Mineral Profile of Goats' Milk and its Relationship to the Surrounding Environment of El Salam Canal Area, East Suez Canal, Egypt

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Abstract: ***The content of selected macronutrients (N, P and K) and micronutrients (Fe, Mn, Zn, Cd and Pb) of soil, forage as well as goats' milk samples collected from El-Salam Canal area, East Suez Canal, Egypt were evaluated. Samples were collected from three different sites, namely: El-Tina Plain, Gilbana and Baloza. The first two sites depending on El-Salam Canal water but the third one depending on potable water which is carried to El-Arish across El-Qantara water station; this is the main source of Nile water to Sinai. The macro and micro mineral concentrations significantly ($P \leq 0.05$) varied among the different locations. All available macronutrients and micronutrients in both of Sahl El-Tina and Gilbana were found to be higher than that recorded in Baloza, except in the concentration of P, but considered to be adequate for normal plant growth, while P and Zn in the soil samples were deficient. It is worthy to mention that, the concentrations of these elements in forage samples had variable amounts and appeared to be higher in N and Mn concentrations at the first two sites (El-Tina Plain and Gilbana) also Pb and Fe concentrations seemed to be high in all locations. In addition, no toxic accumulation of any mineral was detected in forage during the study period. According to the residues of macro minerals N and K in goats' milk samples, the concentrations were under the maximum residue limits. There were severe deficient of phosphorus levels in milk samples, these levels were parallel to forage and soil P concentrations. On the other hand, high levels of Pb were recorded at all the three locations, these levels were also parallel to forage Pb concentrations but were not parallel to soil Pb. Finally, one can say that, these variations in mineral profile between the different locations may be due to the complex relationship between soil, plant, water and goats grazing in these different locations which is reflected on the mineral profile of goats' milk in these specific locations.***

Keywords: Mineral profile, Goats' milk, Macronutrients, Micronutrients.

1. Introduction

El-Salam Canal is one of the five-mega irrigation projects located at the Northern Sinai, Egypt. It has an impact on animals' health and production. The Egyptian Government envisages the reclamation of an estimated 620,000 Fed. of desert situated along the Mediterranean coast of Sinai by diverting considerable amounts of agriculture drainage water to newly reclaimed areas after blending with Nile water in a ratio about 1:1, this mixing of water may be lead to water pollution which is a major global problem [1, 2]. Additionally, it suffers from many pollutants such as: high levels of minerals, heavy metals, organic matters, residues of pesticides, herbicides as well as microbial contamination [3, 4, 5].

The performance and health of grazing livestock is depending upon the adequacy and availability of both essential macro and micro elements from pastures. Under this system, animals depend on forages to satisfy all of their nutritional requirements. Forage minerals are the most variable at pastures but often fail to supply all needed elements in adequate quantity to grazing ruminants [6]. Many dangerous elements or compounds, such as metals and metalloids accumulate along the food chain. Furthermore their concentrations in the environment grow with the increase of urban, agricultural and industrial emissions. The almost ubiquitous presence of some metal pollutants, especially Cd and Pb, facilitates their entry into the food chain and thus increases the possibility of them having toxic effects on humans and animals.

Although heavy metals have industrial uses, their potential toxicity for people and animals is the object of several studies. For some elements the effects are accumulative and it is necessary to control them level in consumed food [7]. On the other hand, minerals are vital for normal growth, reproduction, health and proper functioning of the animal's body, it protect and maintain the structural components of the body, organs and tissues, and are constituents of body fluids, as well as catalyze several enzymatic processes and hormone systems; maintain acid-base balance, water balance and osmotic pressure in the blood and cerebral spinal fluids [6]. The measurements of major and minor contents, which comprising N, P and K and Fe, Mn, Zn, Cd and Pb considered a helpful in assessment of quality of soil, plants and milk especially in the study areas (which depending on El Salam Canal water, North Sinai).

