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The Effect of Propylene Glycol and Chromium on The Productive Capacity of Dairy Cattle

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Abstract

DAIRY CATTLE management assures the integration between nutrition, biochemistry, and microbiology. Close up and post parturient stages are stressful conditions manifested by several physiological changes including feed intake, body reserves mobilization, and nutritional requirements. Chromium (Cr.) and Propylene glycol (PG) have been reported to affect energy metabolism and negative energy balance in periparturient dairy cows, respectively. Fifteen Friesian heifers were selected in the last 3 weeks of pregnancy (500 ± 5 Kg), allotted to three groups (n=5). The first group was assigned to the basal diet, the second group was fed on the basal supplemented with100 ml propylene glycol, and the third group was fed on the basal diet fortified with 10 g chromium. The highest increase milked produced was related to the addition of propylene glycol (P<0.05). The propylene glycol showed high efficacy in decreasing the problem of negative energy balance (NEB) in comparison with control group (P<0.05). After 7 weeks of the feeding trial, differential leukocyte counts showed a significant improvement referring to dietary propylene glycol and chromium supplementation. Serum glucose concentration showed the highest level within the 2nd and 8th week due to addition of propylene glycol and within the 6th week due to supplementation of Chromium. In the 8th week, serum insulin achieved a significant progression due to incorporation of Propylene glycol. During the 8th week, serum triglycerides exhibited the lowest value in the control group and the highest serum HDL value showed due to incorporation of Propylene glycol. Serum non esterified fatty acids (NEFA) displayed a significant alteration after the 7th week of the trial and chromium was more effective than propylene glycol (P<0.05). To sum up, the addition of organic chromium and propylene glycol during transition period enhanced milk yield and its components, biochemical and hematological indices and NEFA profile.

Keywords: Dairy cattle, Propylene glycol, Chromium, Productive Capacity.

Introduction

The food manufacturing sector plays a crucial role in ensuring food security, encompassing various activities such as the production of dairy products which stand out as essential dietary items for humans. Their significance has grown coincide with increased awareness of nutrition and individual incomes, resulting in ascending demand. This issue was obtained from their rich composition of essential nutrients, including various vitamins and minerals. Dairy products

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originate from farm animals such as buffaloes, cows, and goats, constituting a significant source of income in many regions. Despite this, Egypt's dairy industry remains relatively small, nonetheless, there exists ample potential for industry expansion, promising job creation and income generation for local communities. Achieving this growth necessitates further research into cattle nutrition and strategies to enhance reproductive and productive efficiency within the sector.

The high producing dairy cow requires a balanced diet that supplies sufficient needs which fulfills the demands for high production. Carbohydrates, amino acids, fatty acids, minerals, vitamins, and water, all are required nutrients by the lactating dairy cow to meet the mammary gland demand to produce milk and its components. However, developing a cow capable of achieving high milk yields lies in the nutrition provided to the calf and heifer [1].

Feeding dairy cattle involves the integration of nutrition, biochemistry, and microbiology with principles of animal husbandry. Proper feeding of post-weaned heifers is crucial to capitalize the growth achieved during the pre-weaning phase. The objective is to ensure that these heifers reach approximately 55% of their calving weight by breeding at (13-15 months) and 82%-85% of their mature weight at parturition (22-24 months). Although many farms lack scales, detecting heifer body weight accurately can be determined using weight tapes. Additionally, measuring wither heights offers straightforward way to assess the size according to the breed. Generally, taller withered heifers produce more milk at calving than shorter ones [2].

Implementing appropriate nutrition and effective management practices can be achieved by providing the cow with a comprehensive formulated diet based on their performance combined with comforTable housing and adequate water milk production. Maximizing milk production will lead to a more effective transformation of feed into milk, thereby improving nutrient utilization, minimizing waste, and contributing to the sustainability of the dairy industry [3].

Pregnancy and lactation are stressful physiological status manifested by a decrease in voluntary feed intake, intense mobilization of body reserves, and increase the nutritional requirements [4]. For dairy cows, during the final days prior to calving and immediately postpartum, a 30% dry matter intake (DMI) are usually decreased, as during this period a fetus grows rapidly and energy requirements for initiation of lactation are greatly increased, this phenomenon, so called negative energy balance (NEB), induces mobilization of body energy reserves, mainly glycogen, fat and protein to compensate for their energy needs [5, 6].

Chromium is generally accepted as an essential nutrient that potentiates insulin action and thus influences carbohydrate, lipid and protein metabolism [7]. During periods of stress, the urinary elimination of Cr rises along with the circulating levels of cortisol [8]. Cortisol acts antagonistically to insulin, decreasing glucose uptake by peripheral tissues [9]. Studies indicate that supplementing with Cr could potentially mitigate the adverse impact of stress on animals [10]. Chromium has been demonstrated to affect energy metabolism through modulating tissue responses to insulin [11]. The demand for Cr is typically increased during different forms of nutritional, metabolic, and physical stress [12]. Several studies conducted during the transition period and early lactation have demonstrated that cows fed supplemental Cr have increased milk yield and improved energy metabolism, as measured by lower circulating concentrations of NEFA or BHBA [13, 14].

Propylene glycol (PG) is a substance used to prevent negative energy balance in periparturient dairy cows [15]. It is used for prevention and treatment of ketosis in dairy cows. The use of such additional nutrients (PG) increases energy in the late phase of pregnancy due to the increase in food consumption of cattle [16]. Furthermore, it decreases NEFA concentrations and induces an equilibrium in metabolic parameters in peripartum period of cattle [17, 18]. Several studies reported beneficial effects of PG on glucose and fat homeostasis in dairy cows [19]. Nowadays, there has been a surge in the inclination towards incorporating PG as a supplement in animal feed, particularly among dairy farmers, veterinarians, and consultants. This trend can be attributed to the expanding availability of feed products from various companies, which purport to enhance milk yield, mitigate ketosis, and enhance reproductive outcomes owing to their PG component.

The objectives of this study are to determine the effects of organic chromium and propylene glycol supplementation during dairy cow transition period on milk yield and its components, biochemical and haematological indices and reproduction efficiency. Besides, estimating if the cows are meeting their nutrient requirements.

Material and Methods

Ethical Approval

Animal ethics committee, Faculty of Veterinary Medicine, Kafrelsheikh University, Egypt; affirmed and approved the protocol and conducting of the study.

