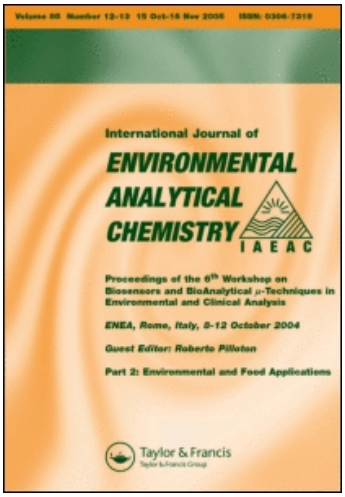

International Journal of Environmental Analytical Chemistry
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713640455

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To cite this Article Rashed, M. N.(1992) 'Determination of Trace Elements in Milk of Some Animals from Aswan (Egypt)', International Journal of Environmental Analytical Chemistry, 48: 1, 41 — 50
To link to this Article: DOI: 10.1080/03067319208027041
URL: http://dx.doi.org/10.1080/03067319208027041

Intern. J. Environ. Anal. Chem., Vol. 48, pp. 41–50
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DETERMINATION OF TRACE ELEMENTS IN MILK OF SOME ANIMALS FROM ASWAN (EGYPT)

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(Received 21 February 1991; in final form 21 October, 1991)

Major, minor and trace elements, including Ag, Au, Ca, Cr, Cu, Mg, Mn, Co, Na, Ni, K, Fe, Pb, Sr and Zn, were determined by AAS in milk of some animals, such as cow, camel, goat, ewe and buffalo from Aswan city, as well as of grazing goat and ewe which are feeded by the naturally growing plants *Indiogefra Agrenta*, *Lotonis Platcarps*, and *Astragalus Vogellia* in Wadi El Allaqi area at the southeastern part of the High Dam Lake (upper Egypt). The present study gives a new picture on trace element concentrations in milk as a result of different environmental conditions such as site, feeding plants and soil contamination. The results show higher concentrations of Na, Mg, Fe, Co, Cu, Mn, Ni, Pb, Sr and Zn in the milk of Aswan ewe than in that of cow, goat, camel and buffalo, while Na, Mg, K, Au, Co, Ni and Pb are found in higher concentrations in the milks of ewe and goat of Allaqi area than those of Aswan city, as a result of the high concentration of these elements in the natural growing plants in Wadi El Allaqi and in the grazing soil.

KEY WORDS: ASS, trace elements, grazing plants, animal milks.

INTRODUCTION

Milk is a universal nutrient alone or in combination with other foods and contains water, milk fat, lactose, protein and mineral matter. The different elements present in milk play an important role in human growth and well-being[1]. The composition of milk is largely affected by the type of animal feed and soil contamination.

This study gives a new picture about the presence of trace elements, i.e. Na, K, Mg, Fe, Ca, Ag, Au, Co, Cu, Cr, Mn, Ni, Pb, Sr and Zn in the milk of different animals in Aswan city, including cow, camel, buffalo, ewe and goat, as well as in the milk of grazing ewe and goat in Wadi El Allaqi area (Figure 1) where they are fed with some erophyte plants grown in the pasture area, i.e. *Indiogefra Argenta*, *Lotonis Platcarps* and *Astragalus Vogellia*. Also, the trace elements in the soil of Wadi El Allaqi pasture have been analyzed for the assessment of relationships between trace elements in the soil and plants and milks.

Atomic absorption spectrophotometry (AAS) was successfully used for the determination of trace elements in milk after dry ashing.

The present study, is a part of a comprehensive programme planned for environmental studies of trace elements in medical and erophyte plants, crops, soil, sediments, fish, water, milk, animal tissues and bloods, in the new lands created after the construction of the High Dam Lake. Previous studies have already been carried out,