Goats are considered highly suitable animals for rising in such arid and semi arid regions in many parts of the world [8]. Milk production is a dynamic growing industry which has been recognized all over the world for its beneficial influence on human health as well as their economic importance [9]. It is an important source of all basic nutrients required for mammals including human beings. Also it is a complex, bioactive substance that promotes growth and development of mammalian infants and it is considered as a nearly complete food since it is a good source of proteins, fats, sugars vitamins and minerals. Therefore, milk and dairy products are important components of human diets that are widely consumed by human children and adults especially elderly people around the world [10].

Concerning goats' milk, it is of particular economic interest in the developing countries. Goat milk has an important role in the nutrition of children who are allergic to cow milk, also it is recommended in the case of digestion problems. Goat milk has many unique characteristics, which supports the contention of high qualities of dairy products from goat milk for human nutrition [11]. Also specific nutritional and functional properties are the main reasons of the higher interest for goat milk and its products regardless of, the physiological and biochemical facts of the unique qualities of goat milk are just barely known and little exploited [12]. Goat's milk is more easily digested due to its different protein composition and finer fat dispersion. Goat milk contains more essential fatty acids, and also more fatty acids with shorter chains. It contains less provitamin A (this accounts for its chalk white color), vitamin B_{12} and folic acid [13].

The production of goats' milk has to be a useful strategy to tackle the problems of under nutrition. Although the world production of goat milk has been relatively minor compared to that of bovine milk with 55% increase during the last 20 years, and goat milk production has reached 12.2 million tones with 58% increase during the same period [13]. Similarly like in other foods, the qualities of goats' milk are carefully checked and comply with general hygienic requirements. Although, milk is an ideal source of macro element (Ca, K and P) and micro elements (Cu, Fe, Zn, Se), addition amounts of contaminant metals may enter milk and dairy products reaching levels that are harmful to humans [14]. Many reports indicate the presence of heavy metals in milk; it is needed to assess the levels of heavy metals in food. Lead, cadmium and mercury residues in milk are of particular concern because milk is largely consumed by infants and children [15, 16] and the determination of these heavy metals levels in milk is particularly attended by international organizations [17].

There has been much interest regarding minerals because they are essential nutrients bearing significant role in the animal nutrition because their excess or deficiency produces "detrimental effect" in the performance of livestock. The quality and quantity of mineral nutrients in foraged mainly depend upon factors like texture of soil, fertilization and irrigation water. Many other factors affect soil mineral content, availability of minerals to plants and availability of minerals in forages to grazing animals. It is therefore difficult to single out one or two factors that explain most of the variation in mineral content of animal tissues, plants and soil [18]. Therefore, the objective of this study was to determinate the concentrations of three major (N, P, K) and five minor (Fe, Mn, Zn, Cd and Pb) nutritional important minerals in soil, forage and goats' milk from three locations around El-Salam Canal area; El-Tina Plain, Gilbana and Baloza because, there is scanty information on the mineral nutritive potential of forages in different regions of North Sinai, Egypt. Mineral profile of soil, forage and goats' milk were done in order to explore the suitability of goats' milk production under the environmental problems in El-Salam Canal area, East Suez Canal, Egypt. Increasing the milk production in Sinai is a very important goal. So, further deep studies are required for optimum productivity of grazing ruminants, especially goat at this specific region of Egypt. As well as the monitoring activities for El-Salam canal water and its all branches must be continuing.

2. Materials And Methods

2.1 Materials

Soil, forage and goats' milk samples were obtained from three different cites namely: Sahl El-Tina, Gilbana (depending on El-Salam canal water) and Baloza (depending on potable water which is carried to El-Arish across Al-Qantara water station, the main source of Nile water to Sinai), located at El- Salam Canal area, North Sinai, Egypt, between longitudes 32º20'35"and 32º33'10" east and latitudes 30º57'25" and 31º04'28" north under arid conditions; the annual rainfall ranges from 33.3 mm to 70.2 mm and occurs over a short period (from October to March) [19].

