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Effect of dietary cobaalt suupementation during late gestation and early lactation of friesian cow on:
2-productive, reproductive performance and economical efficiency

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ABSTRACT

Twenty lactating multifarious cows were divided into four groups, 5 in each. Cows in the 1st group (G1) were fed a control diet; while those in G2, G3 and G4 were fed the control diet supplemented with 0.19, 0.57 and 0.93 mg Co /kg diet on DM of concentrate feed mixture, respectively.This experiment aim to study to evaluate the effect of dietary cobalt (Co) supplementation at different levels on digestibility, milk production, some blood parameters of Friesian cows, growth performance of their offspring. and Economical efficiency.

Total and Average daily milk yield (TMY, ADMY) as well as composition of milk was individually recorded. Blood samples were individually taken pre-partum and 30 and 60 day-postpartum for determination of Co, Fe, Cu and Zn contents and total cholesterol (CHO), IgG and estradiol concentrations in blood serum. Postpartum first estrous interval (PPFEI), conception rate (CR) after artificial insemination, number of services per conception (NSC), and days open (DO) were recorded. After calving, live body weight (LBW) of calves was recorded and average daily gain (ADG) was calculated during the suckling period

Results indicated that, the rations supplemented with cobalt were high palatable in DM intake. Also, the digestibility's of all nutrients for the same rations were significantly (P<0.05) higher than those of control (CR). The feeding values as TDN appeared to the same trend of digestibility coefficients, with significantly (P<0.05) with DCP for tested ration to increase with no significant different. The ADMY for 35 lactation weeks was not affected significantly by dietary Co. ADMY and TMY were the highest (P<0.05) in G3 (11.76 and 4034.3 kg) with the longest (P<0.05) lactation period. Milk in G3 showed lower (P<0.05) fat content (4.90%) than in G1 (5.78%), G2 (5.63%) and G4 (5.67%) with the highest (P>0.05) protein and lactose contents (4.55 and 6.83%) as compared to other groups (4.44-4.50 and 6.65-6.75%), respectively. Prepartum Zn content increased (P<0.05) in G3 and G4 as compared to G1 and G2. The effect of Co on mineral contents and on CHO and IgG concentrations was not significant within 30 day-postpartum. Within 60 day-postpartum, Cu content and IgG concentrations decreased (P<0.05) in Co supplemented groups than in G1, while Fe decreased (P<0.05) only in G3. Cows in G3 showed the shortest (P<0.05) PPFEI (40 d) and DO (78.7 d) and decreased (P<0.05) NSC (2.5 serv.). CR within 120 day-postpartum was 80% in G1 and G3, and 60% in G2 and G4. LBW and ADG of calves were higher (P<0.05) in G2 and G3 than in G4 and G1. Dietary Cobalt Supplementation tended to higher economical efficiency and with improving in economical return. In conclusion, there was tendency of increasing milk production and improve reproductive performance of dairy cows fed diet supplemented with 0.57 mg/kg diet as well as improving LBW and weight gain of their offsprings from birth up to 16 wk of age.

Keywords: Friesian Cows, Cobalt, Digestibility, milk yield and composition, blood parameters, Growth performance, and Economical efficiency

INTRODUCTION

Cobalt (Co) is an essential trace element in ruminant diets for the production of vitamin B12 (cobalamin) by the rumen microbes to fulfill the vitamin B12 requirements of both the ruminal bacteria and the host animal (McDowell, 1992). Elemental Co is absorbed through the intestinal tract (Wapnir, 1990) and transported in blood to various tissues. The liver contains the highest concentration of Co within tissues and is considered the main storage site (Underwood and Suttle, 1999).

In ruminants, the relative production of cobalamin is affected by the dietary content of Co (Sutton and Elliot, 1972) and the efficiency of production of vitamin B12 from Co is low, only about 3% (Smith and Marston, 1970). Serum B12 concentration was found to decline during late pregnancy in cows as a result of lowered feed intake in the early dry period and increased transfer of B12 to the growing fetus (Kincaid and Socha, 2007). Therefore, ruminal synthesis of vitamin B12 is increased by higher concentrations of dietary Co (Mills, 1981). In this respect, synthesis of vitamin B12 increased as the dietary Co concentration increased from 0.1 to 1.0 mg/kg (Tiffany *et al*., 2006).

Secretion of B12 into milk is a drain on maternal reserves of B12; consequently, serum and liver B12 concentrations are reduced in early lactation (Elliot *et al*., 1965). In this way, Elliot *et al*. (1979) reported that vitamin B12 in blood is reduced in cows during early lactation. The dietary requirement for Co is 0.11 mg/kg of diet dry matter of dairy cattle (NRC, 2001) and 0.15-0.25 mg/kg diet dry matter of fattening cattle (Tiffany *et al*., 2003).