Dairy cattle production trial

The present study represents a feeding trial was conducted in a dairy farm related to Animal Health Production Institute, Agriculture Research Center, Alqarada, Kafrelsheikh milk producing farm related to Animal Health Production Institute, Kafrelsheikh Province, Egypt. The study lasted for (11 weeks or 3 months) from January to April 2023. The selected cows were within the transition period in order to assess the effect of chromium and propylene glycol on milk production and milk constitutes as well as milk quality.

Cows, experimental design and diets

The basal diet contained commercial concentrated diet 16 % protein with a fixed amount of corn silage, rice straw and barseem (Alfalfa) along the experiment (10, 5 and 20 kg/day/cow, respectively) to cover the recommended requirements for energy, protein, minerals and vitamins of dairy cows during the transition period and 8 weeks postpartum [7]. The chemical composition of the concentrate diet, corn silage and barseem (Alfalfa) are presented in Table 1.

Fifteen Holstein-Friesian heifers, in the last 3 weeks of pregnancy were selected in similar weight (500 ± 5 Kg) to undergo the current study. The cows were allotted to three groups (5 per each). The first group was assigned to the basal diet (control group), the second group was fed on the basal diet after supplementation the concentrated diet with100 ml propylene glycol (Alwatania United Chemical Company) and the third group was fed on the basal diet after fortification of the concentrated diet with 10 g chromium (Biomed company).

Feeding pattern

Close up diets were fed for three weeks till parturition followed by post calving ration till end of the experiment (8 weeks postpartum). Cows were fed the post calving diet in quantities recommended to provide the expected average of the group daily milk production as reported in Table (2). Feed was offered ad libitum after parturition, while per-calving was given the close-up ration in a restricted manner. Rice straw was offered free choice. Free access of water was available. Feed consumption was recorded daily by weighing offered feed and remaining part per each group.

Sampling, measurements and analyses

Three samples from the experimental rations' components were taken for proximate analysis to formulate the calculated recommended ration before and after parturition. However, 3 samples of each group milk were taken one time at the second week post parturition for analysis of milk constituents using mid infra-red spectroscopy with a milk scan 4000 [20].

Proximate analysis of experimental diets

Proximate analysis of dietary ingredients of the experimental diet's dry matters (DM and as fed), crude protein (CP), ether extract (EE), and ash were analyzed according to [21]. However, the Neutral detergent fiber (NDF) and acid detergent fiber (ADF), were analyzed using Ankom 2000 Fiber Analyzer as described by [22].

Blood biochemistry and hematology

Blood samples were collected every two weeks postpartum (PP) from the jugular vein at four hours after morning feeding at 8:00 am. Blood samples were collected in heparinized and non-heparinized containers which centrifuged at 3000 xg for 10 min. at 4ºC to obtain serum which kept in -20 °C till used in determination of blood biochemical including cholesterol, triglyceride, LDL, HDL, vLDL, glucose, and insulin as prescribed by Johnson et al. [23, 24 and 25]. Heparinized blood samples were kept at 4ºC till be soon used for hematological parameters including (RBCs, WBCs, Hb and PCV) which determined later using a multi-species blood counter (Hema-Vet 850; CDC tech, USA).

Body and calf weight

All cows were weighed before the beginning of the trial and every 2 weeks to evaluate weight loss and energy balance. All calves are weighed immediately after calving.

Feed conversion ratio to milk.

It is the average production of the milk in the experimental period divided by the feed intake of the same period.

Milk lactose, protein and fat yield

As prescribed by [26, 27].

Milk lactose yield = Percentage of lactose produced during the period multiplied by amount of milk in the same period divided by 100.

Milk protein yield = Percentage of protein produced during the period multiplied by amount of milk in the same period divided by 100.

Milk fat yield = Percentage of fat produced during the period multiplied by amount of milk in the same period divided by 100.

Statistical analysis

Obtained data were analyzed using the statistical package SPSS for Windows XP V15.0 (SPSS Inc., Chicago, USA, 2007). The significance of differences between treated samples was evaluated using ANOVA test (Dunkan's) at $P<0.05$. When ANOVA identified differences between all groups, multiple comparisons among means were made with Duncan's new multiple range test.

Results

Weight of dairy cows

The results of the present study revealed that the weight of the dairy cows was significantly altered ($P < 0.05$) 7 Wk post-calving due to supplementation of the feed additives, propylene glycol and chromium as reported in Fig. 1.

Calf birth weight

As reported in Table 3, there was no significant difference referring to the experimental diets ($P>0.05$).

Milk yield and its constituents

The dairy cows' milk production showed significantly increase ($P < 0.05$) in the beginning of the 3rd week post-calving as compared with control (Fig. 2). The highest increase was related to the addition of propylene glycol. As prescribed in Tables 4, 5, and 6, milk fat%, protein%, and lactose% revealed non-significant difference all over the period of the experiment post-calving due to supplementation of the feed additives, propylene glycol and chromium as compared with control. However, all these constituents' milk yield were enhanced in the onset of the 3rd week post-calving regarding the addition of propylene glycol (Figs. 3, 4 and 5).

Milk to feed ratio

The milk to feed ratio disclosed non-significant difference due to supplementation of the feed additives, propylene glycol and chromium as compared with control (Table 7).

The effect on Negative energy balance (NEB)

The dairy herd along the present experimental period revealed significant auspiciously solve to the NEB from first week after parturition. Propylene glycol was a more effective additive in decreasing the problem as compared with control group (Table 8).

Hematology and blood biochemistry

The influence of dietary propylene glycol and chromium supplementation on demonstrated hematological parameters, hemoglobin, red blood cells (RBC) and white blood corpuscles (WBC) showed significant improvement in these parameters but after 7 weeks of beginning the feeding trial (Tables 9). Differential leukocyte counts as affected by dietary propylene glycol and chromium supplementation revealed significant alteration in the tried parameters but after 7 weeks of beginning of the feeding trial and chromium was more effective than propylene glycol (Table 10). Serum glucose concentration showed the highest level within the 2nd and 8th week due to addition of propylene glycol and within the 6th week due to supplementation of Chromium (Table 11). In the 8th week, serum insulin achieved a significant progression due to incorporation of Propylene glycol (Table 12). Serum total cholesterol showed its lowest value within the 8th week due to the addition of Chromium (Table 13).