Soil samples were collected (at depth of 0-30cm and 30-60cm) from selected previous sites (ten samples from each site). Chemical and physical analysis of soil samples were analyzed according to [20] and are presented in **Table 1.**

Table 1: Physical and chemical properties of soil samples

Study Locations	*Coarse Sand (%)*	*Fine sand (%)*	*Silt (%)*	*Clay (%)*	*Soil texture class*	*Soil depth (cm)*	*pH*	*EC (dS/m)*	*O.M (%)*	*$CaCo_3$ (%)*	*SAR*	*ESP (%)*
1	2.16	65.83	10.60	21.41	SCL*	0 -30	7.80	7.70	0.27	5.47	17.50	18.80
						30-60	7.60	8.20	0.25	3.28	12.30	11.40
2	2.78	60.77	13.47	22.98	SCL	0 -30	7.80	10.00	0.38	4.79	34.20	32.90
						30-60	8.00	9.50	0.35	3.44	29.80	26.90
3	2.03	72.19	20.57	5.21	SL*	0 -30	7.90	7.90	0.33	5.61	15.60	19.40
						30-60	8.00	8.50	0.29	2.74	12.40	20.60

1: Sahl El Tina; 2: Gilbana; 3: Baloza; SCL*: Sandy Clay Loam: SL*: Sandy Loam

Forage samples were harvested to include a mixture of grasses crop residues and legumes species that form the major portion of the diet consumed by grazing ruminants in the study locations. Plants were cut using a stainless steel knife and placed in clean cloth bags on location and were weighed and air-dried for a day, to reduce water content, then oven-dried at 70–80°C for 24h, to remove all moisture. Dried samples were powdered using a Wiley mill, with a 1 mm stainless steel sieve for further use. The collected plants were commonly browsed by goats and from the same place where soil and water samples were collected. Chemical composition of forage samples were determined according to [21] and are presented in **Table 2**. Chemical and physical analysis of water (**Table 3**) was analyzed according to [22]

Goats' milk samples were collected from dairy healthy goats (three groups, fifty healthy goats in each group), immediately cooled to 6 ± 1°C, and kept cold until used.

Table 2: Chemical composition of forage samples

Items	*Study locations*		
	1(Sahl El Tina)	*2 (Gilbana)*	*3(Baloza)*
Dry Matter (DM)	37.04	68.18	88.5
Ash	11.49	11.96	14.5
Crude Protein (CP)	7.18	7.26	13.2
Crude Fiber (CF)	28.23	27.93	24.9
Ether extract (EE)	2.76	1.35	2.86
Nitrogen free extract (NFE)	50.34	51.5	44.56
NDF(Neutral Detergent Fiber)	59.93	67.5	76.6
ADF(Acid Detergent Fiber)	37.45	38.32	28.3
Cellulose	27.35	20. 22	25.1
Hemicellulose	22.48	29.18	48.3

Table 3: Chemical analysis of water samples

Study Location	pH	EC dSm^{-1}	Soluble cations (mg/l)				Soluble anions (mg/l)				SAR*
			Na^+	Ca^{++}	Mg^{++}	K^+	CO_3^-	HCO_3^-	Cl^-	SO_4^{--}	
1	8.01	2.20	9.46	4.26	1.55	0.41	-----	2.90	10.75	1.85	5.63
2	8.20	1.97	10.35	3.57	5.30	0.28	-----	2.86	8.40	7.35	5.19
3	8.00	2.40	8.25	5.10	3.11	1.12	-----	4.36	9.17	2.16	4.53

1: Sahl El Tina; 2: Gilbana; 3: Baloza; SAR*: Sodium adsorption ratio.

