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RESEARCH ARTICLE

EFFECT OF CHELATED TRACE-ELEMENTS (ZINC, MANGANESE, IRON) ADMINISTERED IN DAIRY COWS FEED RATION ON PRODUCTIVITY, MILK COMPOSITION AND BIOAVAILABILITY

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ABSTRACT

Trace elements are essential elements despite their name and quantity that is required by the animal organism, as they have many important effects on well-being and performance of cows. These elements, naturally present in cattle feed ration in an inorganic form, are not well assimilated by the animal and therefore the majority of them will be present in the feces; leading to a toxicity to the environment and human. Knowing that the organic form of trace elements is more absorbed than the inorganic one; for this reason, this study aimed to evaluate the influence of organic trace elements supplementation on their absorption, milk yield and composition, by adding Zinc (0.026%), Manganese (0.016%) and Iron (0.04%) to the basic feed ration.16 dairy cows were divided randomly into 4 groups: control, zinc, manganese and iron. Milk yield data was collected weekly for a period of 3 months. Milk composition (fat, protein, Solid-Non-Fat percentages and density) were measured monthly using Milkana. In order to assess the quantities of the studied trace elements in cattles diet and feces, Atomic Absorption Spectrometer was used. The obtained results showed that milk yield data in the second month of the study has decreased, while a significant ($P<0.05$) decrease was seen for iron and manganese treatment; meanwhile for the third month, it increased in all groups except the control. Zinc treatment had the best effect on milk yield. Concerning milk fat, the treated groups showed a higher fat yield than control with iron treated group have a significantly ($P<0.05$) higher fat yield. For milk protein, treatment has no significant ($P>0.05$) effect on this factor. For milk density, for the first two months of the study, no significant difference ($P>0.05$) was seen among groups; meanwhile for the last month, milk density was significantly lower for manganese and iron groups when compared to control group; we concluded that zinc group has the best effect on milk density between treatments. For milk Solid Non Fat, for the first two months there was no significant difference ($P>0.05$) among all groups but for the last month, manganese group has a significantly ($P<0.05$) lower Solid Non Fat. The amount of trace elements absorbed by the cows was significantly ($P<0.05$) higher in treatment group when compared to each corresponding element in control one, while zinc was the best assimilated element. We can conclude that zinc has the best effect and absorption on dairy cows.

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INTRODUCTION

Following the rapid development for food demand, in the animal sector nutritionists formulate a well-balanced ration to meet the animal requirements in nutrients. Between these nutrients, trace elements (TE) are important nutrients to be insured for cows, despite their small required quantities, they are important for growth, production, reproduction, and health (Yatoo *et al.*, 2013).

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Many studies were done to determine the needed amount of TE (Nordberg and Nordberg, 2016). In Lebanon, the use of TE is developing, as farmers are using these minerals but not all of them. TE aren't easily assimilated by the cow's as most of them are naturally unavailable for absorption (Garrett, 2011). TE can be divided into two sources: organic and inorganic. Inorganic sources are the common sulphates, oxides, chlorides, carbonates, that may interact in the gastrointestinal tract or being originally linked in the feed to other nutrients, resulting in a reduction of their absorption. The other category referred to chelates, are organic trace minerals designed to improve bioavailability because they are protected from many interactions, as the bound to chelating agents allow them to become more stable and less reactive (Pal and Gowda, 2015).

Lack in some of these minerals may cause deficiencies in dairy cows leading to decrease milk yield. However, all TE have low bioavailability; therefore they are often excessively added to the diet. These excesses end up mainly in the feces but in lesser quantities, in urine and milk. This can lead to toxicities for the cows, consumers and agricultural parcels spread with this manure (Pal and Gowda, 2015). Organic TE are more absorbed by the animal leading to a reduction of their excretion (Garrett, 2011). This study objects were to compare the effect of TE (Zinc, Manganese and Iron) quantities between that found in dairy cows feed ration to the organic mineral supplemented one and to realize the effect of these minerals on milk yield, milk composition and amount absorbed after measuring the excreted amount in feces.

