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The Impacts of Maternal B Complex Vitamin Injection on Goats and Their Offspring during the Transition Period

Research Article

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ABSTRACT

The effect of maternal B complex vitamin injection on goats and their offspring was investigated in 40 pregnant Sannen goats during the transition period. The goats were randomly divided into two groups (3 years old): control group (without B complex vitamins injection); B complex vitamin group (5 mL B complex vitamins injection per goat). The B complex vitamins group were injected twice intramuscularly into goats, according to the manufacturer's recommendation, during five- and three-weeks prior kidding. According to the results, the production of colostrum and milk, as well as dry matter intake, were raised in the B complex vitamins group compared to the control group (P<0.05). The composition of colostrum and milk, as well as milk fatty acids, were not affected by the experimental treatments. The digestion of dry matter and fiber insoluble in neutral detergent in the group injected with B complex vitamins was higher (P<0.05) compared to the control group during prepartum and postpartum. The levels of B complex vitamins increased in the plasma of goats and their kids by maternal B complex vitamins injection than in the control group during the transition period (P<0.05). Higher (P<0.05) levels of low-density lipoprotein, very-low-density lipoprotein, and glucose, as well as lower (P<0.05) levels of cholesterol and high-density lipoprotein, were observed in goats injected with B complex vitamins than in the control group. However, blood plasma biochemical parameters didn't affect by maternal B complex vitamins injection in newborn kids. These results suggest that B complex vitamin injection is recommended for optimal pregnant goats.

KEY WORDS B complex vitamins, goats, injection, newborn kids, transition period.

INTRODUCTION

For many thousand years, goats have been used as a source of milk and meat in many parts of the world (Prosser, 2021). Low production costs, short generation intervals, low nutritional requirements, and a consistent milk supply appropriate for immediate consumption are some of the advantages goats provide to small communities (Miller and Lu, 2019; Toghdory *et al.* 2022).

Environmental parameters, including maternal nutrients, and hormones, as well as inherited genetic profiles, can significantly influence fetal development during pregnancy. These factors may impact long-term on the health and growth of the offspring throughout their life (Geraghty *et al.* 2015; Asadi *et al.* 2023). Increasing inflammation, oxidative stress, adipose tissue mobilization, and metabolic disorders (such as ketosis, fatty liver, and milk fever) are all associated with the perinatal period (Coleman *et al.* 2021).

Further, the rapid growth of the uterus and fetus during pregnancy, coupled with lactation, leads to increases of nutrient intake during the transition period (NRC, 2012).

The B vitamins were revealed during the first half of the 20th century when it was acknowledged that physiological and morphological changes leading to morbidity and mortality were caused by deprivation of some nutritional factors. There are eight B vitamins: vitamin B1 (thiamine), vitamin B2 (riboflavin), vitamin B3 (niacin), vitamin B5 (pantothenic acid), vitamin B6 (pyridoxine), vitamin B8 (biotin), vitamin B9 (folic acid), and vitamin B12 (cobalamin). The B vitamins are essential for the normal functioning of major metabolic pathways due to their role as coenzymes or cofactors in various biochemical reactions (Girard and Graulet, 2021). As soon as vitamins were discovered, they were equated to the amount sufficient to prevent deficiency symptoms in humans and animals (Bechdel *et al.* 1928). Rumen microorganisms produce B vitamins in ruminants (Girard and Matte, 1998). Recent studies have shown that B vitamins supplementation led to the improvement of performance, health status, blood plasma parameters, hematological status, and antioxidant status in pregnant goats and their kids (Asadi *et al.* 2023; Asadi *et al.* 2024a).

According to recent researches, the effect of maternal B complex vitamins injection has been reported on performance, hormone levels, immunity, hematology, antioxidant status, and metabolic diseases in goats and their newborn kids during the transition period (Asadi *et al.* 2023; Asadi *et al.* 2024b). However, there is no data regarding the effect of maternal B complex vitamins injection on milk, nutrient digestibility, and blood plasma biochemistry in goats and their offspring during the transition period. Therefore, this research aimed the studying the impacts of maternal B complex vitamins injection on dry matter intake, yield and composition of milk and colostrum, fatty acids of milk, nutrient digestibility, plasma biochemical parameters in the Sannen goats during the last five weeks prepartum through the first five weeks postpartum.

MATERIALS AND METHODS

All experimental procedures involving animals were approved by the Animal Welfare and Ethics Committee of Gorgan University Agricultural Science and Natural resources, Gorgan, Iran.