2.2 Methods

1-Chemical and physicochemical analysis:

Milk samples were analysed for their moisture (by dry oven method) , fat (using Gerber method), total nitrogen (TN) (using micro-Kjeldahel method); and ash (using Thermolyne, type 1500 Muffle Furnace) contents ; as well as pH values (using digital pH meter, Inolad model 720, Germany) according to [23]. Total carbohydrates were calculated by the difference. Chemical composition (Mean± Standard deviation) of fresh goats' milk used is presented in Table 4. Minerals profile analyses of the milk samples were determined as described by [24]. Milk samples were dried overnight at 102 °C then ashed at 550ºC (using Thermolyne, type 1500 Muffle Furnace) for 6 h. The metals were determined by spectroscopic methods by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS, ICAP 6500 Duo, thermo scientific, England.) and Flame Photometer Corning 410 Flame Photometer (Ciba Corning Diagnostics Scientific Instruments, Essex, England) for selected macro (N, P& K) and micro (Fe, Mn, Zn, Cd &Pb) minerals, respectively.

Table 4: Chemical composition (Mean± Standard deviation) of fresh goats' milk

Samples	**pH**	**Chemical composition (%)**				
		Fat	**Protein**	**Ash**	**Total carbohydrates**	**Total Solid**
1	6.67±0.01	3.32±0.15	3.49±0.02	0.81±0.04	4.25±0.02	11.87±0.20
2	6.66±0.01	3.37±0.23	3.55±0.02	0.75±0.04	4.28±0.03	11.95±0.27
3	6.65±0.01	3.58±0.18	3.57±0.03	0.69±0.03	4.43±0.01	12.27±029

1: Sahl El Tina; 2: Gilbana; 3: Baloza; Protein % = T.N %× 6.38; Total carbohydrates%: calculated by the difference.

Soil and forage samples were collected from the previous selected locations and examined in order to assess their mineral contents using microwave digestion technique (in a closed Teflon vessel under high temperature and pressure control) as reported by [25]. The metals were determined by spectroscopic methods by Inductively Coupled Plasma Mass Spectroscopy (ICP-MS) and Flame Photometer for selected macro (N, P& K) and micro (Fe, Mn, Zn, Cd and Pb) minerals.

2- Statistical analyses

All experiments and analysis were done in triplicate. Statistical analyses were carried out using the General Liner Models procedure of the SPSS 16.0 Syntax Reference Guide [26]. The results were expressed as least squares means with standard errors of the mean. Statistically different groups were determined by the LSD (least significant difference) test ($p \leq 0.05$).

3. Results and Discussion

3.1 Minerals content in soil samples

Results of soil analysis revealed variations in mineral content among the three locations (Sahl El-Tina, Gilbana and Baloza) at El-Salam Canal area, East Suse Canal, Egypt and comparing with recommended critical levels of soil mineral concentrations. The mean (±SE) values of macronutrients (N, P & K) and micronutrients (Fe, Mn, Zn, Cd and Pb) in soil of the three different zones in the study area are given in Table 5. The maintenance of soil fertility depends on continuous incorporation and transformation of organic matter into soil, nutrients present in soil only become available to plants when certain essential conditions are satisfied. The mineral imbalances in soil and forage cause impaired performance and abnormal growth in ruminants [18]. The high mean (±SE) of nitrogen content of the soil was 42.19±0.08ppm, dry weight (DW) which recorded at site2 (Gilbana), Nitrogen occurs in soil as organic and inorganic forms and soil testing may be performed to measure levels of either.

Table 5: Status of soil available macronutrients and micronutrients (mg/kg) for the study area at North Sinai, Egypt

Element / Samples	N	P	K	Fe	Mn	Zn	Cd	Pb
1	38.44^{b}±0.11	3.63^{ab}±0.42	185.26^{b}±1.46	1.96^{a}±0.02	6.48^{b}±0.03	0.95^{a}±0.001	0.22^{a}±0.001	0.10^{a}±0.0002
2	42.19^{a}±0.08	3.54^{b}±0.15	192.15^{a}±0.98	1.86^{a}±0.05	6.77^{a}±0.02	0.96^{a}±0.002	0.16^{b}±0.001	0.08^{a}±0.0003
3	33.27^{c}±0.06	3.77^{a}±0.10	179.64^{c}±0.99	1.55^{b}±0.01	6.26^{c}±0.02	0.80^{b}±0.001	0.09^{c}±0.003	0.05^{b}±0.0001
C.L.	20*	10	62*	2.5*	5	1	1-3	0.1-0.5

In the same column, means in a certain item having the same letter do not differ significantly. C. L. Critical levels according to [27]; * [28].