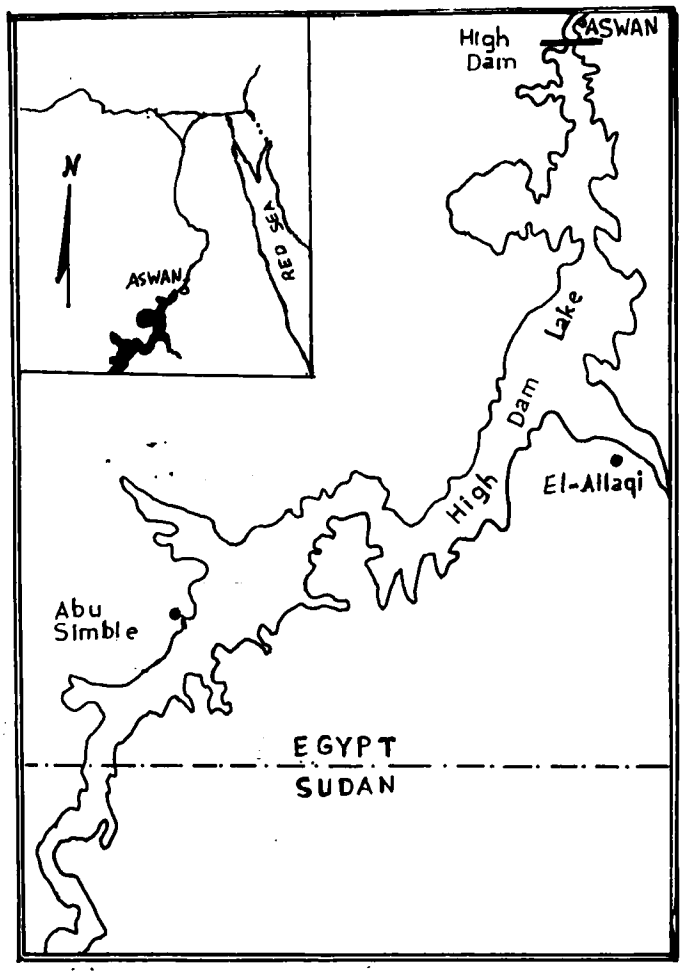

Figure 1 Location map showing the ore of study.

in which trace elements in Egyptian crops and soils were determined by AAS[2,3] as well as, in medical plants in Allaqi desert[4] and in crops cultivated in the experimental farms at the beach of the High Dam Lake. Also, trace element in faeces and blood of sheep and goat of these farms were determined by AAS[5].

EXPERIMENTAL

The milk samples were collected in clean and covered stainless steel bottles, which were previously washed several times with bidistilled and deionized water, and have been kept at 4°C until the analysis was carried out. Plant samples were washed separately and thoroughly with tap and bidistilled water followed by deionized water, and allowed to drain on filter paper, then dried in an electrical furnace at 105°C for

12 hours and blended in a stainless steel blender. Soil samples were air dried, then oven dried at 105°C for 5 hours, thereafter, they were ground and powdered by the aid of a mechanical agate mortar. The powdered samples of soil and plant were kept in very clean polyethylene bottles.

Reagents and standard solution

Atomic absorption spectroscopic standard solutions (1 mg ml^{-1}) for Ag, Au, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn were purchased from BDH (England). Working standard solutions were prepared by diluting the stock solution. Hydrochloric acid, perchloric acid, nitric acid, hydrofluoric acid were all of A.R. quality (BDH, England).

Sample preparation

Milk samples Milk samples were dry ashed in silica crucibles at 550°C for 4 hrs in a muffle furnace (Heaveus Germany). After cooling, 3 ml conc. HCl ws added to 1 gm of the ash, the content was heated to the boiling, and the cooled residue was brought to 25 ml with bidistilled deionized water.

Plant samples Two gram portions of the plant samples were wet ashed in a teflon beaker, using 20 ml 1:1 $HNO_3/HClO_4$ acid mixture, followed by addition of 3 drops HF acid. The content was evaporated. The cooled residue was dissolved in 5 ml conc. HCl and made to 50 ml using bidistilled deionized water.

Soil samples One gram of dried sample was dissolved in 20 ml 1:1 HCl/HNO_3 acid mixture and heated till dryness, the residue was extracted with 2N HCl. The extract solution was made to 50 ml with bidistilled deionized water.

Analytical determination

A SP 1900 Pye Unicam Flame Atomic Absorption Spectrophotometer with digital and direct readout concentration and air-acetylene burner was used.

Single element hollow cathode lamps (Pye Unicam) for Ag, Au, Co, Cu, Cr, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn were used at the recommended current for the studied element (Table 1).