During the 8th week, serum triglycerides showed the lowest value in the control group (Table 14). During the 8th week, serum HDL exhibited the highest value due to the administration of Propylene glycol (Table 15). The highest value of serum LDL was recorded due to the administration of Chromium within the 2nd, 4th and 6th weeks of the experiment (Table 16). Serum vLDL showed its highest value within the 2nd week in the control group and within the 8th week due to the administration of Propylene glycol (Table 17). As reported in Table (18), there is no significant difference on serum CHO/HDL ratio due to addition of any additives ($P>0.05$).

Serum non esterified fatty acids (NEFA) assessment

The effect of dietary propylene glycol and chromium supplementation on serum non esterified fatty acids (NEFA) displayed significant alteration in the tried parameters but after 7 weeks of beginning of the feeding trial and chromium was more effective than propylene glycol (Table 19).

Discussion

The findings regarding dry matter intake (DMI) generally align with existing literature. Hayirli et al. [28] observed a significant increase in prepartum DMI with chromium (Cr) supplementation, while McNamara and Valdez [29] noted a non-significant impact. Conversely, studies by Yang et al. [30], Smith et al. [31], and Sadri et al. [13] found no significant effect of Cr supplementation on prepartum DMI.

Regarding postpartum DMI, several studies, including those by Hayirli et al. [28], McNamara and Valdez [29], Smith et al. [31], Sadri et al. [13], and Soltan [32], reported an enhancement with Cr supplementation. However, Yang et al. [30] did not realize any effect on postpartum DMI.

Supplementing dairy cows with Cr during the periparturient period often led to increased milk yield during early lactation, as evidenced by studies conducted by Hayirli et al. [28], McNamara and

Valdez [29], Smith et al. [31], Sadri et al. [13], and Soltan [32]. However, Yang et al. [30] reported no increase in milk yield among multiparous cows. Fonseca et al. [33] found higher milk yields in the fourth and fifth lactation weeks for cows receiving propylene glycol (PG) pre and postpartum. The same result indicated by Kupczyński et al. [34] who noted increased milk yield and improved colostrum composition in cows fed PG from 3 weeks prepartum to 3 weeks postpartum. Similarly, Miettenen [35] observed higher milk yield on the second test day in treated groups, while Adamski et al. [36] reported increased milk yield with PG application. However, Baldi and Pinotti [37] found that addition of PG into concentrate increased milk yield, consistent with findings by Pickett et al. [38].

The overall effect of treatment on the percentage and yield of major milk components (e.g., fat, true protein, lactose, and total solids) did not show significant differences due to incorporating Cr or PG. Sadri et al. [13] observed a decrease in milk protein content with Cr supplementation, while McNamara and Valdez [29] noted decreased milk fat concentrations in cows fed Cr-Pro. Similarly, other studies, including those by Hayirli et al. [28], Smith et al. [31], and Soltan [32], found no significant impact of Cr supplementation on milk component percentages.

Body weight tended to be increased in cows fed Cr during the prepartum and postpartum periods with a little bit difference. On the same line, Smith et al. [31] reported that gradual increase of the incorporated Cr amounts, linearly increased postpartum BW; however, the effect of Cr on prepartum BW was not significant. However, others have reported that feeding Cr did not affect BW [28, 29, and 13]. Furthermore, no effect of treatment on BCS was detected in the current study. McNamara and Valdez [29] also reported a lack of effect of Cr-Pro on BCS, but another study showed that prepartum BCS significantly increased with increasing Cr supplementation [31].

While there were no significant overall impacts of Cr-Pro on plasma glucose levels observed during either the prepartum or postpartum phases, animals fed with Cr-Pro exhibited lower plasma glucose concentrations compared to the control group at 1 wk postpartum. Besong [39] showed that the plasma glucose level decreased after parturition, regardless of feeding Cr; however, to this point, no study has shown that supplemental Cr reduced plasma glucose concentration right after parturition. Postpartum plasma glucose concentrations were decreased linearly ($P = 0.19$) by administering increasing amounts of Cr [40], whereas milk yield was increased by supplemental Cr in the same experiment [31]. Consequently, the addition of Cr-Pro may enhance the absorption of glucose by the mammary gland or promote glucose uptake by other bodily tissues, leading to a decrease in blood glucose levels.

Kristensen et al. [41] suggested that infusion of 650 mL (mL/kg wt) Propylene Glycol to the rumen of lactating cows increases plasma glucose concentration as it increases gluconeogenic precursors and induces insulin resistance. Concentrations of glucose in serum are significantly increased postpartum to animals feed on propolyne glycol [42]. Which would have contributed to the reduction of negative energy balance (NEB) [36] or improve energy balance [43] during postpartum phase, or due to a decrease in glucose utilization by peripheral tissues, even under increased serum insulin concentrations [44]. By contrast, Garcia et al [45], Borş et al, [46] reported no change in serum glucose concentrations in cattle treated by propylene glycol.

The serum cholesterol concentrations were significantly decreased before parturition [47], this is probably related to the role of the compound in ovary steroidogenesis, so that the total cholesterol concentrations are under control of the complex of factors. Variation in blood cholesterol content has been observed during pregnancy, as a precursor of the steroid hormones [48]. This lactation stress related change in cholesterol level could be attributed to corticosteroid mediated mobilization of body reserves [49].

During late pregnancy, serum concentration of total cholesterol is increased [46]. Schlumbohm et al. [50] reported that PG supplementation has the ability to increase the cholesterol level after the end of administration due to the diminished responsiveness of target tissues towards insulin that together with an increased mobilization of fatty acids from adipose tissue make available new sources for fetal growth. Kumar et al [51] observed that low milk yielder cattle had higher serum cholesterol as compared to high milk yielder. Grummer and Carroll [52] documented the importance of cholesterol as a precursor of ovarian steroidogenesis. While the mean cholesterol concentrations result in blood were not affected by the propylene glycol (PG) treatment during transition period [16, 53 and 15].

Propylene glycol supplementation induced a significant decrease of triglyceride concentration postparturient [53, 54]. In contrast it did not affect the concentration of triglycerides as denoted by Toghdory et al. [16] and Rukkwamsuk et al. [15]. On contrast a significant decrease was observed in triglycerides concentration during the late pregnancy [55] which could be explained as the effect of increased lipolysis, which is hormonally regulated, and not an expression of energy deficiency [56]. Circulating blood triglycerides contribute significantly to milk fat synthesis [55].