Nitrate nitrogen (NO_3-N) is most commonly measured in standard soil tests because it is the primary form of nitrogen available to plants and, therefore, an indicator of nitrogen soil fertility. These high levels may be due to using El-Salam Canal water in this two sites and increasing of the nitrogen fertilizer residues from agricultural drainage water that feed into the canal from the two major agricultural drains (El Serw & Bahr Hadous). While phosphorus content was 3.77±0.10ppm at site3 (Baloza), this concentration was higher than the other two sites and that may be returned to soil in this region has specialized physical and chemical nature [29]. Low soil moisture is said to reduce P uptake by plants thereby causing an increase in soil P, it is also affected by soil pH [30]. Based on the critical levels reported for soil, it was observed that the soil of the study area were classified as below critical level for P. Phosphorus deficiency is the most widespread and economically important mineral deficiency of grazing livestock, this is attributed to the fact that most soil are reported to be deficient in phosphorus [31]. Concerning potassium content in soil of different sites was invariably higher than the critical level in all soil samples and recorded 192.15±0.98ppm at Gilbana. It is worthy to mention that the soil samples obtained from the three sites were deficient in iron and the highest concentration 1.96±0.02ppm was recorded at Sahl El-Tina (site1), this finding was nearly similar to that reported by [32]. Among the micro minerals, iron content in soil was low against the critical level of 2.5 ppm. However, acid soil conditions favor availability and plant uptake of Fe; even plants grown on neutral or slightly alkaline soil often contain quite high levels of Fe. The idea that Fe deficiency cannot be expected to be widespread due to sufficient content of Fe in soil and adequate pasture conditions [33]. It was observed that in all the samples Manganese level was above the critical level (5 ppm) concentration and the lowest concentration was 6.26±0.02ppm and recorded at Baloza (site3) these concentrations were adequate for normal plant growth. Also Zn, Cd & pb concentrations were found to be lower than the critical level in the three soil samples. Lower levels were obtained by [34, 35] Generally, the variation in the concentration of these heavy metals may be attributed to local conditions prevailing in each site such as irrigation, drainage and management. It may be also affected with sedimentation regime prevailing during soil formation and profile development. The high levels may result to these soil irrigates with El-Salam Canal water which feeding from the Damietta Branch of the Nile and the agricultural drains which is rich in nutrients [4].

3.2 Mineral content in fodder samples

All plants depend upon the soil for their supply of mineral nutrients, and grazing ruminant animals obtain the majority of their mineral nutrients from plants grown on these soil. The mean (±SE) concentrations of N, P and K in composite fodder samples were 2.59%, 1.28% and 0.24% for site1 and 3.36%, 0.90% & 0.29% for site2 and1.82%, 0.67% & 0.31for site3, respectively. Majority of the forge samples analyzed contained low N and P based on the critical values; Table 6 at site3. Plant content of mineral elements is dependent upon the interaction of a number of factors including soil, plant species, stage of maturity, yield, pasture management and climate.

Table 6: Status of forage macronutrients and micronutrients

Element / Samples	N%	K%	P%	Fe mg/kg	Mn mg/kg	Zn mg/kg	Cd mg/kg	Pb mg/kg
1	2.59^{b}	1.28^{a}	0.24^{b}	83.02^{a}	50.23^{a}	28.55^{a}	0.80^{a}	5.76^{a}
2	3.36^{a}	0.90^{b}	0.29^{a}	63.25^{b}	47.65^{b}	11.63^{c}	0.71^{a}	4.74^{b}
3	1.82^{c}	0.67^{c}	0.31^{a}	59.19^{c}	16.45^{c}	15.27^{b}	0.54^{b}	3.32^{c}
C.L.	2.5	0.5	0.20	50	40	30	0.1*	0.2*

In the same column, means in a certain item having the same letter do not differ significantly
C. L. Critical levels according to [36] and Cd and Pb * according to [27].