Calcium, sodium and magnesium in whole and skim milk were determined by AAS using air/H_2 and La after dry ashing at 450°C[6]. Cobalt was determined in milk after dry ashing at 450–500°C for 5–15 hrs[7]. Cu, Fe, Pb, Mn and Zn were determined in evaporated milk, human milk and marketed milk after dry ashing at 550°C by AAS measurement using air/H_2 flame[8]. Lead in milk of cows has been determined by AAS using dry ashing technique at 450°C followed by extraction with APDC/MIBK. Pb contents ranged 0.009–0.212 mg l^{-1}.[9] As, Cd, Cr, Pb and Se were determined in milk powder by AAS[10]. Fe and Mn were determined in whole milk by AAS, after boiling with HCl followed by evaporation and extraction with APDC into MIBK[11].

Table 1 Flame atomic absorption operating conditions Unicam SP 1900. With Pye Unicam air compressor PU 9003

Conditions	*Zn*	*Cu*	*Mn*	*Ni*	*Co*	*Cr*	*Ag*	*Pb*	*Au*	*Sr*	*Na*	*K*	*Mg*	*Fe*
Sensitivity	475	504	339	379	361	361	360	277	360	335	333	378	372	351
Slit width (mm)	0.250	0.200	0.200	0.300	0.200	0.200	0.190	0.990	0.500	0.200	0.200	0.802	0.200	0.200
Scale expantion	no	X7	X6	X12	X6	X14	X3	X15	X11	X6	no	X3	no	X11
Cathode lamp current (mA)	8	0.4	10	10	13	0.8	0.4	0.6	0.9	0.8	0.6	0.6	10	12
Burner table height (mm)	1.5	1.2	1.4	1.8	1.6	0.6	1.7	0.9	1.1	0.9	1.8	0.9	1.8	1.0
Rosonance line (nm)	213.8	324.7	279.4	232.0	240.7	357.8	328	283.3	242.8	460.7	589	766.4	285.2	248.3
Burner type and angle	10 Cm acetylene in Line													
Air Flow 1 min^{-1}	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Acetylene flow 1 min^{-1}	1.0	0.8	0.8	1.0	1.0	1.0	1.0	1.0	1.0	1.2	0.8	0.8	0.8	1.0
Integration time (S)	1 Second													
Dilution factor	no	no	no	no	no	no	no	no	no	no	X20	X20	X20	no

Accuracy testing

Optimum running conditions were evaluated and were consistently established throughout the experiment (Table 1). For lead the use of the less sensitive 283.3 nm line give in the air-acetylene flame, a more reliable reading than at 217 nm, because the use of this line may give rise to poorer detection limit as a result of the high flame background absorption, unless an inert gas-separated flame is employed[12]. The method of standard addition was conducted for Ag, Au, Co, Cr, Ni and Pb, since these elements are presented in low concentrations, under the detection limit of the element. Dilution of samples are normally required for the determination of Ca, Na, K, Mg and Fe. The accuracy and precision of the analytical results were estimated through the standard deviation (S.D.) and coefficient of variance (C.V.%). The S.D. of Pb in milks was 0.11–0.8 (C.V.% 0.3–1.9) while in plants was, 0.18–0.62 (C.V.% 1.3–3.8) and in soil, 1.1–2 (C.V.% 1.7–2.5).

RESULTS AND DISCUSSION

The results obtained in the analysis of animals milk from Aswan city and grazing animals from Wadi El Allaqi are given in Table 2, while those of Allaqi and Aswan plants are indicated in Table 3 and for soil of Allaqi and Aswan pastures in Table 4.

The analysis reveals the presence of Na, Mg, Fe, Co, Cu, Mn, Ni, Pb, Sr and Zn in milk of Aswan city ewe in higher concentrations than in cow, camel, buffalo and goat milk. Cow exhibit the highest value of K (57 mg g^{-1} dry ash). In milk of camel the highest values were found for Ag and Pb (6.9 and 34.6 $\mu g\ g^{-1}$ dry ash), while goat milk contains high Cr and Ca concentrations (4 $\mu g\ g^{-1}$ and 11% dry ash).