MATERIALS AND METHODS

Animals and their management: This experiment was conducted at El Sayegh farm, where cows are confined in El Ghine-Ftouh-Keserwan- Lebanon region, located at an altitude of 950 m above the sea. The farm includes a small outdoor court where cows are allowed to rest. The experiment started on March till June 2018 and based on 16 dairy cows of a crossed Holstein with the local breed, and divided into four groups. The age of the cows ranged between 2 and 4 years. The cows were distributed in the farm as seen in Fig.1.

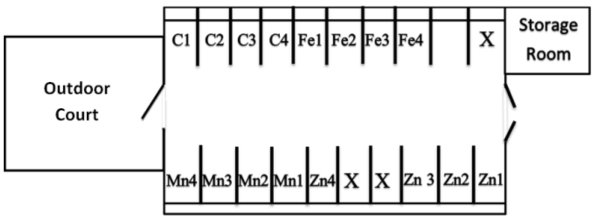


Fig.1. Cow's pen distribution inside the farm, as follow: C: Cow from the control group; Iron group; Zn: Zinc group; Mn: Manganese group; X:Cow not included in the study

Alimentation: The cows were offered feed twice per day. The feed ration of each cow contained in total: 6kg of a complete concentrate mixture as listed in Table 1, 6kg of corn silage and 3kg hay. Each group was receiving his TE supplement by mixing those elements in their concentrates feeds and offered individually in the feeder of each cow as listed below:

- Control group (C) fed the basic ration.
- Iron group (Fe) fed the basic ration + supplemented with chelated Fe at a level of 0.04%.
- Zinc group (Zn) fed the basic ration + supplemented with chelated Zn at a level of 0.026%.
- Manganese group (Mn) fed the basic ration + supplemented with chelated Mn at a level of 0.016%.
- A buffering period of 2 weeks was adapted before the beginning of the sampling.

Samples collection

Milk performance

The milk produced by each cow was collected weekly, individually (**Fig.2**) in the afternoon.

Milk samples (milk composition): Milk samples was done for each cow monthly using plastic containers, then placed in a portable refrigerator to decrease their temperature to around 12°C, then transferred into the laboratory. The samples were tested using Milkana (Superior plus, Turkey) machine for the determination of milk composition. The machine used measures milk protein (%), solid non-fat (%), fatness (%) and density.

Feces samples

Feces collection: Feces samples were taken from each cow and feed sample also collected monthly. At the laboratory, 6g of feces were weighed using a weighing balance, then placed in aluminum cups and moved inside an oven (Wells, USA) to be dried for 4 hours at 105°C. After the drying process, the samples are moved to the furnace (Selecta Horn, Greece), that is gradually heated from room temperature to 500°C, and left for 6 hours for the ashing process following some modifications to the procedure of Abbruzzini *et al.*(2014). Each ashed sample was moved into a beaker with an addition of 8 ml of 60% HNO_3 solution and agitated at an 80°C temperature over a heated agitator while adding 3 drops of 30% H_2O_2. The remaining mix was then solubilized in 10 ml of 1% HNO_3. Then the digest were filtered into falcon tubes, than tested using the Atomic Absorption Spectroscopy device.

Atomic Absorption Spectroscopy device: The measurement of TE concentration was done using the protocol of Beaty and Kerber (1993). The following calculation was used to obtain the amount of TE absorbed by the organism of the animal (in mg/day):

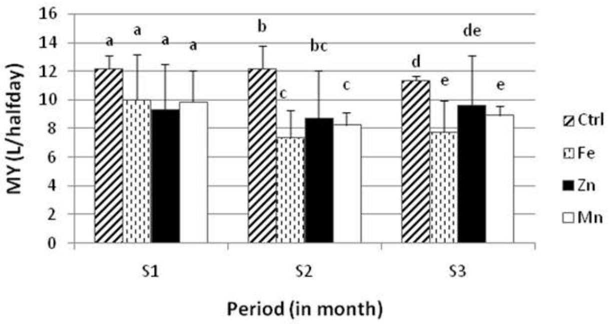
Amount of TE Ingested (Feed + Supplementation) – Amount of TE Excreted (in feces) = Amount of TE absorbed by the animal.