Most naturally occurring mineral deficiencies in herbivores are associated with specific regions and are directly related to soil characteristics [36]. Regarding, phosphorus concentration showed little variation among the three sites. Among all mineral nutrients potassium is one of them which is most effected by forage maturity [18]. Potassium in different growing forages commonly is high thus; the grazing livestock consuming primarily a forage diet would receive adequate K. In certain regions of the world it is possible that K deficiency could arise, in view of decreasing content of this mineral with increasing forage maturity. High forage diets typically contain several times the amount of K present in high grain diets. K is not readily stored and must be supplied daily in the diet [33]. The latter authors indicated that trace mineral concentrations are affected by four interdependent factors:1) the genus, species or variety of crop, 2) type and mineral concentration of the soil, 3) stage of plant maturity, and 4) climatic or seasonal conditions. According to [37] only about 27 percent of the soil sampled had low levels of K or could be considered to be deficient in K. The majority had sufficient reserves of K to meet the requirements of most plants. Concerning micronutrient in forage samples the results revealed that iron concentrations were 83.02, 63.25 & 59.19 ppm for the three sites, respectively; these values were higher than the critical level. These levels were sufficient for the requirements (50 mg/kg) of ruminants for optimal performance [38]. These levels of forage Fe in the present study may support the reports of various researches who found similar concentrations of Fe in Egypt [39]; in Nicaragua [40] and Pakistan [33], this is because mineral content of a plant depends to some extent on the mineral content of the soil [31]. On the other hand, the Mn concentrations in fodder samples were higher than the critical level at site1and site2, while it was lower than this level at site three (Baloza which depend on tap water). Among different sites, narrow variation (11.63 to 28.55 ppm) was observed in case on Zn. Regarding Cadmium concentration, the fodder samples contained high Cd based on the critical level (0.1Vs 0.80 ppm). Cadmium is a highly toxic metal with a natural occurrence in soil, but is also spread in the environment due to human activities. It is easily taken up and accumulated by plants and crops through the root systems and is present in all food [41]. Generally an increase in soil cadmium content will be reflected in a similar increase of cadmium in crop plant tissuez [42]. On the other hand, lead concentration in fodder samples also showed variations among different three sites and recorded 5.76, 4.74& 3.32ppm respectively. The later authors stated that Lead has recently received much attention as a major chemical pollutant of the environment and as a toxic element to plants. It was observed that all the fodder samples contained higher concentration of Pb than the critical level (0.05-0.2ppm) this might be attributed to the higher content of lead in soil samples. The differences of the metal contents in plants depend on the physical and chemical nature of the soil and absorption capacity of each metal by the plant, which is altered by various factors like environmental and human interference, and the nature of the plant [43].

3.3 Mineral Profile of Goats' Milk

The macro and micro nutrient levels in goats' milk samples collected from different sites located at El-Salam Canal area, North Sinai, Egypt are presented in Table 7.