Animals and experimental treatments

This study was conducted on the Sannen goat farm in Gorgan Province, Iran, in 2023. A total of 40 pregnant Sannen goats (3 years old, 48±2.7 kg), were used in this research.

The goats were sonographed to B complex vitamins injection. The pregnant goats were housed in individual boxes and fed the same diet balanced by NRC (2012) during the transition period (five weeks before- and five weeks after-parturition) (Table 1). In the transition period, B complex vitamins was injected intramuscularly twice (five- and three-weeks before parturition) in each animal according to the manufacturer's recommendation. Experimental treatments were as follows: control group: without B complex vitamins injection; B complex group: injection of 5 mL of B complex vitamins per animal. As soon as the kids were born, their navels were disinfected by povidone-iodine and placed in individual pens. Afterwards, 10% of the body weight, the kids were fed through a nipple bottle, colostrum collected in the first hour after birth (Asadi *et al.* 2024c).

Colostrum and milk

A sample of 15-20 mL of goat milk was transferred to the laboratory once a week for milk composition analysis. To calculate the milk yield, the total milk samples produced in several weeks were considered. To measure colostrum yield and composition, colostrum samples were prepared once after kidding. The concentrations of protein, fat, fat/protein, lactose, solids-not-fat (FNS), total solids (TS), Ash, moisture, and somatic cells (SC) were measured in colostrum and milk, as well as C10:0, C12:0, C14:0, C15:0, C16:0, C16:l, C18:0, C18:1, C18:2, C18:3, C20:5 n-3 (EPA), C22: 6it-3 (DHA), saturated, polyunsaturated fatty acids (PUFAs), monounsaturated fatty acids (MUFAs), n-3 PUFAs, and C>20 n-3 PUFAs in milk by the Milcoscan (MilcoscanTMS50-76510) (MatÉs *et al.* 1999).

Dry matter intake and nutrient digestibility

A daily was recorded the amount of the feed intake and post-feed. Feed samples were collected for five days during the last week before parturition and the first week after parturition to analyze dry matter digestibility in goats, using the AOAC (2000) method. The chemical composition of feed samples for fiber insoluble in acid detergent (ADF) and fiber insoluble in neutral detergent (NDF) was determined by Van Soest's (1994) method. Also, crude protein (CP) was measured by a micro Kjeldahl Systems (FOSS-2300), and dry matter (DM), organic matter (OM), and ethereal extract (EE), and according to the AOAC (2000) method.

Blood plasma parameters

To measure plasma biochemical parameters, blood samples were obtained from the jugular vein of goats and their offspring one week after parturition. Afterward, blood samples were transferred to a tube containing K2EDTA (anticoagulant) (Sarstedt Polska, Warsaw, Poland). The blood samples were centrifuged at 3000 g for 10 min at room temperature to prepare plasma (Toghdory *et al.* 2023). Then, the plasma samples were stored at -20 °C until analysis.

Concentrations of cholesterol, high-density lipoprotein (HDL), low-density lipoprotein (LDL), very-low-density lipoprotein (VLDL), triglyceride, insulin, glucose, urea, total protein, albumin, globulin, albumin: globulin were measured in blood plasma of goats and newborn kids using kits manufactured by Pars Azmoun Company (Pars Azmoun, Iran), using a photometric spectrometer (UV-Vis model 365 LAMBDA, Perkinelmer, NY, USA) with the emission wavelength specific for each element (Asadi *et al.* 2022).

Statistical analysis

GLM procedure of SAS (2003) was used to analyze data collected for two treatments and 20 replicates as a completely randomized design arrangement. Duncan's multiple range test was used to compare means at a probability of 5%.

RESULTS AND DISCUSSION

Analysis data of dry matter intake (DMI), as well as production and composition of milk and colostrum in Table 2, was reported. According to the results, the DMI of goats in the B complex vitamins group was increased than in the control group (P<0.05). Higher (P<0.05) production of colostrum and milk was seen in the group injected with B complex vitamins compared to the control group during the transitional period.

However, a significant difference was not observed regarding the colostrum composition (protein, fat, lactose, SNF, TS, ash, moisture) and milk composition (protein, fat, fat/protein, lactose, SNF, TS, ash, moisture, somatic cells), between the B complex vitamins group and the control group during the transition period (P>0.05).