Statistical analysis: For the statistical analysis, the program SPSS 23.0 and Excel 2010 were used. A test of normality was done to make sure that our data is normally distributed. Then, the statistical design T-test was used to determine if there was a significant difference between collected data of different groups during different periods. Also, correlations between factors were determined using the Pearson's correlation coefficients. The results were expressed as mean ± standard deviation and considered significantly different when $p<0.05$.

RESULTS

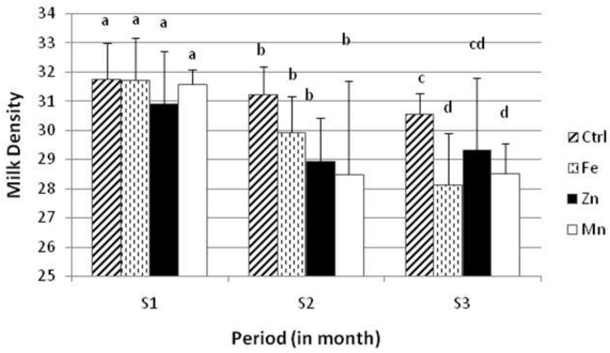
Milk Yield: As seen in Fig.3., for the first month of the study (S1), the higher quantity of milk produced was by control group (12.23±0.87 L/day) followed by Fe group (10.03±3.22 L/day), followed by Mn group (9.86±2.23 L/day) and Zn group (9.35±3.14 L/day). Concerning the second month of the study (S2), control group still producing higher amount of milk (12.21±1.58 L/day) that is a little lesser compared to first month, followed by Zn group (8.7±3.35 L/day) that milk quantity decreased from the first month, Mn group (8.26±0.9 L/day) that decreased also and the least amount produced was by Fe group (7.42±1.84 L/day) that dropped dramatically. As for third month of the study (S3), milk produced from control group has diminished (11.41±0.31 L/day) but still higher milk producer followed by Zn group (9.64±3.5 L/day) that raised compared to S2, followed by Mn group (8.92±0.7 L/day) that increased in comparison with S2 and finally comes Fe group (7.76±2.24 L/day) that has grown when compared to S2.

Fig. 2. Milking machine and the graduated milk container



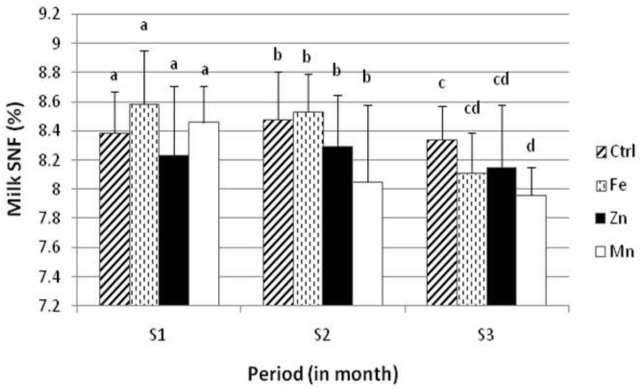
a,b,c,d,e: different letters between groups in same period indicate significant difference at P<0.05. Values for MY are means ± Standard Deviation (SD

Fig. 3. Effect of diets supplemented with organic chelated TE (Zn, Mn and Fe)on milk yield (MY) of dairy cows



a,b,c,d: different letters between groups in same period indicate significant difference at P<0.05 Values for milk density are means ± Standard Deviation (SD)

Fig.4. Effect of diets supplemented with organic chelated TE (Zn, Mn and Fe) on the amount of milk density of dairy cows



a,b,c,d: different letters between groups in same period indicate significant difference at P<0.05 Values for milk Solid Non Fat are means ± Standard Deviation (SD)

Fig.5. Effect of diets supplemented with organic chelated TE (Zn, Mn and Fe)on the amount of milk Solid Non Fat (SNF) of dairy cows

Table 1. The concentrate mixture of the dairy cows (Kg concentrate/cow/day)

Ingredients	Weight (kg)
Barley	0.84
Corn	1.56
Fava Bean	0.72
Limestone Powder	0.072
Premix(vitamins)	0.12
Salt	0.048
Soybean Meal	1.68
Sugar Beet Pulp	0.18
Wheat Bran	0.78

Table 2. Effect of diets supplemented with organic chelated TE (Fe, Zn and Mn) on milk fat yield for dairy cows.