Consistent with other studies [28, 40, and 32] assured that Cr-Pro supplementation during the prepartum period tended to decrease plasma NEFA concentrations. Considering that dry matter intake (DMI) showed a tendency to increase alongside the indication of decreased non-esterified fatty acids (NEFA), the decline in NEFA levels could potentially stem from heightened energy consumption. In a study by Hayirli et al. [28], it was noted that elevated serum insulin levels correlated with lower plasma NEFA concentrations in cows receiving chromium supplementation. Smith et al. [31] also reported that Cr supplementation did not affect postpartum NEFA and BHBA; however, others have reported that Cr supplementation decreased both NEFA and BHBA [30], NEFA only [28, 57].

Castaneda - Gutierrez et al. [42] demonstrated that propylene glycol PG treatment during the prepartum has increased glucose concentration and significantly decreased NEFA concentration in cattle postparturient [34, 15]. Juchem et al., [18] noted that administering glycol to cows via drenching proved to be an effective approach in lowering NEFA levels, likely due to the suppression of adipose adenylate cyclase activity and lipolysis caused by increased insulin concentrations.

Nielsen and Ingvartsen [19] suggested that the propylene glycol reduces NEFA in cows that are too fat at calving. Propylene glycol seemed to exert a greater effect on NEFA via insulin during extensive body fat mobilization, for example the periparturient period [58] or feed restriction.

On contrast, the insignificant decreased effect of PG supplementation in transition period on the concentration of NEFA before and after calving was recorded by Mikula et al. [53] and Moallem et al. [59]. Kabu and Civelek [60] recorded the increased level of NEFA was found in blood of cows receiving propylene glycol as compared to prepartum period and remained elevated during the postpartum period. Nevertheless, the observed increased level of NEFA did not indicate excessive lipolysis [36]. It can indicate short-term negative energy balance and adipose tissue catabolism [61]. No significant effect of propylene glycol treatment in the periparturient period on NEFA concentrations was detected during prepartum and postpartum periods [42].

Conclusions

We conclude that the addition of propylene glycol and chromium had improved milk yield and milk constituents' contents. In addition, they modified the blood parameters and biochemistry, and helped in relieving the negative energy balance state and improving NEFA profile.

Conflicts of interest

The authors declared no competing interests.

Funding statement

Not applicable

Table 1. Chemical composition of feed ingredients on as fed basis:

Nutrient	Concentrate diet	Corn silage	Trifolium alex (Barseem)	Rice straw
Dry matter	89.3	33	14.49	91.5
Crude protein	15.3	8.15	17.3	3.8
Ether extract	1.94	3.1	2.4	1.3
Crude fiber	13.6	22.2	27.3	32.1
Calcium	0.93	0.22	1.4	0.22
Phosphorus	0.51	0.21	0.22	0.08
TDN	68	70	63	44

Table 2. The amount of concentrated feed intake related to the amount of milk produced.

Items	Groups	1st week	2nd week	3rd week	4th week	5th week	6th week	7th week	8th week	PSE*	Linear (Pr>F)	Treatment*Weeks
Milk production (kg/cow/day)	Control	11.45	12.95^{c}	15.33^{c}	18.82^{c}	18.87^{c}	20.72^{c}	19.25^{c}	18.29^{c}	0.071	0.001	
	Propylene glycol	11.64	14.34^{a}	17.85^{a}	22.25^{a}	23.33^{a}	24.38^{a}	24.61^{a}	24.35^{a}	0.071	0.001	0.001
	Chromium	11.54	13.68^{b}	16.74^{b}	21.29^{b}	22.49^{b}	22.48^{b}	22.65^{b}	22.26^{b}	0.071	0.001	
Concentrate level (kg/cow/day)	Control	6.20	6.52^{b}	7.28^{b}	9.31^{c}	9.48^{b}	10.45^{c}	9.29^{c}	9.40^{c}	0.148	0.001	
	Propylene glycol	6.37	7.26^{a}	8.46^{a}	11.46^{a}	11.29^{a}	12.44^{a}	12.43^{a}	12.55^{a}	0.148	0.001	0.001
	Chromium	6.27	6.62^{b}	8.31^{a}	10.45^{b}	11.57^{a}	11.21^{b}	11.38^{b}	11.17^{b}	0.148	0.001	

*Pooled standard error

Table 3. Calf birth weight (kg/calf) as affected by dietary propylene glycol and chromium supplementation.

Group	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Calves birth weight (kg)	33.50±1.04[a]	35.75±0.85[a]	34.75±0.78[a]	0.259

Row different superscripts mean significant difference at $p < 0.05$

Table 4. Milk fat% as affected by dietary propylene glycol and chromium supplementation.

Period/week	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
0-2nd week	3.39±0.18[a]	3.33±0.13[a]	3.31±0.15[a]	0.17
2nd -4th week	3.31±0.18[a]	3.29±0.13[a]	3.25±0.15[a]	0.12
4th -6th week	3.24±0.18[a]	3.24±0.13[a]	3.19±0.15[a]	0.22
6th -8th week	3.22±0.18[a]	3.25±0.11[a]	3.19±0.14[a]	0.96
Average	3.29±0.04[a]	3.28±0.02[a]	3.23±0.03[a]	0.46

Row different superscripts mean significant difference at $p < 0.05$

Table 5. Milk protein% as affected by dietary propylene glycol and chromium supplementation.

Period/week	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
0-2nd week	3.21±0.11[a]	3.11±0.04[a]	3.13±0.06[a]	0.18
2nd -4th week	3.08±0.11[a]	3.04±0.04[a]	3.25±0.24[a]	0.14
4th -6th week	2.95±0.11[a]	2.96±0.04[a]	2.94±0.06[a]	0.15
6th -8th week	2.97±0.11[a]	2.98±0.04[a]	2.95±0.06[a]	0.95
Average	3.05±0.06[a]	3.02±0.03[a]	3.01±0.04[a]	0.87

Row different superscripts mean significant difference at $p < 0.05$

Table 6. Milk lactose% (kg/cow/day) as affected by dietary propylene glycol and chromium supplementation.