Table 3 shows the milk fatty acids level in Sannen goats. According to Table 3, in the transition period, fatty acids concentration of milk (C10:0, CI2:0, C14:0, C15:0, C16:0, C16:l, C18:0, C18:1, C18:2, C18:3, C20:5 n-3 (EPA), C22: 6it-3 (DHA), saturated, PUFAs, MUFAs, n-3 PUFAs, and C>20 n-3 PUFAs) no significantly difference was shown in B complex vitamins group compared to the control group (P>0.05).

The statistical analysis related to nutrient digestibility is reported in Table 4. In this regard, the digestion of DM and NDF in the group treated with B complex vitamins was higher (P<0.05) compared to the control group during the transition period. However, OM, CP, ADF, and EE were unaffected by trial groups during the transition period (P>0.05).

Table 5 shows the concentration of B vitamins in the blood plasma of goats and their kids. According to results, the levels of B vitamins, including cobalamin, pyridoxine, thiamine, folic acid, nicotinic, pantothenic, and unconjugated pteridine increased in the blood plasma of goats and their children by maternal B complex vitamins injection than in the control group during the transition period (P<0.05).

Plasma biochemical parameters of Sannen goats and newborn kids were presented in Table 6. Higher (P<0.05) levels of LDL, VLDL, insulin, and glucose, as well as lower (P<0.05) levels of cholesterol and HDL in the goats receiving B complex vitamins than the control group, were observed during the transition period. However, other plasma biochemical parameters (triglyceride, urea, total protein, albumin, globulin, and albumin: globulin) were unaffected by B complex vitamins injection in goats (P>0.05). In addition, mentioned biochemical parameters in kids unaffected by the maternal B complex vitamins injection (P>0.05).

Nutrients such as vitamins are vital for growth, maintenance, and production (Yoshii *et al.* 2019). There are a few studies in ruminants during the transition, especially goats. Therefore, in this study, we investigated the effect of maternal B complex vitamins injection in goats and their offspring during the transition period. In this research, DMI was higher in the B complex vitamins group compared with the control group. The ruminants experience severe negative energy balance after parturition due to increasing nutritional requirements for milk production and negative energy balance decreases with increasing feed intake (Serbetci *et al.* 2024). According to Vijayalakshmy *et al.* (2018) is demonstrated that B vitamins group, especially B1, B5, and B6, may increase ruminant appetite. Thus, in this study, the B complex vitamins group may decrease negative energy balance by increasing appetite (Ongan and Yuksel, 2017), reducing oxidative stress (Dalto and Matte, 2017) during the transition period, and improving animal feed intake. In agreement with these results, the DMI was higher in folic acid and vitamin B12 injected dairy cows compared with cows without injection (Preynat *et al.* 2009). It was in contrast with the studies of Girard and Matte (2005) and Duplessis *et al.* (2017), in which vitamin B12 injection did not affect DMI and milk production in dairy cows.

Milk production in ruminants is affected positively by feed intake during the lactation. Many ruminants turn catabolic during the lactation period to maintain their milk production, because they can not increase the feed intake at the same rate as milk production is increasing. Milk production has the highest priority for the ruminant during lactation, which means that almost all dietary nutrients are directed toward the mammary glands.

Table 1 Diet components of goats

Ingredient (%) DM basis-pre-partum		Ingredient (%) DM basis-post-partum	
Wheat straw	5.7	Corn silage	34
Alfalfa	32	Alfalfa	30
Corn silage	30	Corn grain	19.75
Corn grain	18.5	Soybean meal	7.75
Soybean meal	7.2	Beet pulp sugar	2
Beet pulp sugar	1	Wheat bran	2.7
Wheat bran	2.9	Fat powder	2.8
Fat powder	1.5	Calcium carbonate	0.42
Calcium carbonate	0.7	Salt	0.33
Salt	0.3	Mineral-vitamin supplement	0.25
Mineral-vitamin supplement[1]	0.2		
Chemical composition		Chemical composition	
Nutrients diet	Amount	Nutrients Diet	Amount
Metabolizable energy (Kcal/kg)	2.44	Metabolizable energy (Kcal/kg)	2.54
Crude protein (%)	14.40	Crude protein (%)	14.40
Crude fat (%)	4.10	Crude fat (%)	5.20
Non-fibrous carbohydrates (%)	32.80	Non-fibrous carbohydrates (%)	32.10
Fiber insoluble in neutral detergent (%)	44.20	Fiber insoluble in neutral detergent (%)	40.90
Starch (%)	21.60	Starch (%)	25.00
Ash (%)	7.88	Ash (%)	8.40
Calcium (%)	1.42	Calcium (%)	0.89
Phosphorus (%)	0.71	Phosphorus (%)	0.52

[1]Each kilogram contained: Ca: 140 g; P: 20 g; Mg: 35 g; S: 40 g; Mn: 1200 mg; Zn: 1000 mg; Cu: 800 mg; Co: 8 mg; I: 10 mg; Fe: 400 mg; Se: 10 mg; vitamin A: 350000 IU; vitamin D: 60000 IU; vitamin E: 4000 IU and Anionic salts: 650 g.