		S1	S2	S3
Milk fat (%)	Ctrl	2.53±0.6a	3.51±0.67a	3.18±0.81a
	Fe	3.46±0.03b	5.22±0.47b	5.37±1.29b
	Zn	2.77±0.57ab	4.13±0.96ab	3.5±0.87ab
	Mn	3.01±0.75ab	4.79±1.42ab	3.97±0.83ab

a,b: different letters in same column indicate a significant difference at P<0.05
Values for milk fat percentage are Means ± SD

Table 3. Effect of diets supplemented with organic chelated TE (Zn, Mn and Fe)on the amount of protein in milk of dairy cows.

		S1	S2	S3
Milk Protein (%)	Ctrl	3.16±0.11a	3.2±0.13a	3.14±0.09a
	Fe	3.24±0.13a	3.24±0.09a	3.09±0.1a
	Zn	3.1±0.21a	3.14±0.14a	3.08±0.17a
	Mn	3.19±0.1a	3.05±0.21a	3.03±0.39a

a,b: different letters in same column indicate a significant difference at P<0.05
Values for milk protein percentage are Mean ± SD

Table 4. Pearson's correlations, generated for the study, between fat, protein, Solid Non Fat, density and milk yield (N= 16)

	Fat	SNF	Density	Protein	MY
Fat	1				
SNF	0.011	1			
Density	-0.413	0.834**	1		
Protein	0.430	0.302	-0.105	1	
MY	-0.522*	0.456	0.667**	-0.262	1

*P<0.05, **P<0.01

Table 5. Effect of diets supplemented with organic chelated TE (Zn, Mn and Fe)on the amount absorbed of TE (in mg/day) in dairy cows

		S1	S2	S3
TE absorbed (mg/day)	Control(Zn)	830.5±412.51a	2801.75±745.21a	1627±746.3a
	Zn	7311.25±1007.61b	3973±1066.28a	5763±1510.29b
	Control(Fe)	3063±693.27a	3404±459.88a	3295.5±749.97a
	Fe	6390.25±2560.43a	9958.25±451.89b	9972.25±1120.63b
	Control(Mn)	497.5±226.37a	872±374.22a	417.75±235.87a
	Mn	1427.25±468.03b	898±231.05a	1189.5±500.52b

a,b: different letters in same column for same element, indicate a significant difference at P<0.05; Values for TE absorption are Means ± SD

Milk composition

Fat: For the three months of the study, milk fat is higher for Fe group (3.46±0.03; 5.22±0.47; 5.37±1.29) followed by Mn (3.01±0.75; 4.79±1.42; 3.97±0.83), Zn (2.77±0.57; 4.13±0.96; 3.5±0.87) and control (2.53±0.6; 3.51±0.67; 3.18±0.81) as seen in Table 2. This amount of fat has increased comparing S1 and S2, but has increased only for Fe group when comparing S2 to S3.

Protein: The amount of milk protein during S1 and S2, is higher for Fe group (3.24±0.13; 3.24±0.09) followed by Mn (3.19±0.1; 3.05±0.21), control (3.16±0.11; 3.2±0.13) and Zn (3.1±0.21; 3.14±0.14) groups; while in S3, the highest milk protein is for control group (3.14±0.09) followed by Fe (3.09±0.1), Zn (3.08±0.17) and Mn (3.03±0.39) groups as seen in Table 3. For the three months of the study, no significant difference (P>0.05) seen between milk protein of all groups.

Density: Milk density during the three months of the study is considered the highest for control group (31.75±1.23; 31.23±0.96; 30.96±0.70); while for the other elements, in S1 it is followed by Fe (31.73±1.44), Mn (31.58±0.51) and Zn (30.9±1.82). In S2, it is followed by Fe (29.92±1.26), Zn (28.85±1.48) and Mn (28.43±3.76). In S3, followed by Zn (29.95±2.47), Mn (28.73±1.03) and Fe (28.13±1.77) as figured in Fig.4.