Increased Co in ruminant diets has been reported to increase the percentage of elemental Co in liver, which contains the highest concentration of Co within tissues and is considered the main storage site (Underwood and Suttle, 1999). As reported earlier, Co concentrations in serum and liver were significantly ($P<0.05$) correlated ($r = 0.74$), and supplemental dietary Co did not increase Co storage in the liver (Kincaid *et al*., 2003). Moreover, in a series of studies with dairy cattle, Kincaid and Socha (2007) found that liver Co concentration was not affected by either Co intake or postpartum day. Also, the concentrations of Cu, Zn and IgG in serum of cows were not affected by Co intakes. Moreover, Kincaid *et al*. (2003) indicated that the addition of supplemental dietary Co (supplemental Co ranged from approximately 15 to 30 mg per day did not affect Co concentrations in liver or serum or serum concentrations of vitamin B-12 within 140 days. Also, there was no effect of Co supplementation at low, medium and high levels on concentration of Cu, Zn and Fe in blood serum or whole blood of dairy cows.

In Egypt, the information on the dietary requirements of lactating Friesian cows from Co is scare. Thus, the aim of this study was to evaluate the effect of dietary Co supplementation at different levels (0.19, 0.57 and 0.93 mg/kg diet) during pre- (50-60 days) and post-partum (120 days) on Feed intake, Nutrients digestibility and feeding values, milk production, some blood parameters and reproductive performance of dairy cows, in addition to growth performance of their offsprings and Economical efficiency.

MATERIALS AND METHODS.

This study was conducted at El-Karada Experimental Station, Animal Production Research Institute, Agriculture Research Center, Egypt, to study the effect of different levels of cobalt (Co) supplementation at different levels on Feed intake digestibility, milk production, some blood parameters of Friesian cows, and growth performance of their offspring and Economical efficienc.

Feeding trail:

Twenty lactating Friesian cows with 436-450 kg live body weight (LBW) and within 2-3 parities were used in this study. Cows were divided according LBW, milk yield and parity in a completely randomized block design into four similar groups (5 in each). Cows in the 1st group (G1) were fed a control diet without supplementation, while those in the 2nd (G2), 3rd (G3) and 4th (G4) groups were fed the control diet supplemented with 0.19, 0.57 and 0.93 mg/kg diet of cobalt mineral(cobalt sulphate 20%) on dry matter of concentrate feed mixture (CFM), respectively. All animals were kept under the same conditions, being under semi-open sheds.

Animals were fed individually according to NRC (2001). The control diet consisted of CFM, corn silage (CS), rice straw (RS) and berseem hay (BH). Roughage concentrate ratio was nearly 1:1. Nutrient requirements were adjusted every two weeks according to changes in body weight and milk yield. The experimental feeding period from 50-60 days pre-partum up to 120 day-post-partum.

The CFM used in this study was in pelleted form (16% CP, 15.0% CF and 65% TDN) and was composed of 34% uncorticated cotton seed meal, 33% wheat bran, 28% yellow corn, 3% molasses, 1.5% limestone and 0.5% common salt. The chemical analysis of feed stuffs is shown in Table 1.

The CFM was offered to cows in all groups twice daily at 8 am. and 4 pm, while CS, BH and RS were offered once daily during the morning feeding. All animals were allowed to drink fresh water three times daily and kept under the routine veterinary management.

Digestibility trail:

During the milk collection period for each treatment, the nutrient digestibility and feeding value were determined by chosen three Friesian cows randomly, using, acid in soluble ash (A I A) technique of Van keulen and Young (1977). Feeds feces and milk samples were analyzed according to A.O. A.C (1990).

Table 1. Ingredients of concentrate feed mixture (CFM) and chemical analysis (on DM basis) of different feed stuffs in the basal diet.

Nutrient	Concentrate feed mixture (CFM)	Rice straw (RS)	Corn silage (CS)	Berseem hay (BH)
DM (%)	90.00	89.00	35.50	89.00
Chemical analysis (%):				
OM	93.65	86.97	90.90	87.70
CP	15.45	3.23	9.51	11.30
CF	15.03	38.50	30.50	30.50
EE	3.40	1.55	3.15	3.20
NFE	59.77	43.69	47.74	37.70
Ash	6.35	13.03	9.10	12.30

Milking:

Cows were machine milked twice daily at 5.00 am 5.00 p.m. Milk yield was individually recorded in all group on fixed day of each week of lactation period, then total milk yield of the whole lactation period was recorded for each group. Monthly milk samples (for morning and evening milking) were individually collected and chemically analyzed for fat, protein, lactose and total solids content.

Total solids (TS) in milk were determined by drying milk at 105 ^{o}C for 4 h to a constant weight. Content of fat (Gerber, 1960), protein and lactose was determined in milk samples. Solids not fat (SNF) content was calculated as the differences between TS and fat contents. Concentration of estradiol in blood serum was determined according to Batzer (1980).

Blood samples of cows:

Blood samples were individually taken from the jugular vein of each cow in all groups before morning feeding in clean test tubes. Blood samples were allowed to clot within 4 h for serum collection, and then blood samples were left until chemical analysis at -20 ^{o}C.