Table 2 The impact of maternal B complex vitamin injection on dry matter intake, yield and composition of milk and colostrum

Milk	Control	B complex	SEM	P-value
Dry matter intake (kg/day)	2.02^{b}	2.29^{a}	0.0598	0.0022
Milk yield (g/day)	3656.08^{b}	3991.25^{a}	166.433	0.0001
Protein (g/day)	33.09	33.04	0.676	0.2405
Fat (g/day)	38.76	38.44	0.414	0.3113
Fat/protein	1.17	1.16	0.017	0.8176
Lactose (g/day)	41.21	40.98	0.755	0.6715
Solid-not-fat (g/day)	74.30	74.01	1.516	0.7718
Total solid (g/day)	113.86	113.25	3.211	0.5189
Ash (g/day)	0.79	0.81	0.008	0.8196
Moisture (g/day)	886.14	886.74	23.895	0.5189
Somatic cells (SC×1000)	1133.79	1208.05	69.116	0.4416
Colostrum				
Colostrum yield (g/day)	3879.08^{b}	4041.25^{a}	202.511	0.0001
Protein (g/day)	112.01	118.02	4.274	0.4231
Fat (g/day)	56.99	55.84	2.007	0.6619
Lactose (g/day)	27.81	28.08	0.445	0.8814
Solid-not-fat (g/day)	139.82	146.10	8.776	0.6215
Total solid (g/day)	197.85	202.95	12.056	0.4291
Ash (g/day)	1.04	1.01	0.016	0.8497
Moisture (g/day)	802.15	797.05	19.214	0.6471

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 3 The impact of maternal B complex vitamin injection on fatty acids of milk (% of total fatty acid)

Fatty acids[1] of milk (28 days)	Control	B complex	SEM	P-value
C10:0	10.68	9.65	0.721	0.0901
CI2:0	5.21	4.92	0.268	0.1497
C14:0	11.99	10.84	0.406	0.0949
C15:0	0.84	0.78	0.025	0.6481
C16:0	26.82	24.90	0.782	0.5415
C16:l	1.86	2.45	0.051	0.0688
C18:0	8.29	7.84	0.417	0.5454
C18:1	26.84	29.10	2.216	0.0715
C18:2	4.85	4.44	0.067	0.7481
C18:3	0.69	0.74	0.092	0.8811
C20:5 n-3 (EPA)	052	0.58	0.041	0.0615
C22:6it-3(DHA)	0.17	0.29	0.070	0.1671
Saturated	66.85	59.86	1.981	0.0677
Polyunsaturated fatty acids	5.51	6.04	0.241	0.2621
Monounsaturated fatty acids	26.81	28.08	1.621	0.2414
n-3 polyunsaturated fatty acids	0.84	1.00	0.076	0.0816
C>20 n-3 polyunsaturated fatty acids	0.88	0.92	0.004	0.6841

[1] C10:0: capric acid; C12:0: lauric acid; C14:0: myristic acid; C15:0: pentadecanoic acid; C16:0: palmitic acid; C16:1: palmitoleic acid; C18:0: stearic acid; C18:1: oleic acid; C18:2: linoleic acid; C18:3: linolenic acid; C20:5n-3 (EPA): eicosapentaenoic acid; C22: 6it-3 (DHA): docosahexaenoic acid.
The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 4 The impact of maternal B complex vitamin injection on nutrient digestibility of goats (g/kg DMI)

Nutrient's digestibility	Control	B complex	SEM	P-value
Pre-partum				
Dry matter	640.60[b]	684.80[a]	29.446	0.0001
Organic matter	689.44	692.50	33.456	0.1978
Crude protein	622.40	624.40	16.740	0.5565
Acid detergent fiber	520.10	532.40	28.470	0.2249
Neutral detergent fiber	561.80[b]	608.40[a]	16.792	0.0001
Ethereal extract	644.30	633.87	24.841	0.4412
Post-partum				
Dry matter	714.70[b]	756.80[a]	33.012	0.0001
Organic matter	742.70	751.80	24.616	0.7128
Crude protein	648.00	660.00	21.544	0.8840
Acid detergent fiber	392.70	382.20	15.333	0.6849
Neutral detergent fiber	601.40[b]	664.50[a]	22.441	0.0001
Ethereal extract	810.70	821.10	24.119	0.8874