Solid Non Fat: For S1, SNF for Fe group is higher (8.59±0.36) followed by Mn (8.46±0.25), control (8.39±028) and Zn (8.23±0.48) groups; In S2, Fe group still having the higher (8.53±0.26) SNF followed by control (8.48±0.33), Zn (8.29±0.36) and Mn (8.05±0.53) groups; while in S3, control group (8.34±0.23) is having the higher SNF followed by Zn (8.15±0.43), Fe (8.11±0.28) and Mn (7.96±0.19) (Fig.5).

AAS results: When comparing amount of TE absorbed by control group in S1, S2 and S3 to the amount absorbed by supplemented groups (Zn, Mn and Fe), the amount of absorption is always higher for TE groups (Table 5).

DISCUSSION

Milk Yield: According to Weiss *et al.* (2010), no effect for organic Fe supplementation on dairy cow's milk production, this is the case in our study in S1 as no significant difference (P>0.05) between Fe and control group, but that wasn't the case in S2 and S3, as control group produced significantly (P<0.05) more milk than Fe group. But when comparing the amount of milk produced by Fe group between S1 and S2,there is a significant (P<0.05) decrease; while between S2 and S3 an increase that wasn't significant (P>0.05) was seen. Following a study done by Kellogg *et al*. (2004), there is a significant increase (P<0.05) in milk yield between cows fed Zn-Met and cows without Zn supplementation; this wasn't the case in our study as in S1, S2 and S3 a non-significant (P>0.05) decrease was observed. If we compare the milk produced by Zn group following the study, between S1 and S2 a non-significant decrease (P>0.05), meanwhile between S2 and S3 a non-significant (P>0.05) increase was seen. A non-significant (P>0.05) increase in milk yield was seen in cows fed Mn in a study done by Wang *et al.* (2011); this study is in accordance with our results in S1 as no significant difference (P>0.05) between these two groups, but contradict our results in S2 and S3 were a significant increase (P<0.05) between Mn and control group was seen. When comparing milk yield for Mn group following the study, a significant (P<0.05) decrease in S1 and S2. But in S3, milk produced has increased but not significantly (P>0.05) than that in S2. Results of studies done by Baliyan (2015) and Hackbart *et al.* (2010) showed an increase in milk yield after a TE supplementation, those studies contradict our results between S1 and S2 for all treatment groups that have showed a decrease in milk yield, this was caused by external factors present in the farm, as climatic condition in S2 has led to increase stress of the animals, because they were kept in their pen without access to the outdoor court following rainy and cold weather. In addition, forS2also, a bad quality corn silage caused a reduction of milk produced by stressed cows. While between S2 and S3, milk yield has increased in all treated groups, this could be caused by TE supplementation. This result is in accordance with the mentioned two studies above. Regarding the higher milk produced remained for control group among Fe, Zn and Mn groups following all the study; but we should take into consideration that cows of control group originally produce higher milk yield than other groups; in addition, milk yield for control group has decreased from initial quantity in S1 till S3, while it has increased for treatment groups (Fe, Zn, and Mn) between S2 and S3, showing their important effect on MY specialy concerning Zn group that showed a significant (P<0.05) increase in milk yield in S3. Between the three supplemented groups, we can conclude that Zn treatment has showed an increase in milk yield higher than other studied groups.

Milk composition

Fat: Following a study done by DeFrain *et al*. (2016), a significant difference (P<0.05) between fat yield of cows from Fe group and non-treated cows yielded more fat; this result disclaim our results as there is a significant difference (P<0.05) between fat milk of control and Fe group as the last group yielded more fat during all the study. When comparing the yielded fat for Fe group between S1 and S2, we can see a significant increase (P<0.05) between those 2 months. Meanwhile, for S3 a non-significant (P>0.05) difference is seen. According to Sobhanirad *et al*. (2010), no significant difference (P>0.05) between groups supplemented with Zn-Meth and non-supplemented group in milk fat. The result of the previous study is in accordance with our results, as no significant difference (P>0.05) between milk fat of Zn and control group, with Zn group having a higher amount of fat. If we compare the amount of fat produced by Zn group between S1 and S2, a significant(P<0.05) increase of fat in S2 was seen. While a significant (P<0.05) decrease in S3.