Blood samples were taken during pre-partum period (2-3 wk before parturition), and 30 and 60 day-postpartum. Blood serum was carefully digested by adding 10 ml concentrated H_2SO_4 and two drops of H_2O_2 to 1 ml of blood serum and heated. The digested sample was diluted with distillated water at a ratio of 1:50. Concentration of Co, Fe, Cu and Zn was determined using an atomic absorption spectrophotometer (Unicam 929 AA). A standard ICP-OES (Perkin-Elmer, Optima 2000 DV) analyzer system was used for determination of macro- and micro-elements according to **(Oser, 1965)**. Biochemical concentration of total cholesterol (CHO) and IgG and hormonal concentration of estradiol were determined in blood serum using commercial kits (Diagnostic System Laboratories, Inc., USA).

Growth performance of born calfes:

After calving, live body weight of calfes produced from each experimental group was recorded at 0 (birth day), 4, 8 and 12 weeks (weaning) of age and then average daily gain at intervals of 0-4, 4-8, 8-12 and 0-12 wk of each group was calculated.

Statistical analysis:

The obtained data were statistically analyzed by one way complete design to study the effect of dietary Co supplementation using **SAS (**2002) according to the following model:

$Y_{ij} = \mu + A_i + e_{ij}$

Where: Yij= observed values, µ= overall mean, Ai= experimental group and eij= Random error. The detected significant differences among the experimental groups were tested using Multiple Range Test according to Duncan (1955).

RESULTS AND DISCUSSION

Feed intake, Nutrients digestibility and feeding values:

Total dry matter concentrate feed mixture (CFM) and Roughage intakes are presented in Table (2). Cobalt supplementation with rate of 0.19, 0.57 and 0.93 mg/kg / kg DM intake increased (P<0.05) feed consumption as dry mater intake, concentrate feed mixture (CFM) and Roughage intakes with compared the control group. These results are agreement with those obtained by Allen (1986), Olson et al., (1999), and Girard and Matte., (2005). Supplementation Cobalt to experimental ration with levels at 0.19, 0.57 and 0.93 mg / kg DM intake significantly (p<0.05) improved nutrients digestibility as organic mater, crude protein, ether extract, crude fiber and nitrogen free extract compared to those obtained with control ration (Table 2). Nutritive value in term of total digestible nutrient (TDN) and digestible crude protein (DCP) significantly (P<0.05) increased with rations treated by Cobalt (Table 2). Other reports have also shown increases in digestibility of dry matter particularly fiber with Cobalt supplementation. These results are agreement with those obtained by Allen (1986), Olson et al., (1999),and Girard and Matte., (2005) reported that significant effect was observed on the digestibility of dry matter, organic matter, crude protein, and ether extract and crude fiber by supplementation cobalt to the diet of lactating cows. There are very few sporadic feeding trials conducted to assess the influence of Co on nutrient digestibility under varied feeding regimes. Most of the reports from various parts of the world are the outcome of in vitro work where cellulose was used as substrate. Animals consuming concentrates are less likely to suffer from inadequate mineral supply (Mc Dowel l , 1992) and thus any additional mineral supplementation may not yield any visible response. Saxena and Ranjhan (1978) observed no significant effect of supplementation of cobalt and copper (0.22 Co, 12.64 Cu) separately and in addition to other macro and microelements on digestibility of DM, OM and CP of a roughage - concentrate mixed diet , however, they reported significant increase in the digestibility of cellulose and crude fibre in fistulated Hariana calves. It is evident from the results of this trial that the Co supplementation over and above inherently available in the diet (0.48 ppm) did not impart any effect on the efficiency of nutrient utilization or intake by the animals. Similar to these findings, Tiffany et al., (2006) reported no change in digestibility of nutrients (DM, NDF,A D F) , except O M , or intake o f DCP and

TDN in Sahiwal cows given a basal diet of Para grass and standard concentrate mixture supplemented with trace mineral (Cu, Co, Mn & Zn) capsule.

Table 2.Effect of cobalt treatment on feed intake digestibility and nutritive values of tested rations

Item	Control Group	Treatment group		
	G1	G2	G3	G4
Animal weight kg	446.0±14.35	436.0±6.00	438.0±12.40	450.0±8.14
Daily DM intake				
CFM	7.63±0.04	7.65±0.02	7.57±0.08	7.74±0.05
Roughage	7.96.±0.05^{b}	8.70±0.03^{b}	8.86±0.02^{b}	9.45±0.04^{a}
Total DM intake	15.59±0.06^{c}	16.35±0.04^{b}	16.43±0.05^{a}	17.19±0.03^{a}
Digestion coefficient %				
DM	66.53±0.03^{b}	66.94±0.02^{b}	69.25±0.08^{a}	69.81±0.06^{a}
OM	67.81±0.05^{b}	68.57±0.06^{b}	70.71±.007^{a}	71.56±0.05^{a}
CP	69.12±0.09^{c}	71.55±0.05^{b}	74.74±0.09^{a}	74.16±0.09^{a}
CF	59.97±0.05^{c}	62.55±0.02^{b}	63.97±0.08^{a}	64.12±0.09^{a}
EE	75.20±0.01^{b}	75.85±0.05^{b}	77.96±0.04^{a}	77.54±0.37^{a}
NFE	74.32±0.04^{b}	74.85±0.07^{b}	79.28±0.09^{a}	79.11±0.05^{a}
Nutritive value:				
TDN	65.59±0.05^{b}	66.81±0.03^{b}	68.08±0.07^{a}	69.78±0.02^{a}
DCP	7.89±0.02^{c}	8.16±0.01^{b}	8.52±0.009^{a}	8.46±0.009^{a}