Period/week	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
0-2nd week	4.70±0.05[a]	4.85±0.10[a]	4.82±0.11[a]	0.16
2nd -4th week	4.83±.03[a]	4.91±0.10[a]	4.91±0.10[a]	0.17
4th -6th week	4.96±0.06[a]	4.97±0.10[a]	4.96±0.11[a]	0.16
6th -8th week	4.93±0.06[a]	4.95±0.10[a]	4.94±0.11[a]	0.99
Average	4.86±0.06[a]	4.92±0.03[a]	4.90±0.03[a]	0.61

Row different superscripts mean significant difference at $p < 0.05$

Table 7. Milk to feed ratio as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
0-1st week	0.67±0.03a	0.69±0.03a	0.68±0.03a	0.92
1st-2nd week	0.75±0.03a	0.79±0.03a	0.78±0.03a	0.67
2nd-3rd week	0.83±0.04c	0.92±0.04a	0.88±0.04b	0.000
3rd-4th week	0.92±0.04a	1.04±0.05a	1.01±0.04a	0.145
4th-5th week	0.95±0.04a	1.06±0.05a	1.04±0.04a	0.17
5th-6th week	1.00±0.04a	1.08±0.05a	1.04±0.04a	0.43
6th-7th week	0.96±0.04a	1.10±0.05a	1.05±0.04a	0.12
7th-8th week	0.92±0.04c	1.08±0.05a	1.04±0.04b	0.047
Average	0.88±0.06c	0.99±0.09a	0.95±0.08b	0.63

Row different superscripts mean significant difference at $p < 0.05$

Table 8. Effect dietary propylene glycol and chromium supplementation on Negative energy balance (NEB) of dairy herd along the experimental period

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
0-2nd week	-2.82 ±0.36a	-1.92 ±0.24b	-2.22±0.28a	0.015
2nd -4th week	3.54±0.44c	7.80±0.38a	6.93±0.58b	0.000
4th -6th week	8.18±0.48c	13.16±0.41a	11.20±0.47b	0.000
6th -8th week	7.15±0.44c	14.30±0.42a	11.44±0.44b	0.00
Average	1.79±0.11c	3.57±0.10a	2.86±0.11b	0.00

Row different superscripts mean significant difference at $p < 0.05$

Table 9. Blood picture as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Hb%				
Hb (1st - 2nd wk)	10.03±0.53a	11.80±1.10 a	11.15±1.25a	0.53
Hb (2nd - 4th wk)	11.23±0.42a	14.17±1.39a	14.97±1.19a	0.108
Hb (3rd - 6th wk)	12.80±0.76a	14.33±1.72a	13.55±1.18a	0.73
Hb (4th – 8th) wk	11.30±0.32b	15.23±0.35a	10.77±0.69c	0.001
RBCs				
RBCs (1st – 2) wk	2.01±0.11a	2.36±0.22a	2.23±0.25a	0.53
RBCs (2nd- 4th) wk	2.25±0.08a	2.83±0.28a	3.00±0.24a	0.109
RBCs (3rd -6th) wk	2.56±0.15a	2.87±0.35a	2.71±0.24a	0.72
RBCs (4th - 8th) wk	2.26±0.06b	3.05±0.07a	2.15±0.14b	0.001
PCV%				
PCV% (1st – 2) wk	33.10±1.75 a	38.94±3.63 a	36.80±4.13a	0.53
PCV%(2nd-4th) wk	37.07±1.38a	46.75±4.57a	49.50±4.03a	0.109
PCV%(3rd-6th) wk	42.24±2.50a	44.72±3.89a	44.72±3.89a	0.72
PCV%(4rd-8th) wk	37.29±1.06b	50.27±1.15a	35.53±2.27c	0.001
WBCs				
WBCs (1st – 2) wk	7.30±0.40 a	7.70±0.20 a	7.90±0.50 a	0.59
WBCs(2nd-4th) wk	7.40±0.62a	8.10±0.29a	8.27±0.24a	0.366
WBCs(3rd-6th) wk	7.23±0.26a	7.87±0.50a	7.93±0.19a	0.31
WBCs(4rd-8th) wk	7.10±0.17b	8.40±0.21a	7.90±0.35b	0.031

Row different superscripts mean significant difference at $p < 0.05$

Table 10. Differential leukocyte counts as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Neutrophil%				
Neutrophil% 2wk	62.75±0.85[a]	52.85±2.85[a]	60.15±3.05[a]	0.13
Neutrophil% 4wk	58.70±2.86[a]	59.70±2.52[a]	54.83±2.72[a]	0.453
Neutrophil% 6wk	60.23±4.24[a]	55.47±1.53[a]	56.08±3.93[a]	0.64
Neutrophil% 8wk	55.00±6.75[a]	42.47±0.46[c]	51.67±3.34[b]	0.190
Eosinophil%				
Eosinophil% 2wk	2.45±0.35[a]	2.65±1.55[a]	4.55±0.35 [a]	0.35
Eosinophil% 4wk	3.00±0.81[a]	2.37±0.79[a]	3.13±1.29[a]	0.847
Eosinophil% 6wk	2.77±0.87[a]	2.87±0.57[a]	2.55±0.20[a]	0.91
Eosinophil% 8wk	1.77±0.43[c]	3.03±0.15[b]	5.20±2.00[a]	0.197
Monocyte%				
Monocyte% 2wk	4.15±0.75[a]	6.15±0.45[a]	7.60±0.4[a]	0.77
Monocyte% 4wk	6.07±1.29[a]	4.97±0.78[a]	8.93±2.88[a]	0.368
Monocyte% 6wk	6.53±1.62[a]	8.70±30.65[a]	5.85±2.02[a]	0.31
Monocyte% 8wk	5.73±2.45[a]	6.00±1.66[a]	5.03±5.85[a]	0.98
Lymphocyte%				
Lymphocyte% 2wk	30.65±0.45[c]	38.35±2.75 [a]	27.70±0.60[b]	0.04
Lymphocyte% 4wk	32.17±3.79[a]	32.97±1.21[a]	33.10±2.27[a]	0.964
Lymphocyte% 6wk	30.43±2.33[a]	34.37±1.45[a]	35.53±2.34[a]	0.29
Lymphocyte% 8wk	37.50±4.31[b]	48.50±1.50[a]	38.07±1.46[b]	0.052
N/L Ratio				
N/L Ratio 2wk	2.05±0.06[b]	1.38±0.03[c]	2.17±0.06 [a]	0.003
N/L Ratio 4wk	1.90±0.35[a]	1.82±0.15[a]	1.68±0.19[a]	0.810
N/L Ratio 6wk	1.59±0.13[a]	1.62±0.12[a]	1.63±0.24[a]	0.99
N/L Ratio 8wk	1.55±0.36[a]	0.88±0.03[a]	1.36±0.09[a]	0.150

