتاج الحيوانى، كلية الزراعة، جامعة الوادي الجديد، مصر.

[2] قسم الانتاج الحيوانى، كلية الزراعة، جامعة الازهر باسيوط، مصر.

[3] قسم الانتاج الحيواني، كلية العلوم الزراعية البيئية، جامعة العريش، مصر

[4] كلية الطب البيطري، جامعة الشمال الغربي للزراعة والغابات، يانج لينج، الصين.

الملخص

أجريت هذه الدراسة لتقييم تأثير اضافة البيتايين وحمض الفوليك على إنتاج اللبن، ومعايير الدم ، و مضادات الأكسدة الكلية للماعز أثناء الإجهاد الحراري. تم تقسيم 40 عنزة بلدي عشوائيا الي اربع مجموعات 10 عنزات لكل مجموعة. المجموعة الاولي للمقارنة (كنترول)، بينما تلقّت المجوعتين الثانية والرابعة مكملات البيتايين بمعدل 4 جم/رأس/يوم،كما تلقت المجموعة الثالثة والرابعة 500 ملجم/رأس/ يوم من حمض الفوليك. تم تسجيل معدل النبض ، ومعدل التنفس ، ودرجة حرارة الجلد ، ودرجة حرارة المستقيم. تم سحب عينات الدم لتقدير معايير الدم ومضادات الأكسدة الكلية. أظهرت النتائج أن البيتايين وحمض الفوليك أدى إلى انخفاض كبير في درجة حرارة المستقيم و الجلد ومعدل النبض والتنفس، بينما زاد تركيز الهيموجلوبين. زاد البيتايين وحمض الفوليك بشكل ملحوظ من بروتينات الدم الكلية ، بينما انخفضت مستويات انزيمات الكبد (AST – ALT) بشكل ملحوظ في مجموعات المعاملة عن الكنترول . زادت مضادات الأكسدة الكلية في المجموعات المعاملة بشكل كبير مقارنة بمجموعة الكنترول. بالإضافة إلى ذلك، أدت المعاملات إلى زيادة كبيرة في إنتاج اللبن ونسبة دهن وبروتين اللبن مقارنة بالكنترول. نستنتج من ذلك ان اضافة البيتايين وحمض الفوليك في علائق الماعز حسن بشكل ملحوظ من الأداء الانتاجي للماعزكما خفف من تأثير الاجهاد الحراري خلال الموسم الحار.

الكلمات الدالة: حمض الفوليك، البيتايين، الإجهاد الحراري، معايير الدم، الماعز.