Milk of Allaqi ewe contains higher concentrations of Na, Mg, Fe, Au, Cr, Ni, Pb and Ca than that of the city, while grazing goat milk recorded higher concentrations of Na, K, Mg, Ag, Au, Co, Mn, Ni and Pb than the city one.

The chemical analysis results of Allaqi grazing plants show that *Lotonis Platcarps* contains higher concentrations of Na, K, Mg, Fe, Mi, Co, Cu, Cr, Mn, Ni, Pb and Zn than *Indiogefra Argenta* and *Astragalus Vogellia.* It seems that *Lotonis Platcarps* represents the favourable food for Allaqi animals, and posses higher values of Na, K, Mg, Fe, Ag, Au, Co, Cr, Mn, Ni and Pb than in Aswan clover which represent the favourable food for Aswan ewe and goat.

Soil of Allaqi pasture contains high values of Ca, Fe, K, Mg, Mn, Na, Co and Cu[5] while concentrations of K, Fe, Ag, Au and Pb were higher in Allaqi soil than in Aswan as a result of the Allaqi soil is composed of the weathering products of Nubian granite, gradiorite, Nile alluvium and wadi alluvium, which are enriched in these elements whereas the Aswan soil is composed of Nile mud and weathering sandstone, which contain mainly the other elements[13,14].

The presence of these elements in the milk of grazing animals in higher concentrations than that of the city animals is related to the higher concentrations of these elements in Allaqi soil and plants with respect to those of the Aswan area.

The chemical analysis, also, reveals that milk of grazing ewe contains concentra-

Table 2 Trace elements in milk of Aswan city and Allaqi pasture animals[a]

Animals / *Elements*	*Cow*			*Camel*			*Goat*			*Ewe*			*Buffalo*			*Grazing*			*Grazing*		
			%			%			%			%			%		*Goat*	%		*Ewe*	%
	M	*S.D*	*C.V*	*M*	*S.D*	*C.V*	*M*	*S.D*	*C.V*	*M*	*S.D*	*C.V*	*M*	*S.D*	*C.V*	*M*	*S.D*	*C.V*	*M*	*S.D*	*C.V*
mg g^{-1}																					
Na	47	0.66	1.3	44	0.57	1.2	42	0.37	8	63	0.76	1.2	28	0.28	1.1	43	0.12	0.2	65	0.47	0.7
K	57	1	1.7	46	0.26	0.5	41	0.25	0.6	25	0.57	2.3	13	0.25	1.9	58	0.49	0.8	11.5	0.37	3.2
Mg	9.8	0.26	2.6	7.9	0.69	8.7	8.1	0.17	2	11	0.11	1	9.8	0.26	2.6	11.7	0.21	1.7	15	0.20	1.3
Fe	0.15	0.005	3.4	0.13	0.002	1.5	0.19	0.005	2.5	0.23	0.002	0.8	0.17	0.005	2.8	0.13	0.002	1.5	0.25	0.004	1.5
μg g^{-1}																					
Ag	5.06	0.11	2.1	6.9	1.8	26	3.1	0.15	4.8	4.1	0.1	2.4	5.1	0.17	3.3	4.1	0.08	1.9	3.1	0.12	3.7
Au	12.1	0.3	2.4	22	0.26	1.1	16	0.32	2	19	0.32	1.8	12	0.25	2	25	0.23	0.9	22	0.20	0.9
Co	9.7	0.25	2.5	8.7	0.25	2.8	9.6	0.55	5.7	13	0.15	1.1	5.5	0.30	5.4	16	0.16	1	6.3	0.24	3.8
Cu	25	0.23	0.9	15	0.36	2.4	15	0.25	1.7	47	1.1	2.3	4.6	0.53	11.9	6.2	0.26	4.1	18	0.20	1.1
Cr	1.56	0.05	3.2	1.6	0.05	3.2	4	0.10	2.5	0.8	0.01	1.2	0.0	0.0	0.0	1.5	0.04	2.6	0.79	0.009	1.1
Mn	6.4	0.15	2.3	3.2	0.11	3.4	1.6	0.06	3.6	24	1	4.1	0.79	0.005	0.6	8.2	0.04	0.4	11.5	0.04	0.3
Ni	5.7	0.11	4.2	4.1	0.10	2.7	6.5	0.05	0.7	7.4	0.11	1.4	5.6	0.11	1.9	6.4	0.16	2.5	7.4	0.14	1.8
Pb	30	0.57	1.9	35	0.57	1.6	31	0.80	2.5	33	0.51	1.5	31	0.11	0.3	33	0.47	1.4	35	0.47	1.3
Sr	23	0.57	2.5	39	0.57	1.4	27	0.32	1.1	36	0.34	0.9	18	0.57	3.1	24	0.47	1.9	29	0.47	1.6
Zn	346	5.7	1.6	406	5.7	1.4	328	2.8	0.8	528	2.6	0.4	368	2	0.5	336	2.9	0.8	193	4.4	2.2
Ca%	5.9	0.07	1.1	10	0.20	1.9	11	3.2	3.2	6.5	0.16	2.4	6.6	0.09	1.3	6.5	0.14	2.1	8.2	0.22	2.6