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05)

Milk production:

Milk yield and lactation period:

Data illustrated in Fig. (1) show that average daily milk yield during each of 35 lactation weeks was not affected significantly by dietary Co supplementation, although cows in G2 and G3 alternated the highest average daily milk yield at most lactation weeks as compared to other supplemented and control groups. Average daily milk yield ranged between 6.13-14.08, 8.10- 15.05, 10.03-16.38 and 8.05-15.23 kg during different lactation weeks in G1, G2, G3 and G4, respectively.

When milk yield was expressed either as average daily milk yield (ADMY) or as total milk yield TMY) for the whole lactation period, cows in G3 showed the highest AVDMY and TMY (11.76 and 4034.3 kg, respectively) with the longest lactation period as compared to other groups. The group differences were significant (P<0.05) in TMY and lactation period with insignificant effect of Co supplementation on ADMY (Table 2).

Increasing (P<0.05) TMY in cows of G3 (4034.3 kg/h) was mainly attributed to the increased lactation period (343.0 days) in this group as compared to other groups. It is of interest to note that cows in G4 (supplemented with 0.93 mg Co/kg diet) showed lower AVDMY (10.26 kg) and higher TMY (3451.2 kg) than G1 (10.53 and 2756.8 kg/h) as a result of increasing lactation period (P<0.05) in G4 (336 days) compared with G1 (260.8 days, Table 2).

Table 3. Effect of cobalt treatment on average daily milk yield, total milk yield and lactation period o cows in the experimental groups.

Item	Control group	Treatment group		
	G1	G2	G3	G4
Daily milk yield (kg/h)	10.53±0.891	11.24±1.142	11.76±1.28	10.27±0.874
Total milk yield (kg/h)	2756.8±78.0^{c}	3384.2±168.4	4034.3±188.7^{a}	3451.2±83.6
Lactation period (d)	261.8±9.21^{c}	301.0±12.78^{b}	343.0±4.95^{a}	336.0±7.56^{a}

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05)

Cobalt is one of the essential trace elements for the production of vitamin B12 by the rumen microbes that meet requirements of both the ruminal bacteria and the host animal from this vitamin (McDowell, 1992) required especially for milk production, which was affected by dietary content of Co (Sutton and Elliot, 1972). Therefore, ruminal synthesis of vitamin B12 is increased as the dietary Co concentration increase from 0.1 to 1.0 mg/kg (Tiffany *et al*., 2006). Therefore, Girard and Matte (2005) obtained an increase in milk yield of cows injected with 10 mg of vitamin B12 every week.

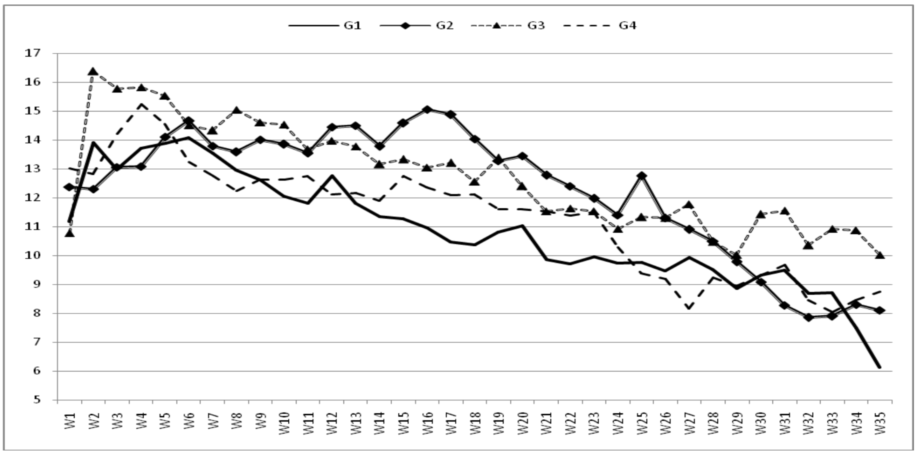

Fig. 1. Average daily milk yield of cows in the experimental groups during lactation period of 35 weeks.

Inspite of these findings, some investigators found no effect of dietary Co supplementation at different levels on milk yield of dairy cows and they indicated that Co supplementation of prepartum and postpartum diets containing 0.15 to 0.19 mg Co/kg did not affect milk production (Kincaid *et al*., 2003; Kincaid and Socha, 2007). Also in the present study the high level of Co (0.57 and 0.93 mg/kg) failed to significantly increase milk yield as compared to the control or 0.19 mg/kg. This result may be due to that the cows were obtaining adequate Co from their diet meeting their requirements.