A study done by El Esawy *et al.* (2017), has concluded that feeding organic Mn can lead to a significant increase (P<0.05) of fat in cow's milk when compared to a control group. Our results weren't in accordance with El Esawy *et al.*(2017) during all the study, whereas a higher fat yield in Mn group was seen but that wasn't significantly (P>0.05) higher than that of control group. When comparing the amount of fat produced by Mn group between S1 and S2, we can find a significant increase (P<0.05) of fat, while for S2 and S3, no significant difference is present (P>0.05) for the fat produced.A significant negative correlation (r=-0.522; P<0.05) between fat yield and MY figured in Table 4. This negative correlation explains that when MY decreased, milk fat has increased for Fe group especially in S2. For Zn and Mn groups, fat decrease in S3 could be caused by the fact that when milk yield increase, milk fat decrease as in accordance with a study done by Hamad and El-Raghi (2015). Concerning milk fat, Fe group is the best element above others elements studied that increased this component.

Protein: For Fe, De Frain *et al.* (2016) concluded that control group has higher milk protein then Fe supplemented group. This study isn't in accordance with our results, as protein during all the study are higher in control group but not significantly (P>0.05) higher than Fe group. Following all the study, the amount of protein of Fe group wasn't significantly different (P>0.05). For Zn, a study done by Sobhanirad *et al.* (2010), found that there is no significant difference (P>0.05) between organic Zn supplemented and non-supplemented group, in the level of protein in milk. This study is in relation with our results as no significant difference (P>0.05) between control and Zn groups following all the study. When comparing milk protein for Zn group for S1, S2 and S3, we conclude that no significant difference (P>0.05) was seen. Finally for Mn, Wang *et al.* (2011), showed that there is no significant difference (P>0.05) between groups supplemented with organic Mn and non-supplemented group (control) for their amount in protein. The obtained results are related to the previous study as no significant difference (P>0.05) is seen between control and Mn group following all the study. For Mn group, the period of the study did not affect the milk protein of this group as no significant difference (P>0.05) was present. A study done by Del Valle *et al.* (2015), showed that no effect of supplementing organic TE on milk protein. As in accordance to this study, we can conclude that these evaluated TE have no effect on milk protein.

Density: Weiss *et al*. (2010) has shown that no effect for organic Fe supplementation on milk composition. This study is related to our results in S1 and S2 with no significant difference (P>0.05) when comparing control to Fe groups; while it is not the case in S3, as milk density of Fe group is significantly (P<0.05) lower than control group. Milk density of Fe group has decreased in S2 when compared to S1 and was significant (P<0.05), and it continue to drop in S3 but wasn't significant (P>0.05) when compared to S2. Sobhanirad *et al.* (2010) has proved that no significant (P>0.05) effect of Zn supplementation on milk density. The results of our study are in accordance with this study as the density of milk between control and Zn group wasn't significantly different (P>0.05) in S1, S2 and S3. If we compare the milk density of Zn group following the study, we conclude that a significant difference (P<0.05) is seen when comparing S1 and S2 as milk density decreased, but in S3 density has increased with no significant difference (P>0.05) with S2. According to El Esawy *et al.* (2017), feeding Mn-met has improved milk composition; as the results of our study has shown no significant difference (P>0.05) between control and Mn group when comparing S1 to S2, but a significant difference (P<0.05) was seen in S3, as Mn group has a lower milk density than control group. The factor of time affected the milk density of Mn group, as when we compare S1 to S2, the difference was significant (P<0.05) and has dropped in S2. Whereas between S2 and S3, no significant difference (P>0.05) in milk density is seen. Between milk density and MY, a strong positive correlation (Table 4) that is highly significant (r=0.667; P<0.01) is present. We can find that when MY increased, milk density increased as this finding also figured by a study done by Ueda (1999). As for milk density, treatment with these TE showed no effect on this factor.

SNF: Weiss *et al*. (2010) founded that no significant difference (P>0.05) between Fe supplemented group and control group. This result is in accordance with our results, where no significant difference (P>0.05) between Fe and control groups following all the study. Concerning Fe group, when comparing S1,S2 and S3 for SNF amount, we can see a small reduction in S2 but a higher decrease in S3, but still those differences weren't significant (P>0.05).

According to Sobhanirad *et al*. (2010), there is no significant difference (P>0.05) between groups supplemented with organic Zn and control group in the amount of SNF in milk. This study is in accordance with our study, as no significant difference (P>0.05) in SNF for Zn and control groups.

