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Full Length Research Paper

Effect of zinc from zinc sulfate on trace mineral concentrations of milk in Varamini ewes

A. Zali and M. Ganjkhanlou*

Department of Animal Science, Faculty of Agronomy and Animal Science, University of Tehran, P. O. Box#3158711167-4111, Karaj, Iran.

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This study was conducted to evaluate the effect of feeding supplemental zinc (zinc sulfate) in different levels (15, 30, or 45 mg/kg) on trace mineral concentrations in milk of ewes. Thirty lactating Varaminni ewes were assigned to three experimental groups according to their live body weights, milk production and lambs sex in a completely randomized design. Ewes were fed a basal diet containing alfalfa, wheat straw, cottonseed meal, barley grain, wheat bran, cracked corn and vitamin-mineral supplements at 3.2% of body weight (BW) to meet NRC requirements for protein, energy and macro minerals. The basal diet contained 15 mg/kg Zn and zinc sulfate was added to the basal diet to supply 30 or 45 mg/kg of dietary zinc. Daily milk yielded was recorded at 7 days intervals and samples of the milk were taken once per week for determination of milk composition and trace mineral concentration. Concentrations of Zn, Cu, Mn and Fe in milk were determined. Dry matter intake (DMI), milk yield and milk compositions were not affected by supplemental zinc ($P > 0.05$). But zinc concentrations in milk were affected by supplemental zinc ($P < 0.05$). Other mineral concentrations were not affected by supplemental zinc ($P > 0.05$). It suggests that supplementation of ewes diet with zinc sulfate could be an effective way to increase zinc concentration in milk when zinc concentration of basal diets is limited for ewes in lactation period.

Key words: Supplemental zinc, zinc sulfate, Varaminni ewes.

INTRODUCTION

Zinc is a trace element essential for every form of life (Underwood, 1977). Poor growth is a prominent characteristic of Zn deficiency of animal and plant species (Dijkhuizen et al., 2001). Lamb production in before weaning can be influenced by ewe nutrition during critical life cycle stages of the ewe (Rattray, 1987). However plasma zinc status is difficult to assess, because plasma zinc concentrations do not sufficiently reflect individual zinc status due to strong homeostasis.

The mammalian neonate's requirement for nutrients must be met by dietary sources or body stores and usually the dietary source is supplied by milk from the animals (Hill et al., 1983). Some mineral elements in milk are influenced more by diet composition than are others as a result of transfer from the plasma to the mammary gland (Linzell, 1968). For example, Ca, Fe and Cu are generally thought to be resistant to the influence of dietary levels (Pond et al., 1965; Underwood, 1977; Pond and Houpt, 1978), while Zn (Miller et al., 1965; White et al., 1991) and Mn (Ptumtee et al., 1956) can be increased in milk by increasing the dietary levels of the animals. High levels of supplemental Zn were also shown to have a positive influence on ewe milk production and ultimately lamb weaning weights (Hatfield et al., 1995). However, the objectives of this study were conducted to compare three levels of inorganic Zn (zinc sulfate) around of NRC (1985) recommendation in Iranian sheep by evaluating Zn concentrations in milk, and also milk production of Varamini ewes breed.

*Corresponding author: E-mail: mganjkhanloo@yahoo.com. Tel.: 09125129045. Fax: 0261-2246752.

Abbreviation: BW, body weight; **DMI,** dry matter intake.

MATERIALSAND METHODS

Animals and location of experiment

Thirty lactating Varaminni ewes (n = 30; initial BW 47.95 ± 2.86 kg)

Table 1. Components and chemical composition of basal diet.