Generally, there are at least three possible modes of action by which Co could affect ruminant production. Firstly, increased ruminal synthesis and subsequent absorption of vitamin B12 with added dietary Co. Secondly, supplemental Co could increase ruminal fermentation, possibly by an increased vitamin B12 supply to bacterial strains that do not synthesize B12. Finally, there may be a possible metabolic role for Co (Kincaid *et al*., 2003) that might have several similarities to chromium metabolism (Anderson, 1987).

Milk composition and milk physical characteristics:

Results presented in Table 3 regarding milk composition show that G3 had significantly (P<0.05) lower fat content (4.90%) than in G1 (5.78%), G2 (5.63%) and G4 (5.67%). Although G3had the highest protein and lactose contents (4.55 and 6.83%) as compared to other groups of control and G2 (4.44-4.50 and 6.65-6.75%), respectively, this difference was not significant.

Cobalt might either influence the fat metabolism in the rumen and thereby the supply the udder with individual fatty acids, or it can affect the desaturation of saturated fatty acids within the mammary gland, or both (Taugbøl *et al*., 2008). The reduction (P<0.05) in milk fat percent in G3 may be attributed to increasing total milk yield, rather than dietary Co supplementation, as a result of prolonged lactation period. Therefore, the present results indicated no effect of Co supplementation on milk composition, which agreed with the results of Kincaid *et al*. (2003), who found that the percent of fat and protein in milk was not affected by dietary Co treatment. Also, Kincaid and Socha (2007) found no effect of dietary Co treatment on milk composition (fat and protein percentages and yields). Furthermore, Croom *et al*. (1981) did not find an effect on milk fat percentage when cows were injected weekly with 15 mg of vitamin B12, for 21 d of early lactation.

Table 4. Effect of cobalt treatment on milk composition of cows in the experimental groups.

Item	Control group	Treatment group		
	G1	G2	G3	G4
Milk composition (%):				
Fat	5.78±0.201[a]	5.63±0.239[a]	4.90±0.116[b]	5.67±0.091[a]
Protein	4.44±0.183	4.50±0.190	4.55±0.312	4.46±0.105
Lactose	6.65±0.271	6.75±0.287	6.83±0.120	6.68±0.160
Solids not fat	12.10±0.493	12.27±0.521	11.56±1.268	12.14±0.288

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05)

Blood parameters and Minerals metabolites:

Data presented in Table 4 show that cows fed different Co supplementations insignificantly increased prepartum mineral contents of Co, Fe and Cu as well as concentration of CHO and IgG in blood serum of cows, while Zn content significantly (P<0.05) increased in G3 and G4 as compared to that in G1 and G2. Within 30 day-postpartum, the effect of treatment on mineral contents or CHO and IgG concentrations was not significant, but there was a tendency of decreased contents of Cu and Zn and increased IgG concentration by Co supplementation in G2, G3 and G4 as compared to the control (G1). Within 60 day-postpartum, dietary Co supplementation significantly (P<0.05) decreased Cu content and IgG concentration than in the control (G1), but Fe content significantly (P<0.05) decreased only in G3 as compared to other groups. Meanwhile, Co and Zn contents and concentration of CHO were not affected significantly by Co supplementation (Table 4). According to the present results, Co supplementation to diets of lactating cows may alter the metabolism of minerals (Co, Fe, Cu and Zn) and of CHO and IgG with different trends of effects during prepartum or early postpartum up to 60 days.

Table 5. Effect of cobalt treatment on some blood parameters of cows in the experimental groups.

Item	Control Group	Treatment group		
	G1	G2	G3	G4
Pre-partum:				
Co (µg/l)	0.477±0.012	0.930±0.263	0.557±0.018	1.187±0.105
Fe (µg/l)	0.270±0.006	0.558±0.211	0.894±0.293	0.755±0.094
Cu (µg/l)	0.213±0.009	0.525±0.260	0.901±0.258	0.719±0.090
Zn (µg/l)	0.272±0.026[c]	0.316±0.093[b]	0.813±0.008[a]	0.831±0.141[a]
CHO (mg/dl)	0.195±0.003	0.215±0.049	0.201±0.006	0.284±0.066
Ig G (mg/ml)	4.467±0.555	6.680±0.722	4.923±0.184	7.183±1.661
30 days postpartum:				
Co (µg/l)	0.991±0.107	1.493±0.908	0.773±0.218	1.320±0.050
Fe (µg/l)	0.752±0.378	0.398±0.073	0.781±0.274	0.263±0.049
Cu (µg/l)	0.780±0.184	0.398±0.073	0.655±0.235	0.263±0.049
Zn (µg/l)	0.925±0.007	0.685±0.121	0.684±0.118	0.755±0.218
CHO (mg/dl)	0.348±0.044	0.308±0.050	0.213±0.012	0.356±0.044
Ig G (mg/ml)	5.983±1.227	7.653±0.842	7.150±1.300	9.537±0.777
60 days postpartum:				
Co (µg/l)	1.320±0.044	1.260±0.114	1.247±0.028	1.273±0.122
Fe (µg/l)	0.731±0.048[a]	0.485±0.139[ab]	0.214±0.023[b]	0.454±0.064[ab]
Cu (µg/l)	0.732±0.048[a]	0.393±0.057[bc]	0.223±0.025[c]	0.458±0.067[b]
Zn (µg/l)	0.593±0.214	0.843±0.099	0.758±0.171	0.833±0.175
CHO (mg/dl)	0.391±0.028	0.374±0.029	0.290±0.048	0.286±0.031
Ig G (mg/ml)	9.207±0.428[a]	7.823±0.428[b]	10.353±0.393[a]	9.173±0.660[a]