Row different superscripts mean significant difference at $p < 0.05$

Table 11. Serum glucose concentration as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Glucose 2nd wk	58.09±9.93[c]	65.37±3.93[b]	73.81±2.66[a]	0.04
Glucose 4th wk	61.76±7.24[b]	69.66±0.69[a]	59.61±5.13[c]	0.041
Glucose 6th wk	91.83±7.16[c]	102.37±6.67[b]	107.39±4.19[a]	0.02
Glucose 8th wk	97.36±3.38[c]	118.27±6.86[a]	101.83±5.41[b]	0.05
Average glucose	79.00±6.15[c]	91.06±7.31[a]	86.24±6.40[b]	0.046

Row different superscripts mean significant difference at $p < 0.05$

Table 12. Serum insulin level as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Insulin 2nd wk	3.30±0.10[a]	4.40±1.30[a]	2.85±0.05[a]	0.43
Insulin 4th wk	2.40±0.29[a]	1.83±0.12[a]	2.23±0.31[a]	0.40
Insulin 6th wk	5.57±1.73[a]	6.97±2.97[a]	6.25±1.46[a]	0.900
Insulin 8th wk	2.40±0.75[b]	5.90±0.40[a]	2.83±0.32[b]	0.006
Average insulin	3.43±0.62[a]	4.81±0.96[a]	3.71±0.65[a]	0.413

Row different superscripts mean significant difference at $p < 0.05$

Table 13. Serum total cholesterol (CHO) concentration as affected by dietary propylene glycol and chromium supplementation.

Group / Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
CHO 2nd wk	181.25±1.11[a]	188.60±17.28[a]	196.68±12.13[a]	0.70
CHO 4th wk	190.42±32.34[a]	186.27±12.13[a]	199.26±10.95[a]	0.81
CHO 6th wk	184.91±6.94[a]	180.08±12.69[a]	197.385.58[a]	0.35
CHO 8th wk	215.92±7.01[a]	208.38±12.15[b]	167.08±9.58[c]	0.02
Average CHO	194.58±7.24[a]	191.04±6.52[a]	190.86±5.59[a]	0.9

Row different superscripts mean significant difference at $p < 0.05$

Table 14. Serum triglyceride concentration as affected by dietary propylene glycol and chromium supplementation.

Group Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
Triglyceride 2nd wk	201.55±18.67[a]	181.04±14.38[a]	172.22±13.40[a]	0.48
Triglyceride 4th wk	201.96±7.17[a]	214.81±2.15[a]	201.94±6.54[a]	0.30
Triglyceride 6th wk	242.26±1.43[a]	241.17±3.46[a]	233.33±7.43[a]	0.48
Triglyceride 8th wk	178.86±5.68[c]	234.42±8.79[a]	215.46±3.42[b]	0.002
Average triglyceride	206.57±8.23[a]	221.21±7.41[a]	210.15±6.69[a]	0.30

Row different superscripts mean significant difference at $p < 0.05$

Table 15. Serum HDL concentration as affected by dietary propylene glycol and chromium supplementation.

Group Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
HDL 2nd wk	47.29±0.52[a]	47.80±3.52[a]	48.17±4.33[a]	0.98
HDL 4th wk	39.38±0.52[a]	46.11±6.09[a]	38.85±1.34[a]	0.17
HDL 6th wk	40.61±2.98[a]	44.46±1.08[a]	45.11±1.25[a]	0.25
HDL 8th wk	39.34±1.54[b]	49.07±2.60[a]	35.72±1.15[c]	0.006
Average HDL	41.14±1.22[b]	46.84±1.42[a]	41.49±1.51[b]	0.016

Row different superscripts mean significant difference at $p < 0.05$

Table 16. Serum LDL concentration as affected by dietary propylene glycol and chromium supplementation.

Group *Experiment Wk*	*Dietary supplementation*			*P-value*
	Control	*Propylene glycol*	*Chromium*	
LDL 2nd wk	93.65±5.35[c]	104.60±17.92[b]	114.07±13.77[a]	0.05
LDL 4th wk	109.10±30.93[b]	101.63±24.85[c]	120.02±9.39[a]	0.05
LDL 6th wk	95.85±9.60[b]	87.38±12.43[c]	105.60±5.60[a]	0.03
LDL 8th wk	140.81±8.86[a]	119.94±16.34[b]	88.26±11.25[c]	0.04
Average LDL	111.55±8.79[a]	101.61±8.02[c]	107.34±5.32[b]	0.05

Row different superscripts mean significant difference at $p < 0.05$

Table 17. Serum very LDL concentration as affected by dietary propylene glycol and chromium supplementation.

Group Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
vLDL 2nd wk	40.31±3.73[a]	36.21±2.88[b]	34.44±2.68[b]	0.048
vLDL 4th wk	41.44±1.70[a]	43.07±0.72[a]	40.39±1.31[a]	0.47
vLDL 6th wk	48.45±0.29[a]	48.23±0.69[a]	46.67±1.49[a]	0.48
vLDL 8th wk	35.77±1.14[c]	46.21±2.81[a]	43.09±0.68[b]	0.009
Average vLDL	41.62±1.79[a]	43.96±1.76[a]	42.03±1.34[a]	0.58

Row different superscripts mean significant difference at $P < 0.05$

Table 18. Serum CHO/HDL ratio as affected by dietary propylene glycol and chromium supplementation.

Group Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
CHO/HDL ratio 2nd wk	3.83±0.07[a]	3.99±0.66[a]	4.14±0.62[a]	0.92
CHO/HDL ratio 4th wk	4.78±0.85[a]	4.27±0.99[a]	5.13±0.27[a]	0.58
CHO/HDL ratio 6th wk	4.62±0.48[a]	4.05±0.26[a]	4.38±0.06[a]	0.43
CHO/HDL ratio 8th wk	5.51±0.33[a]	4.34±0.63[a]	4.70±0.41[a]	0.24
Average CHO/HDL ratio	4.76±0.28[a]	4.15±0.24[a]	4.65±0.17[a]	0.17

Row different superscripts mean significant difference at $P < 0.05$

Table 19. Serum Non esterified fatty acids (NEFA) as affected by dietary propylene glycol and chromium supplementation.