Table 7: Macronutrients and micronutrients of goats' milk from different sites at North Sinai, Egypt

Element / Samples	N	K	P	Fe	Mn	Zn	Cd	Pb
1	$30.25^{a}\pm0.02$	$1287^{c}\pm1.16$	$9.38^{b}\pm0.20$	$0.56^{a}\pm0.004$	$0.22^{a}\pm0.001$	$3.31^{a}\pm0.0051$	$0.089^{a}\pm0.002$	$0.184^{a}\pm0.068$
2	$27.43^{b}\pm0.01$	$1349^{b}\pm1.14$	$9.50^{b}\pm0.16$	$0.43^{b}\pm0.002$	$0.19^{b}\pm0.001$	$3.08^{a}\pm0.0021$	$0.072^{a}\pm0.003$	$0.160^{b}\pm0.025$
3	$27.26^{b}\pm0.01$	$1544^{a}\pm1.33$	$10.44^{a}\pm0.36$	$0.38^{b}\pm0.002$	$0.18^{c}\pm0.001$	$1.44^{b}\pm0.001$	$0.016^{b}\pm0.005$	$0.153^{c}\pm0.022$
MRLs*	36	1500	1210	0.7	0.32	5	0.01	0.02

1: Sahl El-Tina; 2: Gilbana; 3: Baloza; *: Maximum residue limits according to [44].

Means in the column with the same small $^{(a,\ b)}$ superscript letters indicate no significant ($P<0.05$) differences between locations.

The results revealed that, variations in mineral content were found among the three locations. Goats' milk samples collected from Sahl El-Tina were characterized with the highest nitrogen (N) (30.25±0.02ppm) residues than that of Gilbana and Baloza. It could be due to that, Sahl El-Tina using depending on El-Salam Canal Canal water and the high amount of the nitrogen fertilizer residues from agricultural drainage water that feed into the canal from the two major agricultural drains (El Serw & Bahr Hadous). Significant differences ($p\leq0.05$) were found between different locations. While, no significant differences ($p\leq0.05$) were found between goats' milk samples collected from Gilbana and Baloza. It is well known that, N is essential for the maintenance of osmotic and fluid balance in the body [45].

There were significant differences ($p\leq0.05$) between different locations in the concentration of K (ppm), Goats' milk samples collected from Baloza had the highest potassium (K) concentration followed by Gilbana and Sahl El-Tina. Regarding, K was the most concentrated of the major metals in soil samples (Table, 5). [46] Reported that the average of Potassium requirement for goats and sheep are 0.50-0.80%. It is well known that, milk is the major source of K and similar concentration of K in goats' milk has been reported by [45].

On the other hand, phosphorus (P) is the most deficient mineral throughout the world and must be supplemented to livestock grazing native forages in order to meet requirements also eighty percent of P in the body is found in the bones and teeth [46]. It could be observed from the data that, there were significant ($P\leq0.05$) differences in P levels between milk samples collected from Baloza in one side and Sahl El-Tina and Gilbana on the other side (Table, 7), being the lowest level in goats' milk samples from Sahl El-Tina (9.38 ppm). In addition, it could be noticed from the presented data and previous results of both soil (Table, 5) and forage (Table, 6) that, phosphorous levels in milk were parallel to soil and forage P.

From Table (7), it could be observed that, the concentration of iron (Fe) varied according to the location ($P\leq0.05$). Based on the presented results, there was significant ($P<0.05$)

difference between the level of Fe in milk samples among Sahl El-Tina and the two other sites (Gilbana and Baloza), the concentrations were below maximum residue limits. Goats' milk samples collected from Sahl El-Tina was characterized by highest Fe values during the study period. On the other side, Goats' milk samples collected from Gilbana had higher Fe values than that from Baloza; it could be attributed to the presence of Fe concentrations in both of soil and forage (Table 5, 6, respectively). Concerning iron (Fe), it is normally causes slight toxicity, but excessive intake can cause siderosis and damage to organs through excessive iron storage. The concentration of Fe of goats' milk samples collected from the three locations is below the maximum residue limit (0.7) according to [44]. [47] Reported that Fe deficiency is rare in grazing livestock due to a generally adequate content in soil and forages together with contamination of plants by soil. However, milk does not contain enough iron and foliate to meet the needs of growing infants, and the low iron content is one reason that milk are not recommended for infants younger than 12 months old.