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05)

Reproductive performance of cows:

Results presented in Table 5 concerning the effect of dietary Co supplementation on reproductive efficiency of lactating cows revealed that cows in G3 showed the best reproductive measures in terms of the shortest postpartum first estrous interval (PPFEI, 40 d, P<0.05), consequently the shortest days open (DO, 78.7 d, P<0.05) and decreased number of service per conception (NSC, 2.5 serv., P<0.05) as compared to the control group (78.8 d, 183.4 d and 2.7 serv.. respectively). However, cumulative conception rate (CR) within 120 day-postpartum did not differ significantly from that in the control group (G1), being 80%. However, cows in G2 showed significantly (P<0.05) lower NSC (2 serv.) and CR (60%) than in the control group (2.7 serv. and 80%, respectively). In accordance with the beneficial effect of dietary Co supplementation on reproductive performance of cows in G3, Kellogg *et al*. (2003) demonstrated that cows fed complexed zinc, manganese, copper, and cobalt had fewer days open and fewer days to first service.

It is worthy noting that, cows in G4 showed the poorest reproductive measurements in term of PPFEI (117.5 days), NSC (3.0 serv.) and DO (224.8 days) as compared with the control group, reflecting adverse effect of the dietary Co supplementation on reproductive performance of lactating cows. The observed impaired effect of high Co level on reproductive performance of cows, is in accordance with the result of Olson *et al*. (1999), who reported that supplementing beef cows with zinc, copper, manganese, and cobalt at concentrations at least twice the NRC requirement, following calving, reduced pregnancy rates in beef cows.

Results in Table (6) also revealed insignificant effect of dietary Co supplementation on estradiol concentration in blood serum of cows during late prepartum or within 30 and 60 day-postpartum. However, concentration of estradiol (E2) was higher during 60 day-postpartum than prepartum and 30 day-postpartum, reflecting resumption of ovarian activity in all experimental groups up to within 30-60 day-postpartum. The highest concentration of E2 was recorded in G2 on day 60 postpartum.

Table 6.Effect of cobalt treatment on reproductive performance of cows in the experimental groups.

Item	Control Group	Treatment group		
	G1	G2	G3	G4
Reproductive measurements:				
Live body weigh of cow (kg)	446.0±14.35	436.0±6.00	438.0±12.40	450.0±8.14
PPFEI (d)	$78.8±19.41^{b}$	$80.0±20.35^{b}$	$40.1±15.10^{b}$	$117.5±24.81^{a}$
NSC	2.7±0.42	2.0±0.38	2.5±0.27	3.0±0.35
Days open	$183.4±18.74^{ab}$	150.1±21.42	78.7±17.84	$224.8±23.74^{a}$
Conception rate (%)	80^{a}	60^{b}	80^{a}	60^{b}
Estradiol concentration (pg/ml):				
Prepartum	0.533±0.177	0.425±0.274	0.393±0.041	0.079±0.011
30 day-postpartum	0.200±0.138	0.652±0.282	0.103±0.054	1.157±0.145
60 day-postpartum	50.87±12.825	69.07±32.78	40.51±0.644	33.97±16.41

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05).

PPFEI: Postpartum first estrous interval. NSC: Number of services per conception.

Growth performance of calfs:

Result of growth performance of calfs produced from each experimental group presented in Table (7). These results show significant (P<0.05) differences in LBW of calves in experimental groups during the suckling period up to 16 wk of age. Calves of cows in G2 and G3 showed significantly (P<0.05) higher LBW than those in G4 and the control group (G1) at all suckling times up to 16 wk of age, being the highest in G3. At different intervals of the suckling period, only calves of cows in G3 showed the highest average daily gain (ADG) as compared to those in other groups, but the differences were significant (P<0.05) only at 0-4 and 12-16 wk intervals. During the whole suckling period (0-16 wk), calves in G2 and G3 showed higher ADG (0.728 and 0.766 kg) than in G1 (0.674 kg) and G4 (0.683 kg), being the highest in G3 (0.766 kg, Table 6).