Item	Diet	Water
CP (%)	12.2	---
Zn (ppm)	15	<001
Fe (ppm)	88	<001
Cu (ppm)	9	<001
Ca (%)	0.9	----
P (%)	0.6	----

All of composition on DM basis.

were used in a 70-d study (February 22 to April 30) at the sheep facility of the Animal Science Department of Tehran University in Karaj, approximately 45 km west of Tehran city to determine the effects of supplemental Zn (0, 15 and 30 mg Zn ewe^{-1} d^{-1}) on ewes weight, milk production, Zn concentrations in serum and serum alkaline phosphates activity. Zinc supplements were administered daily for 70 d. Supplies of premixes needed for the trial were prepared prior to the start of the trial by zinc sulfate. The rations were fed to ewes as total mixed rations (TMR), but zinc premix was top-dressed on the a.m. Based on NRC (1985) estimated DMI for a 50 kg lactating ewe of 1.6 kg DMI ewe^{-1} d^{-1} (3.2% BW). The diets were fed twice daily (0800 and 1600 h) and feed offered was adjusted daily about 5% orts. The TMR was comprised of 65% forage and 35% of a concentrate mix to formulate diets to meet NRC (1985). Diet plus zinc supplements provided 15, 30 and 45 mg/kg DM of Zn, which was approximately around the Zn recommended levels of NRC (1985).

Ewes were managed as one group with *ad libitum* access to feed, water and white salt and the mineral composition of basal diet and water was presented in Table 1. Ewes were weighed on days 1, 21, 42, 63 and 70 after an overnight shrink without feed or water.

Milk sampling and analyses

Milk yielded of ewes was recorded at 7 days intervals and this value was assumption mean yield for one weak. Samples of the milk were taken once per week for determination of milk composition and milk fat, protein, lactose and mineral concentration were determined in the Centre Laboratory of Animal Science Department. Milk samples were analyzed for fat, protein and lactose by infrared procedures at the animal nutrition laboratory (Milko-scan 133B, Denmark). For determine milk mineral concentration, Samples of milk were collected in 100 mL bottles and stored in vials at -20°C until analyzed. Duplicate milk samples for analytical preparation were first dried overnight in an oven at 60℃ and then ashed overnight in a muffle furnace at 550℃ (AOAC, 1990). Ash was solubilized by digestion with 50 and 10% nitric acid and finally with distilled water using the technique described by Miles et al. (2001). Solutions were filtered, diluted to appropriate detection level and analyzed by flame atomic absorption for Copper, Zn and Fe. Mn concentration was determined with Inductively Coupled Plasma (ICP, GBC Integra XL, Australia).

Experimental design

Ewe was the experimental unit in a completely randomized design that assigned to three experimental groups according to their live body weights, milk production and lambs sex. The procedure of MIX (SAS, 1998) was used to evaluate milk Zn, Fe, Mn and Cu status and ewes BW and milk production.

RESULTS

Dry matter intake and body weight change

Dry matter intake and BW were not affected by treatment ($P > 0.05$; data not shown) at any time during the experiment. As noted previously, BW on d 0 averaged 47.95 kg (SD = 4.59). On d 70 of the study, BW averaged 49.79 kg (SD = 4.44). The mean DMI for ewes fed control (0 mg Zn ewe^{-1} d^{-1}) and zinc sulfate (15 and 30 mg Zn ewe^{-1} d^{-1}) averaged 1.61, 1.62 and 1.61 kg (SE = .84), respectively, for the 70-d trial period.

Milk production and mineral concentration

In ewes, actual milk yield averaged in 70-d on 49.90 kg/d and was not affected with supplementation of zinc sulfate (Figure 2). Milk contents of fat, protein and lactose were also similar among the treatments and for ewes fed control (0 mg Zn ewe^{-1} d^{-1}) and zinc sulfate (15 mg and 30 mg Zn ewe^{-1} d^{-1}) averaged 51.4, 54.2, 57.8; 54.2, 59.8, 52.1; 55.3, 54.8, 52.2 g/kg respectively, for the 70-d trial period.