The density of milk produced by Zn group for the 3 months of the study isn't significantly different (P>0.05). A study done by Wang *et al*. (2011) has concluded that no significant difference (P>0.05) between groups supplemented with organic Mn and non-supplemented group in SNF of milk; this result is in conformity with our study for S1 and S2 as no significant difference (P>0.05) between control and Mn groups; while it contradict the results in S3 where there is a significant difference (P<0.05) with Mn group having a lowest level of SNF. Following the months of the study, SNF for Mn group has decreased but the decrease isn't significant (P>0.05). Pearson correlation between SNF and milk density (Table 8.) is considered a perfect positive correlation that is significant (r=0.834; P<0.01), this is seen when SNF and milk density decreased in S3 especially for Fe group. This is also found in a study done by Ueda (1999). We can conclude that the three tested supplementations (Zn, Mn and Fe) didn't affect the amount of SNF in milk.

AAS results: For Zn absorption, a significant difference (P<0.05) between Zn and control group during S1 and S3, with Zn group having higher amount absorbed. Concerning S2, the amount of Zn absorbed by treated group is greater but isn't significantly (P>0.05) higher than control group. The amount of Fe absorbed by Fe treated group is higher than control group but isn't significant (P>0.05) in S1. Meanwhile for S2 and S3, the difference is significant (P<0.05) with major amount of Fe absorbed. Finally, for Mn absorption, a significant (P<0.05) difference in the amount absorbed of TE when comparing Mn to control group in S1 and S3; but wasn't significant (P>0.05) in S2 despite the higher amount absorbed by Mn group. The amount absorbed of each studied elements was higher for the treatment groups compared to the control group, those results where predicted as in the basal diet, most of TE are in a unavailable form or interact with other nutrients in the gastro-intestinal tract, meanwhile highly absorbable and protected organic TE, allow the cow a better use of these elements with reduction of their excretion in the environment.

As the amount of TE absorbed in treated groups is higher than that found in feces, than they will not found in the soil after being applied to it, avoiding soil and ground water pollution that leads to toxicities for plants, animals and humans (Goselink and Jongbloed, 2012). From the results obtained, we can conclude that, despite the higher amount of TE absorbed from Fe, the uptake of Zn was better because we compared the initial ingested amount with the amount absorbed. Furthermore, Grace (1975) showed that inorganic source of Zn found in the basal ruminant diet is absorbed in a rate of 26.5%, so 73.5% are non-assimilated and excreted. Also, according to Eren *et al.* (2013), concerning the comparison between organic and inorganic form of Zn, has proved that organic Zn is found in 25% lesser amount in feces then that of inorganic Zn group. When comparing to our study, results showed that 57% of ingested Zn was absorbed while only 43% are eliminated by feces. Finally, this leaded us to conclude the importance of organic form of TE in mean of absorption, and more precisely for Zn.

Conclusion

TE are essential elements for dairy cow's production and health, but their absorption is low. This study objective was to evaluate the absorption of chelated Zn, Mn and Fe elements and their effect on cow's milk production and composition. Collected results confirmed that supplementation with organic TE have many positive effects on cow's milk performance, as the results showed a small increase in milk produced by supplemented groups compared to control in the third month of the study. In addition, they showed some effects on milk components, as Fe has increased significantly milk fat; while an increase was also observed for Mn and Zn groups but wasn't significant, yet still higher than control's group milk fat. And finally, organic TE supplementations have reduced large amounts of unabsorbed TE in the environment, by making them a dissipated form in the body of the ruminants. Those effects highlight the addition of these elements in dairy cows feeding practices and to replace inorganic unavailable forms. Our study showed that Zn element has best effect on cow's milk (quantity and quality) and absorption.

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List of Abbreviations

AA	Amino Acid
AAS	Atomic Absorption Spectroscop
et al.	And others
Fe	Iron
Fig.	Figure
g	gram
Kg	kilogram
Mn	Manganese
Milk	Yield
S1	First month of the study
S2	Second month of the study
S3	Third month of the study
SD	Standard of Deviation
SNF	Solid Non Fat
TE	Trace Elements
Zn	Zinc

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