Regarding, the results revealed that the mean concentrations of manganese (Mn) of all examined goats' milk samples collected from the different locations were below the maximum residue limits according to [44]. In addition, there were significant ($P \leq 0.05$) differences in Mn levels (ppm) between milk samples among the study locations (Sahl El-Tina, Gilbana, Baloza) being the highest values at Sahl El-Tina (0.22 ppm). [9] Reported that Mn acts as cofactor in several enzyme systems and the high level of heavy metals occurred in fresh milk is mainly explained by the pollution of the environment and feed stuff's accumulated contamination, goats' milk samples recorded 0.27±17ppm Mn.

Considering the concentrations of zinc (Zn), data reveled that, Zn concentration was varied between the study locations, being the lowest contents at Baloza (1.44±0.001ppm) (Table,7). While, the highest concentration was observed at milk samples collected from Sahl El-Tina. Also, Zn values at the three sites were below the maximum residue limits and there were significant ($P \leq 0.05$) differences among the three study locations in the respective milk samples. It is well known that, Zn is an important in stress management, immune response, enzyme systems and protein synthesis [9].

Table (7) shows that, the differences in cadmium (Cd) concentration between milk samples collected from Baloza and the other two sites were significant ($P \leq 0.05$).Among collected goats' milk samples, Sahl El-Tina characterized by the highest Cd concentration. [12] reported that, Cd is an essential nutrient for goats. It affects calcium metabolism and skeletal changes resulting from calcium loss and ends in decrease bone mineral density [48]. The later authors recorded that Cd concentration was 0.03ppm in milk samples from Najran Region in K.S.A.

Concerning of lead (Pb) residues of collected milk samples, the results revealed that mean concentrations were 0.184±0.068, 0.160±0.025 and 0.153±0.022 ppm for Sahl El-Tina, Gilbana and Baloza, respectively. It could be also noticed that, there were significant ($P \leq 0.05$) differences between the levels of Pb in milk samples among the three sites (Table, 7). The detection of residual concentrations of Pb in all milk samples could be due to the contamination of the soil and fodder, which the lactating goats were nourished [49, 50].

Meanwhile, there were variations in micro minerals of goats' milk samples among different study locations. Milk samples collected from Sahl El-Tina and Gilbana regions characterized with the higher residual concentrations of both Cd and Pb than that found of milk samples collected from Baloza. Possible explanation could be due to that, these two locations (Sahl El-Tina and Gilbana) depending on El-Salam Canal water which is suffering from many pollutants such as high levels of minerals and heavy metals, same findings reported by [39, 4]. On the other hand, [51] reported that, Pb values in soil, forage and milk are very low, so there were no hazards of any toxicity of lead for animals and public health, concentrations in milk samples were ranged from 0.018 to 0.050 mg/L which is lower than our results.

Among the trace metals cadmium (Cd) and lead (Pb) were higher than the maximum residues limits according to [44] in all milk samples (Table, 7). Cd and Pb levels of goats' milk samples collected from Sahl El-Tina and Gilbana were parallel to the previous obtained results presented in Tables 5 and 6. Also, water used in these two regions, either to irrigate crops or drinking animals have an important role significantly affected our results. Same observations reported by [48]. More detailed studies are needed.

From the aforementioned results, it could be concluded the examined soil, plants and goats' milk samples from the investigated area (Sahl El-Tina, Gilbana and Baloza) at northern Sinai Governorate, included a high variety of heavy metals residues at Sahl El-Tina and Gilbana, which depending on El-Salam Canal water than that at Baloza. Also, some minerals levels in milk were parallel to soil and/or forage. Therefore, caution should be taken when establishing programs for the use of drainage water as El-Salam canal project. The impact (short or long) of such programs on soil properties, crop and animal production should be carefully assessed. Water, soil, pla nt and biological indicators monitoring programs are required to follow the changes which will take place and adjust policies accordingly. So further deep studies are required for optimum productivity of grazing ruminants, especially goats at these specific regions of Egypt. As well as the monitoring activities for El-Salam canal water and its all branches must be continuing.

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