Such trend may indicate beneficial effects of dietary Co supplementation of cows in G3 on growth performance of their calves during the suckling period. In accordance with the obtained results, Kincaid *et al*. (2003) found that body weights increased in cows fed Co-supplemented diets as compared to the control during the 60-d feeding period. Also, Co addition to the diet significantly increased average daily gain during the first 84 d and over the total finishing period (Tiffany and Spears, 2005).

Table 7. Effect of cobalt treatment on average of live body weight and daily gain of calves born from cows in the experimental groups.

Item	Control Group	Treatment group		
	G1	G2	G3	G4
Average live body weight (kg/animal):				
0 wk	27.25±0.479	28.75±0.479	29.50±0.645	29.00±0.913
4 wk	46.25±1.109^{b}	50.500±0.645^{a}	51.50±0.645^{a}	50.25±0.479^{a}
8 wk	63.50±0.866^{c}	67.00±0.408^{ab}	69.00±0.707^{a}	65.25±0.750^{bc}
12 wk	82.25±1.377^{c}	88.00±0.707^{b}	91.50±0.645^{a}	85.50±1.041^{b}
16 wk	102.75±1.109^{c}	110.25±0.946^{b}	115.25±1.250^{a}	105.50±0.645^{c}
Average daily gain (kg/d/h):				
0~4 wk	0.679±0.041^{b}	0.777±0.022^{a}	0.786±0.014^{a}	0.759±0.017^{a}
4~8 wk	0.616±0.051	0.589±0.018	0.625±0.018	0.536±0.041
8~12 wk	0.670±0.040	0.750±0.032	0.804±0.042	0.724±0.037
12~16 wk	0.732±0.018^{bc}	0.795±0.009^{ab}	0.848±0.022^{a}	0.715±0.033^{c}
Overall mean (0~16 wk)	0.674±0.014^{b}	0.728±0.009^{a}	0.766±0.017^{a}	0.683±0.008^{b}

a, b and c: Means within the same row with different superscripts are significantly different at P<0.05).

The noticed increase in LBW and average daily gain of calf of cows in G3 may be attributed to increasing Co level in milk of these cows, Since it has reported that Co supplemented as an intraruminal pellet increased B12 concentrations in milk. Milk B12 concentration might be a useful indictor of effectiveness of Co supplementation, a better indicator than plasma B12 (Judson *et al*., 1997). Also, the concentrations of vitamin B12 in colostrum and milk tended to be increased by dietary Co supplementation. Thus, dietary Co supplementation likely increased ruminal synthesis of vitamin B12 even though serum B12 concentrations were not affected. Although Co concentration in colostrum was not affected by Co intake, the concentration of Co in milk was increased by Co supplementation. The elevated concentration of Co in milk of Co-supplemented cows indicates that intestinal Co absorption likely was greater in these cows even though Co concentrations in serum and liver were not affected (Kincaid and Socha, 2007).

Generally, dietary Co increased cellulose digestibility *in vitro* of diets containing 40% forage, 60% concentration (Allen, 1986). A lack of dietary cobalt for vitamin B12 synthesis by rumen microorganisms can also alter ruminal fermentation. Low dietary cobalt in high concentrate finishing diets reduces molar proportion of ruminal propionate (Tiffany *et al*., 2003; Tiffany and Spears, 2005). Cobalt supplementation may increase propionate production by certain ruminal bacteria that are dependent upon vitamin B12 in order to convert succinate to propionate (Strobel, 1992).

Economical efficiency

Data in Table 8 showed that the final margin increased with cobalt supplementation than in the control group. It is worthy noting that final margin was increased with adding cobalt to lactating cows. The best margin obtained for lactating cows was in the group fed on the diet supplemented with 0.57 mg cobalt/ kg diet comparing with the control group. Studies on cobalt supplementation to dairy animals diets have shown increased milk yields (Allen, 1986; Tiffany *et al*., 2003; Tiffany and Spears, 2005). The improvement of final margin on groups treated by cobalt may be due to increase in milk yield.

Table(8):Economical efficiency of Friesian cows fed rations supplemented with cobalt (Co) supplementation.

Item	Control Group	Treatment group		
	G1	G2	G3	G4
Total feed cost L.E (1)	21.55	22.48	23.27	24.99
Return of milk (2)	52.66	56.2	58.8	51.3
Final Margin (2-1)	31.10	33.72	35.53	26.31

According tofree market, the price of CFM = 2200 LE/ ton, RS = 300 LE /ton, CS = 300 LE /ton, BH= 1200 LE /ton Milk = 5 LE /kg - Cobalt = 300 LE/ kg.

CONCLUSION

Although dietary Co supplementation during pre- and post-partum period had no effect on serum Co concentration, there was a tendency of increasing milk production and improved reproductive performance of dairy cows fed diets supplemented with 0.57 mg/kg diet. Moreover, improved LBW and daily weight gain of their offsprings from birth up to 16 wk of age. The present results may indicate that dairy cows used in this study were obtaining adequate Co from their diet needed to meet their requirements. Further studies appear to be needed concerning the effects of Co supplementation on, ruminal fermentation, Co metabolism and vitamin B12 level in blood, milk and liver in dairy cattle fed purified and Co-supplemented diets.