Milk Zn concentration was higher in Zn supplemented than control ewes and this increase was significant ($P > 0.05$). The mean milk Zn concentration for ewes fed control (0 mg Zn ewe^{-1} d^{-1}) and zinc sulfate(15 and 30 mg Zn ewe^{-1} d^{-1}) averaged 0.9, 1.01 and 1.05 ppm (SE = 0.05), respectively. Supplemented ewes with 30 mg Zn had higher concentrations of milk Zn than other ewes especially in weeks 2, 3 and after week 6 (Figure 4). Milk Cu and Mn concentration did not differ ($P > 0.05$) between ewes supplemented with sulfate zinc and control ewes (Figures 2 and 5). Fe concentration in milk also did not differ between control and supplemented ewes (Figure 3).

DISCUSSION

Zinc supplement did not affect dry matter intake and final body weight of lactating ewes. This result in agreement with other studies (Hatfield et al., 2001), but contrasted to the results of Hatfield et al. (1995, 1992). The last authors suggested that zinc supplement in above NRC (1985) recommendation increased feedlot lamb performance and had a positive influence on lambs weaning weight. Hatfield et al. (1995) suggested that zinc supplement increased dry matter intake 11.3% in ewe's that receiving the zinc than DM1 by control supplemented ewes.

Milk production of the lactating ewe typically peaks at 2 to 3 kg/d in the 2nd or 3rd wk of lactation. Thereafter, production decreases steadily to approach 1 kg/ewe daily or less by approximately week 12 of lactation (Treacher, 1983; Rattray, 1992). But Iranian lactating ewes peaks at 1 to 2 kg/d kgld in the 2nd or 3rd week of lactation. In the present study, zinc supplement did not affect milk

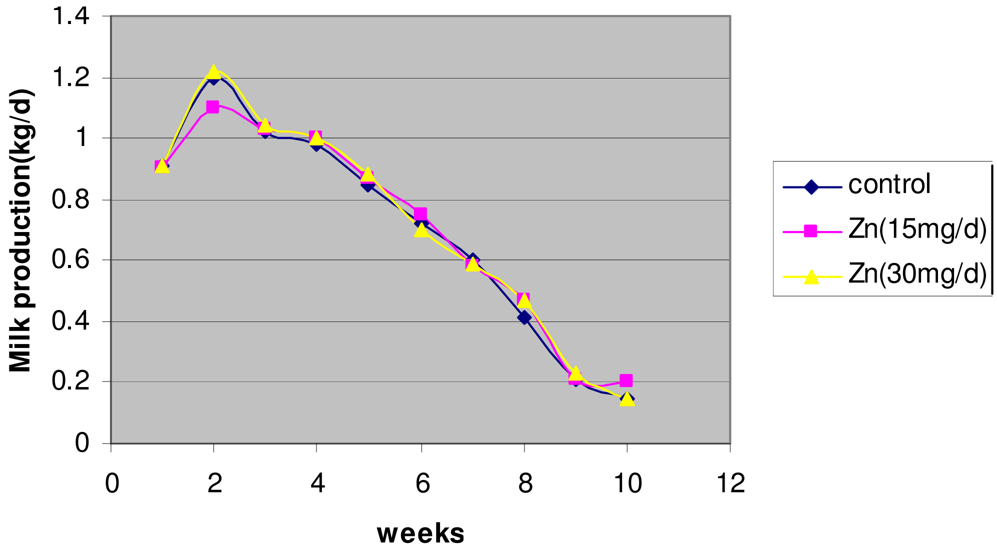

Figure 1. Milk production (kg) by ewes fed either a control or zinc supplemented diet. The SEM associated with total milk production was 0.49 kg/d.