Group Experiment Wk	Dietary supplementation			P-value
	Control	Propylene glycol	Chromium	
NEFA 2wk	0.68±0.04[a]	0.74±0.03[a]	0.53±0.14[a]	0.316
NEFA 4wk	0.91±0.02[a]	0.85±0.01[a]	0.82±0.04[a]	0.139
NEFA 6wk	0.80±0.04[a]	0.74±0.01[a]	0.73±0.04[a]	0.385
NEFA 8wk	0.87±0.01[a]	0.59±0.03[c]	0.76±0.03[b]	0.000
Average NEFA	0.83±0.03[a]	0.73±0.03[b]	0.73±0.04[b]	0.05

Row different superscripts mean significant difference at $p < 0.05$.

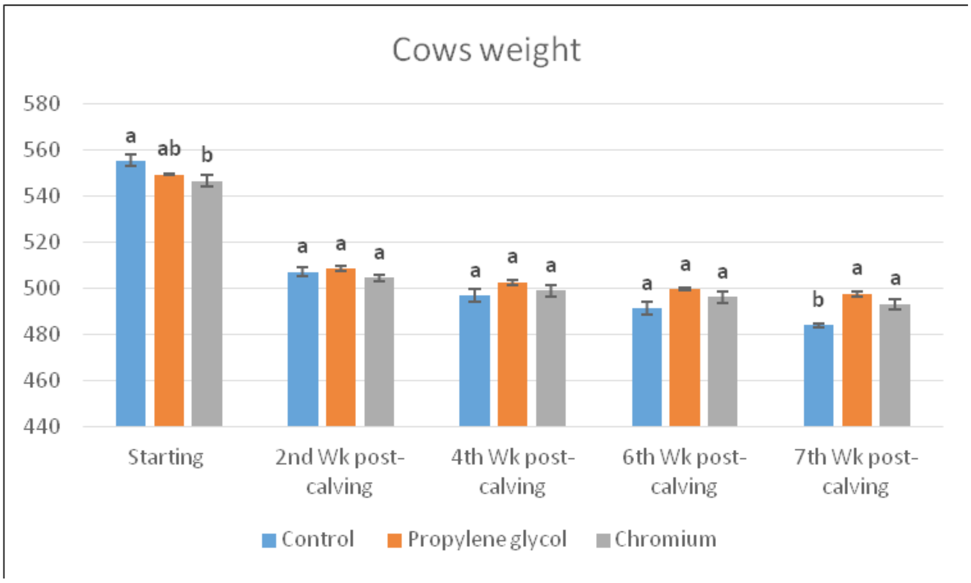

Fig. 1. Body weight of dairy cows (kg/head/day) as affected by dietary propylene glycol and chromium supplementation.

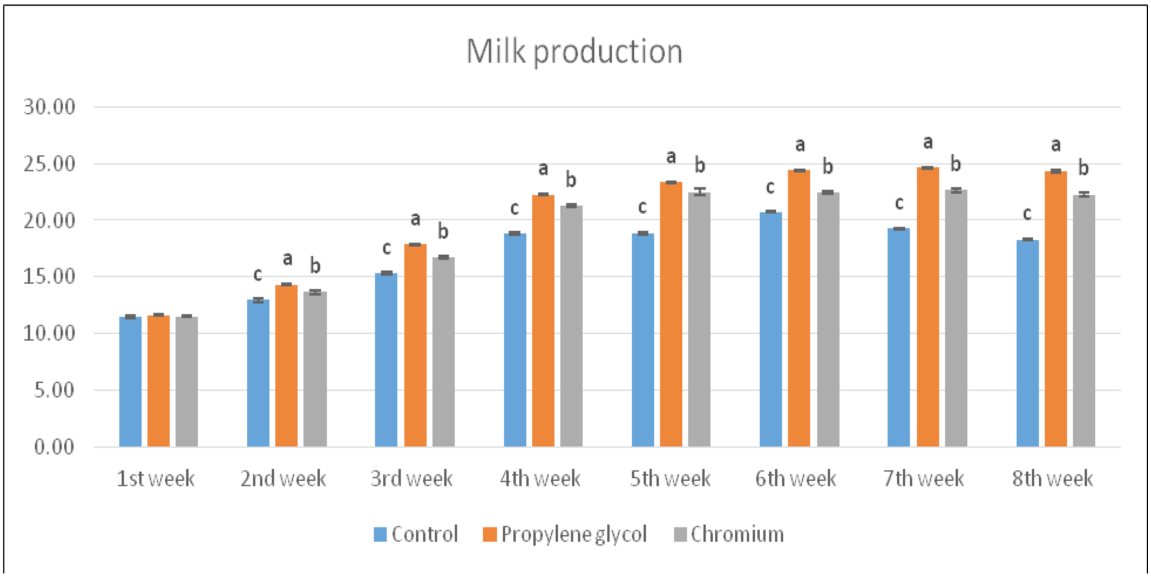

Fig. 2. Milk production of dairy cows (kg/head/day) as affected by dietary propylene glycol and chromium supplementation.

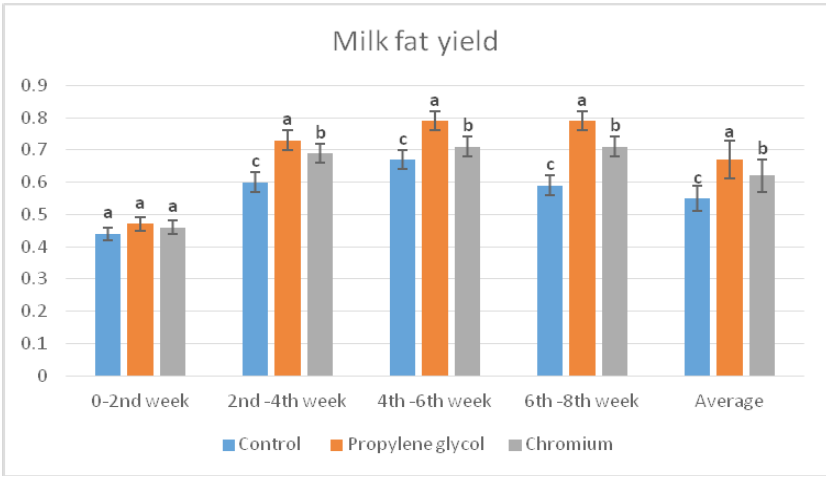

Fig. 3. Milk yield (kg/cow/day) as affected by dietary propylene glycol and chromium supplementation.