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 5 The effect of maternal B complex vitamins injection on concentrations of B complex vitamins of goats and their offspring

B vitamins (μg/mL)	Control	B complex	SEM	P-value
Goats				
Cobalamin	0.24[b]	0.55[a]	0.012	0.0001
Pyridoxine	27.04[b]	44.00[a]	2.006	0.0001
Thiamine	6.18[b]	11.61[a]	0.814	0.0001
Folic acid	8.21[b]	16.05[a]	1.001	0.0001
Nicotinic	61.07[b]	79.07[a]	4.991	0.0001
Pantothenic	506.92[b]	1011.77[a]	52.866	0.0001
Unconjugated pteridine	14.26[b]	40.95[a]	2.018	0.0001
Kids				
Cobalamin	0.17[b]	0.43[a]	0.010	0.0001
Pyridoxine	23.77[b]	35.92[a]	3.096	0.0125
Thiamine	4.61[b]	8.28[a]	0.901	0.0001
Folic acid	7.04[b]	12.85[a]	1.202	0.0001
Nicotinic	56.11[b]	74.96[a]	4.556	0.0001
Pantothenic	449.77[b]	881.61[a]	42.869	0.0001
Unconjugated pteridine	11.72[b]	29.84[a]	1.882	0.0001

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

Table 6 The impact of maternal B complex vitamin injection on plasma biochemical parameters

Parameters	Control	B complex	SEM	P-value
Goats				
Cholesterol (mg/dL)	55.44[a]	47.71[b]	0.681	0.0001
High-density lipoprotein (mg/dL)	34.61[a]	30.01[b]	0.499	0.0019
Low-density lipoprotein (mg/dL)	7.97[b]	9.02[a]	0.068	0.0487
Very-low-density lipoprotein (mg/dL)	4.22[b]	4.70[a]	0.711	0.0062
Triglyceride (mg/L)	24.55	26.74	1.889	0.6889
Insulin (ng/mL)	0.56	0.59	0.062	0.8014
Glucose (mmol/L)	7.26[b]	8.44[a]	0.299	0.0012
Urea (mg/L)	35.86	36.08	2.986	0.4189
Total protein (g/dL)	7.74	8.09	1.007	0.5501
Albumin (g/dL)	4.76	4.95	0.749	0.7448
Globulin (g/dL)	2.98	3.14	0.701	0.6267
Albumin:Globulin	1.59	1.57	0.088	0.4127
Kids				
Cholesterol (mg/dL)	62.41	59.76	1.251	0.6002
High-density lipoprotein (mg/dL)	34.64	35.84	0.862	0.6445
Low-density lipoprotein (mg/dL)	8.17	8.22	0.890	0.6849
Very-low-density lipoprotein (mg/dL)	4.92	4.99	0.011	0.8890
Triglyceride (mg/L)	23.33	24.42	1.842	0.2421
Insulin (ng/mL)	0.51	0.54	0.041	0.4248
Glucose (mmol/L)	7.06	7.29	0.801	0.5182
Urea (mg/L)	32.26	33.01	2.001	0.6460
Total protein (g/dL)	7.04	7.21	0.987	0.5462
Albumin (g/dL)	4.11	4.25	0.626	0.6864
Globulin (g/dL)	2.93	2.96	0.455	0.4971
Albumin:Globulin	1.40	1.43	0.056	0.4127

The means within the same row with at least one common letter, do not have significant difference (P>0.05).
SEM: standard error of the means.

When the animal increases feed intake, more energy and nutrients become available for milk synthesis, which is converted into goat growth (Strathe *et al.* 2017). Therefore, according to the above evidence, in this study, B complex vitamins increased the goats' appetite and feed intake (Vijayalakshmy *et al.* 2018), as well as reduced negative energy balance (Serbetci *et al.* 2024), leading to increased production of colostrum and milk. In agreement with this research, Girard and Matte, (1998) and Graulet *et al.* (2007) observed increase of milk yield with supplementation of B vitamins in transition period. A combination of folic acid and vitamin B-12 was injected intramuscularly once every week during the first 16 weeks of lactation tended to increase milk production in multiparous cows, according to Preynat *et al.* (2009). According to Bonomi *et al.* (1996), biotin supplementation increases milk production. Milk yield of goats is significantly was affected by biotin levels in their diet (Habeeb and Gad, 2019).