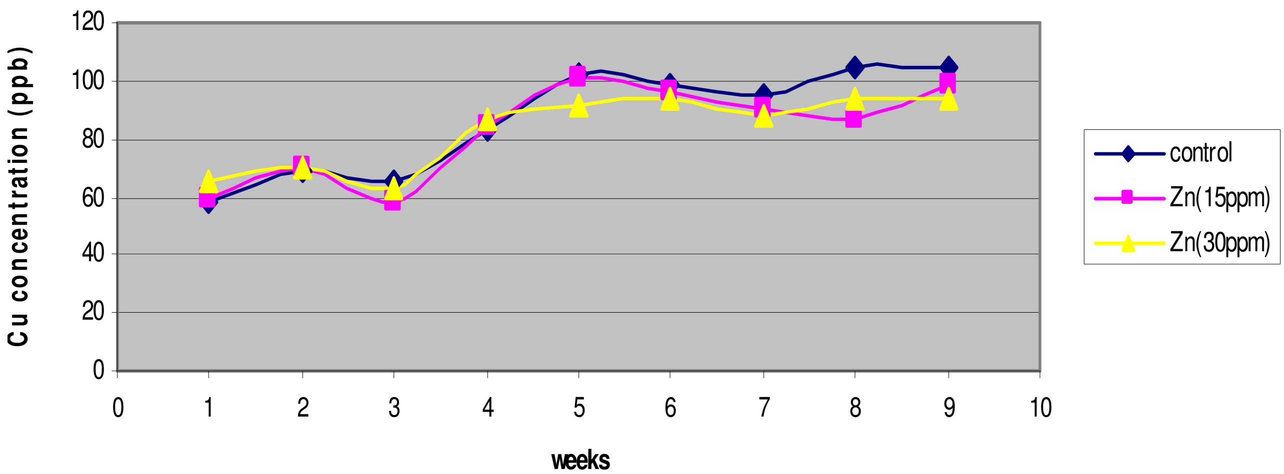

Figure 2. Copper concentration (ppb) in milk of ewes fed either a control or zinc supplemented diet. The SEM associated with zinc concentration was 16.2 ppb.

production. This agrees with result of Hatfield et al. (2001) and Miller et al. (1965), but contrasted to the results of others (Hatfield et al., 1995; Formigoni et al., 1993). Hatfield et al. (1995) observed zinc supplement had positive influence on ewe milk production. Similar results have been reported previously when dairy cows were supplemented with chelated minerals (Formigoni et al., 1993). In our study, milk production trend did not differ between ewes on any days of postpartum (Figure 1) and indicating a similar decrease in milk production by ewes fed control diet or diets supplemented with Zn sulfate.

Milk compositions were not affected by treatment, which is similar to results in another study (Ahmed et al., 2003) but contrasted to the results of Hatfield et al. (1995) and O'Donoghue et al. (1995). Supplementation with Zn reduced milk fat by 9.6% in dairy ewes (Hatfield et al., 1995) and by 2.3% in dairy cows (O'Donoghue et al., 1995).

During the 70 d of experimental period, the concentrations of Cu, Fe and Mn in milk of ewes were not affected by dietary treatment. The milk collected from ewes receiving 30 ppm added Zn contained less Cu ($P = 0.15$) and Fe ($p = 0.07$) than milk from ewes on the other treatments, but Mn was depressed by the 15 or 30 ppm added Zn treatment. The effect of dietary Zn on the level of Cu in tissues and enzymes requiring Cu and Cu of milk has been reported (Ott et al., 1966; Chvapil and Misiorowski, 1980; Hill et al., 1983; white et al., 1991). However, Hill et al. (1983) concluded that supplemental