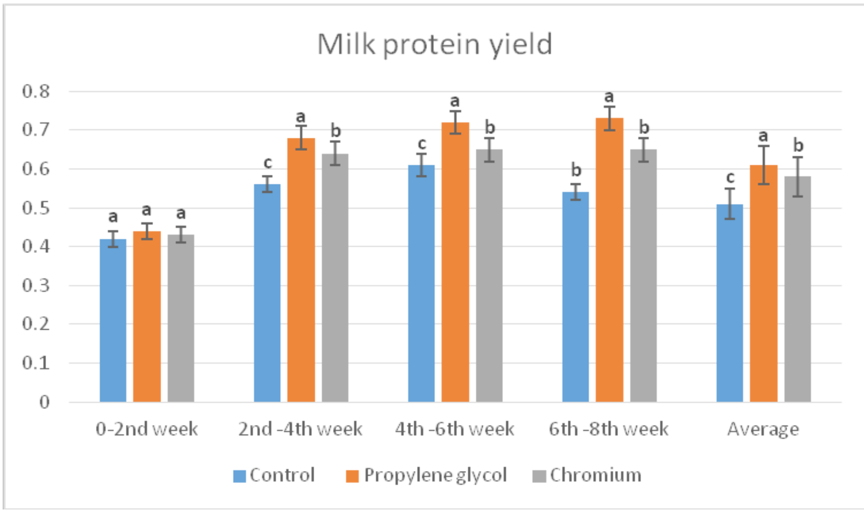

Fig. 4. Milk protein yield (kg/cow/day) as affected by dietary propylene glycol and chromium supplementation.

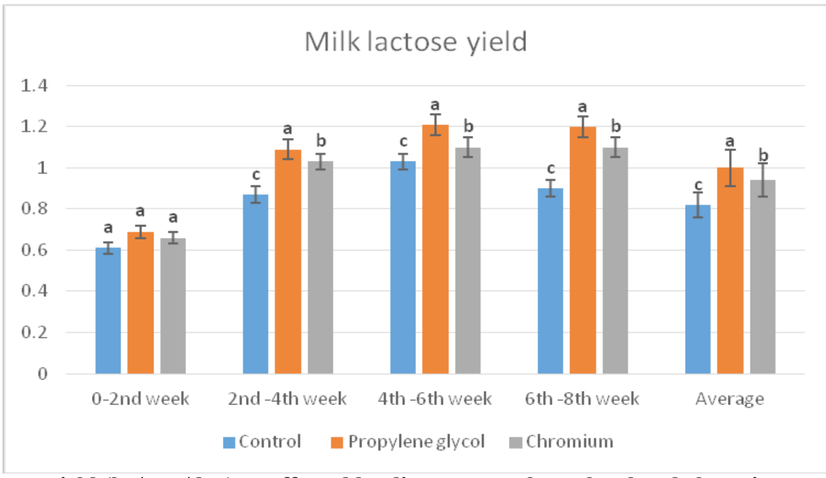

Fig. 5. Milk lactose yield (kg/cow/day) as affected by dietary propylene glycol and chromium supplementation.

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تأثير البروبيلين جليكول والكروم على القدرة الإنتاجية للأبقار الحلاب

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تضمن إدارة ماشية الألبان التكامل بين التغذية والكيمياء الحيوية وعلم الأحياء الدقيقة. تعد المراحل القريبة وما بعد الولادة من الظروف العصيبة التي تتجلى في العديد من التغيرات الفسيولوجية بما في ذلك تناول الطعام، وتعبئة احتياطيات الجسم، والمتطلبات الغذائية. تم الإبلاغ عن أن الكروم (Cr.) والبروبيلين غليكول (PG) يؤثران على استقلاب الطاقة وتوازن الطاقة السلبي في أبقار الألبان المحيطة بالولادة، على التوالي. تم اختيار خمسة عشر بقرة فريزيان في الأسابيع الثلاثة الأخيرة من الحمل (500 ± 5 كجم)، وزعت على ثلاث مجموعات (العدد = 5). غذيت المجموعة الأولى على العليقة الأساسية، والمجموعة الثانية غذيت على العليقة القاعدية المدعمة بـ 100 مل بروبيلين جلايكول، والمجموعة الثالثة غذيت على العليقة الأساسية المدعمة بـ 10 جرام كروم. أعلى زيادة في إنتاج الحلب كانت مرتبطة بإضافة البروبيلين جليكول (P<0.05). كشفت نسبة دهون الحليب، ونسبة البروتين، ونسبة اللاكتوز عن اختلافات غير معنوية خلال فترة التجربة. أظهر البروبيلين جليكول فعالية عالية في تقليل مشكلة توازن الطاقة السلبي (NEB) مقارنة بمجموعة السيطرة (P<0.05). بعد الأسابيع السابعة من تجربة التغذية، أظهر تعداد الكريات البيض التفاضلي تحسنًا ملحوظًا عند استخدام البروبيلين غليكول الغذائي ومكملات الكروم. أظهر تركيز الجلوكوز في الدم أعلى مستوى خلال الأسبوع الثاني والثامن بسبب إضافة البروبيلين جليكول وخلال الأسبوع السادس بسبب إضافة الكروم. في الأسبوع الثامن، حقق الأنسولين في الدم تقدمًا ملحوظًا بسبب دمج البروبيلين غليكول. خلال الأسبوع الثامن، أظهرت الدهون الثلاثية في الدم أقل قيمة في المجموعة الضابطة وأظهرت أعلى قيمة HDL في الدم بسبب دمج البروبيلين غليكول. أظهرت الأحماض الدهنية غير الأسترة في المصل (NEFA) تغيرًا ملحوظًا بعد الأسبوع السابع من التجربة وكان الكروم أكثر فعالية من البروبيلين جليكول (P <0.05). خلاصة القول، إن إضافة الكروم العضوي والبروبيلين جليكول خلال الفترة الانتقالية أدى إلى تحسين إنتاج الحليب ومكوناته والمؤشرات البيوكيميائية والدموية وملف NEFA.

الكلمات الدالة: ماشية الألبان، بروبيلين جلايكول، كروم، مكون الحليب، NEFA