For metabolic processes such as fatty acid metabolism, B vitamins, including biotin, play a crucial role as co-factors or metabolic constituents (Duplessis *et al.* 2022). During fatty acid synthesis, biotin transports carboxyl groups to the enzyme acetyl-CoA carboxylase. In the mammary gland, this synthesis produces a variable part of C16:0, a large part of C14:0. Nearly all fatty acids with less than 14 carbons except C4:0, which can be synthesized in part by non-malonyl-CoA mechanisms (Chilliard *et al.* 2000). The current study found that B complex vitamins injections did not affect goat milk fatty acids contrary to the mechanism mentioned. It may be due to the vitamin dosage injected and animal species.

According to prior studies, improvement of DM and NDF digestibility can be related to the role of B vitamins group to improve intestinal morphology, because nutrient digestibility is closely related to villi height and width, as well as crypt depth, which can be enhanced by the influence of B vitamins (Pond *et al.* 2004). Moreover, B complex vitamins play a primary role catalyzing more than 100 distinct enzymatic reactions and the intestinal tract is one of the major sites (Yu *et al.* 2019). Therefore, in this study, we hypothesized that B complex vitamins, by improving intestinal cell division and differentiation, as well as participating in enzyme synthesis as coenzymes, contribute to the maintenance of the function and structure of the gastrointestinal tract, thereby improving the digestion of DM and NDF in the intestine (Ren *et al.* 2022). According to a study on bulls, adding riboflavin increased the degradability of DM and NDF (Wu *et al.* 2021). The NDF digestibility was increased by niacin supplementation, whereas ADF digestibility was not affected by treatment (Aschemann *et al.* 2012).

As enzymatic cofactors or metabolic constituents, all B vitamins play an important role in metabolic processes, including Kreb's cycle, gluconeogenesis, carbohydrate, fatty acid, and protein metabolism (McDowell, 2000; Zimmerly and Weiss, 2001; Al-Abbasy, 2013). In this regard, possible mechanisms involved in the increase of plasma glucose level in goats injected with B complex vitamins can be as follows: Biotin is a cofactor for the enzymes propionyl-CoA carboxylase and pyruvate carboxylase (McDowell, 2000), which are involved in glucose synthesis that increases glucose production (Zimmerly and Weiss, 2001). Additionally, niacin is key in increasing energy use and blood sugar levels (Al-Abbasy, 2013). Maintaining normal blood glucose levels is possible with pyridoxine. To maintain normal blood sugar levels when caloric intake is low, pyridoxine converts stored carbohydrates into glucose (Herrmann *et al.* 2007; Albert *et al.* 2008). Furthermore, thiamine is a co-factor in the Krebs cycle, which is responsible for the metabolism of carbohydrates. This role enables the conversion of blood sugar (glucose) into biological energy (Vijayalakshmy *et al.* 2018). In agreement with these results, plasma glucose levels significantly increased in goat blood plasma that received biotin supplementation (Habeeb and Gad, 2019). In addition, glucose levels were higher in Holstein cows that received niacin compared to the control group (Karkoodi and Tamizrad, 2009).

B vitamins are effective in fat metabolism. But there is slight information about their exact mechanisms in ruminant fat metabolism. Based on recent studies, treatment with niacin for six weeks resulted in a decrease in the concentration of total cholesterol and LDL as well as an increase in HDL in rabbits' plasma (Yang *et al.* 2008). According to Ashen *et al.* (2005), niacin therapy reduces free fatty acids, triacylglycerols, lipoproteins, and LDL while increasing HDL significantly.

CONCLUSION

It is concluded that maternal B complex vitamins injection in pregnant goats increased concentrations of B complex vitamins (cobalamin, pyridoxine, thiamine, folic acid, nicotinic, pantothenic, and unconjugated pteridine) in the blood plasma of goats and their kids. Following increasing of B complex vitamins levels, feed intake and the production of colostrum and milk increased in the goats. In addition, digestibility of DM and NDF improved in B complex vitamins group. Higher plasma levels of LDL, VLDL, and glucose and lower plasma levels of cholesterol and HDL were seen in the goats injected with B complex vitamins. However, the injection of maternal B complex vitamins unaffected on fatty acids levels of milk in pregnant goats.

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