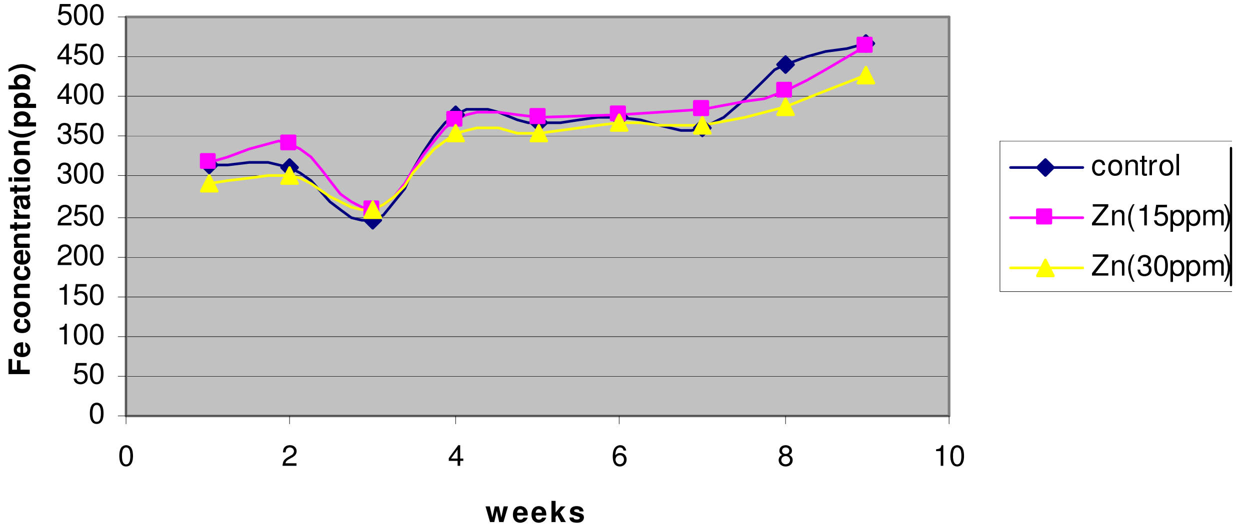

Figure 3. Iiron concentration (ppb) in milk of ewes fed either a control or zinc supplemented diet. The SEM associated with zinc concentration was 34.23 ppb.

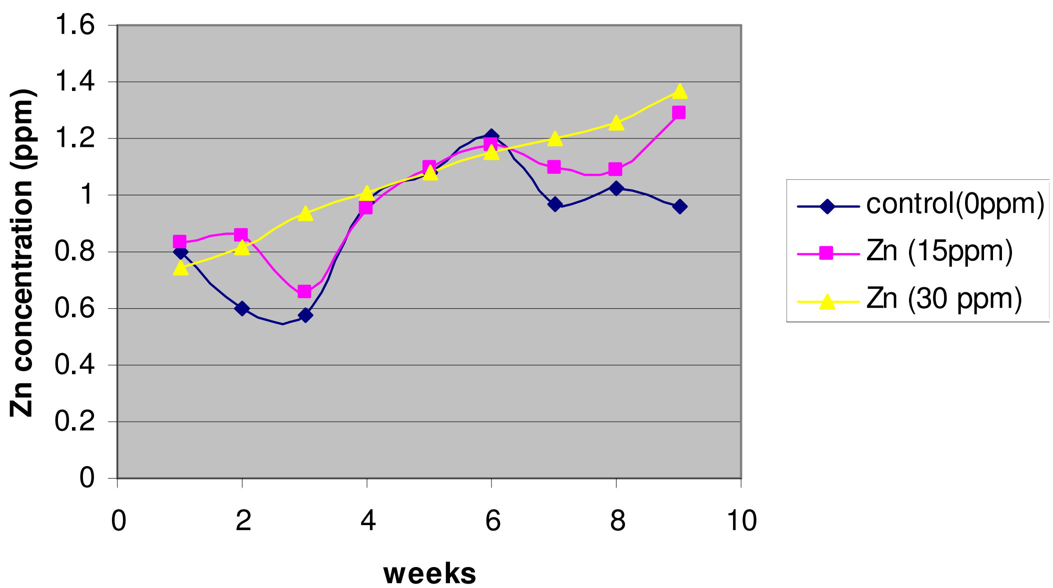

Figure 4. Zinc concentration (ppm) in milk of ewes fed either a control or zinc supplemented diet. The SEM associated with zinc concentration was 0.05 ppm.

zinc decreased concentration of Cu in milk.