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تأثير إضافة الكوبلت المعدنى الى العليقة أثناء فترة الحمل المتأخر وبداية فترة الحليب لأبقار الفريزيان على:
٢- الكفاءه الانتاجية والتناسليه-العائد الاقتصادى

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كان الهدف من هذه الدراسة تقييم تأثير إضافة مستويات مختلفة من الكوبلت المعدني في علائق الأبقار خلال مرحلة ما قبل الولادة (٥٠-٦٠ يوما) وحتى بعد الولادة (١٢٠ يوما) على كمية المأكول من المادة الجافة والقيمة الغذائية ومعاملات هضم المكونات الغذائية المختلفة وانتاج اللبن وتركيبة والأداء التناسلى وبعض مكونات الدم وكذلك نمو العجول الناتجه. تم تقسيم الأبقار التجريبيه (٢٠ بقره حلاب) إلى أربع مجموعات، ٥ في كل منهما. تم تغذية الأبقار في المجموعة الأولى (ج١) بدون إضافة الكوبلت (مجموعة المقارنة)، كما تم تغذية الأبقار فى المجاميع ج٢، ج٣ و ج٤ على عليقة المجموعه المقارنه مضاف اليها ٠.١٩، ٠.٥٧ و٠.٩٣ ملجم كوبلت (كبريتات الكوبلت)/كجم عليقة مركزه. ثم تسجيل انتاج اللبن اليومى (يتم حلابة الأبقار مرتين يوميا) ومكونات اللبن فرديا وتم أخذ عينات الدم فرديا قبل الولادة يوم وبعد الولادة بـ ٣٠ و ٦٠ يوما، تم تقدير كلا من الكوبلت والحديد، والنحاس والزنك وكذلك الكوليسترول والاستراديول في سيرم الدم. تم تسجيل أول شياع بعد الولادة وبعد التلقيح الصناعى للابقار تم تسجيل معدل الحمل وعدد التلقيحات اللازمة للاخصاب والأيام المفتوحة بعد الولادة، كذلك تم تسجيل وزن الجسم الحي للعجول المولوده وحساب متوسط الزيادة اليومية أثناء فترة الرضاعة.

أظهرت النتائج أن:

١ - كمية المادة الجافة المأكولة والقيم الغذائية باضافة االكوبلت قد زادت زيادة معنويةعند مستوي ٥% . كما ان معامل هضم كل من المادة الجافة والمادة العضوية و البروتين والالياف والدهن الخام والمستخلص الى الازوت قد زاد زيادة معنوية عند مستوي ٥% االكوبلت

٢- لم يتأثر متوسط إنتاج اللبن اليومي لمدة ٣٥ أسبوعا بشكل معنوى تحت تأثير إضافة الكوبلت

٣- كان متوسط إنتاج اللبن اليومي والكلى وطول فترة الحليب مرتفعة معنويا في ج٣

٤- سجلت ج٣ اقل محتوى الدهن (٤.٩٠%) عن المجاميع الأخرى حيث كان في ج١ (٥.٧٨%) و ج٢ (٥.٦٣%) و ج٤ (٥.٦٧%).

٥- ارتفعت نسبة البروتين واللاكتوز (٤.٥٥-٦.٨٣٪) فى ج٣ بالمقارنة مع المجموعات الأخرى (٤،٤٤-٤،٥٠ % و ٦.٦٥- ٦.٧٥%)، على التوالي فى ج١ و ج٢.

٦- أرتفع تركيز الزنك معنويا في ج٣ و ج٤ بالمقارنة مع ج١ و ج٢، قبل الولادة.

٧- إضافة الكوبلت فى العليقة كان له تأثير غير معنوى على تركيز العناصر المعدنية في الدم الدم بعد الولادة بـ ٣٠ و ٦٠ يوما.

٨-انخفض تركيز النحاس فى دم ج١ وفى ج٣ لوحظ انخفاض تركيز كلا من الحديد والنحاس وفي دم ج٤ انخفض تركيز النحاس فقط نتيجة إضافة الكوبلت فى الغذاء بعد الولادة بـ ٦٠ يوما.

٩- أظهرت أبقار ج٣ أفضل كفاءة تناسلية من حيث أقصر فترة لظهور الشياع الأول بعد الولادة وأقل فترة أيام مفتوحة وعدد التلقيحات اللازمة للاخصاب مقارنة بمجموعة المقارنة (ج١).

توصى الدراسه يمكن بان اضافة الكوبلت المعدنى بمستوى ٠.٥٧ ملجم/كجم عليقة مركزه حبث ان هذ المعدل يؤدى الى زيادة وتحسن فى القيمة الغذائية للعلائق مع زيادة انتاج اللبن وتحسن الأداءالانتاجى و التناسلي للأبقار فضلا عن زيادة وزن الخلفة من الولادة وحتى ١٦ أسبوع من العمر. وانخفاض التكاليف و زيادة العائد الاقدصادى.

قام بتحكيم البحث

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