Fe was greatly reduced ($P < 0.01$) in milk at many stages of lactation in ewes fed 30 ppm Zn but elevated in week 6 milk from animals fed the highest Zn level. Milk Mn concentration at all stages of lactation was similar for ewes receiving 0, 15 or 30 ppm supplemental dietary Zn, but was elevated in those milk in week 7 experimental period.

A concentration of Zn in milk of ewes was affected by dietary treatment and zinc supplement had positive influence on ewe milk zinc concentration. Zinc concentration was greatly increased ($P < 0.01$) in milk at all stages of lactation in ewes fed 0, 15 or 30 ppm Zn. The increase of concentration of zinc in milk with supplementation of zinc is consistent with the most findings in the literature (Miller et al., 1965; Hill et al., 1983; White et al., 1991) but in the latest literature, there are different results (Pechova et al., 2009; Kirhgessner et al., 1994). However, the effects of zinc supplement on the Zn concentration in milk of ewes that are kept in intensive system has not been reported. Miller et al. (1965) found that supplementing lactating dairy cows with 0, 500, 1000 and

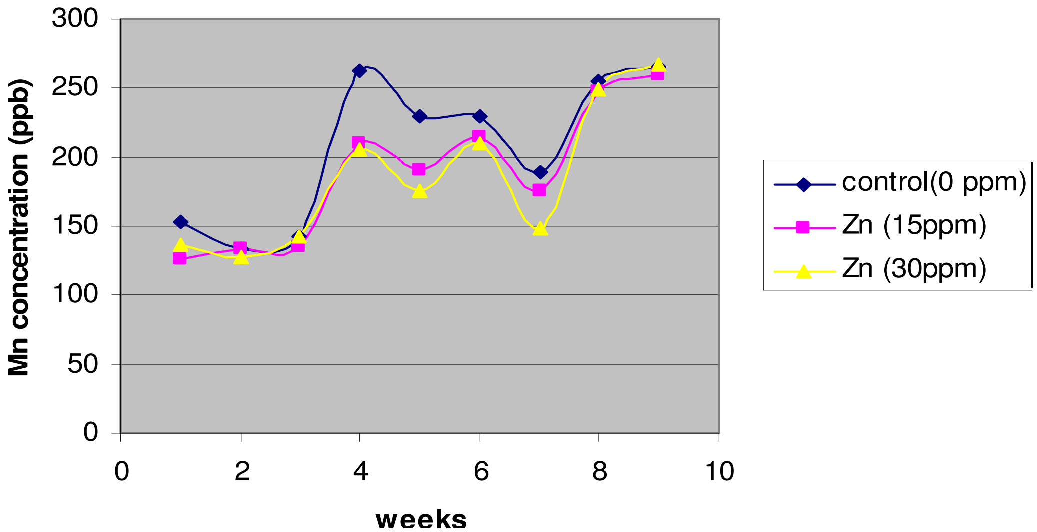

Figure 5. Manganese concentration (ppb) in milk of ewes fed either a control or zinc supplemented diet. The SEM associated with zinc concentration was 15, 4 ppb.

2,000 ppm Zn as ZnO resulted in average milk Zn levels of 4.1, 6.7, 8.0 and 8.4 ppm, respectively. Pechova et al. (2009) concluded that after 28 days of Zn supplementation, Zn concentration in milk of dairy goats was similar as at the start of the experiment in all groups. In our study, the Zn concentration in the milk of ewes fed 30 ppm additional Zn was consistently higher than that of animals fed lower Zn levels, but progressively increasing Zn levels in milk were not observed when the lower levels of Zn were consumed.

Conclusion

Supplementing lactation diets in ewes fed a basal diet with 15 ppm Zn increased Zn concentration in milk but did not affect concentration of Fe, Cu and Mn. As a result, milk production, dry matter intake and body weight were not improved with zinc supplementation. Results suggest that supplementation of ewes diet with zinc sulphate could be an effective way to increase zinc concentration in milk when zinc concentration of basal diets is limited for ewes in lactation period.

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