[a] Mean of 5 Samples (ash).

Table 3 Trace element concentrations in grazing plants growing in Wadi El Allaqi pasture and Aswan plants[a]

	Na	*K*	*Mg*	*Fe*	*Ag*	*Au*	*Co*	*Cu*	*Cr*	*Mn*	*Ni*	*Pb*	*Sr*	*Zn*	*Ca*
			$mg\ g^{-1}$						$\mu g\ g^{-1}$						%
Indiogefra argenta															
Mean	0.65	7.9	2.5	0.72	1.2	4.7	4.8	4.7	6.7	29.3	8.2	13.3	165	12.5	2.6
S.D.	0.04	0.20	0.12	0.02	0.07	0.20	0.21	0.20	0.20	1.69	0.20	0.18	4	1.8	0.12
C.V. %	6.1	2.5	4.8	2.7	5.8	4.2	4.3	4.2	2.9	5.7	2.4	1.3	2.4	14	3
Lotonis platcarps															
Mean	2.8	9.4	5.6	1.63	0.63	7.2	11	10.3	24	149	23	16	34	20	1
S.D.	0.12	0.20	0.47	0.12	0.10	0.21	0.40	0.62	0.47	10	0.81	0.62	4.9	0.43	0.11
C.V. %	4.2	2.1	8.3	7.3	15	2.9	3.6	6	1.9	6.7	3.5	3.8	14	2.3	6
Astragalus vagellia															
Mean	0.95	8.8	1.8	0.89	0.63	0.49	3.1	5.2	4.7	32	4.7	7.7	37	13	0.60
S.D.	0.04	0.16	0.02	0.01	0.10	0.004	0.004	0.20	0.20	0.81	0.20	0.20	1.69	0.40	0.08
C.V. %	4.2	1.8	2.2	1.1	15	0.8	1.2	3.8	4.2	2.5	4.2	2.5	4.4	2.9	5
Clover															
Mean	0.38	0.067	0.67	0.52	0.27	1.2	0.49	19.6	3.4	41.9	8.2	8.1	39	50	1.5
S.D.	0.01	0.002	0.02	0.02	0.01	0.07	0.005	0.41	0.38	0.05	0.37	0.3	0.28	0.57	0.11
C.V. %	2.6	2.9	2.9	3.8	3.7	5.9	1	2	11	0.11	4.5	3.7	0.7	1.1	2

[a] Mean of 5 samples.

Table 4 Trace element concentrations in the soil of Wadi El Allaqi pasture and Aswan city

	Na	*K*	*Mg*	*Fe*	*Ag*	*Au*	*Co*	*Cu*	*Cr*	*Mn*	*Ni*	*Pb*	*Sr*	*Zn*	*Ca*
Unit	mg g^{-1}				$\mu g\ g$										%
Mean[a]	0.93	4.3	8.2	42	2	10.3	17.3	17	21	310	20	12	13	31	2.4
S.D.	0.011	0.12	0.05	0.7	0.1	0.25	0.3	0.1	0.26	1.73	0.6	2	0.5	0.45	0.036
C.V. %	1.2	2.7	0.6	1.6	5.0	2.4	1.7	0.58	1.2	5.5	3.0	2.5	3.6	14	1.5
Mean[b]	9.5	0.17	15.2	38.8	1.7	6.8	20	37	38	567	48	6.4	35	78	3
S.D.	1.5	0.04	0.55	3.4	0.25	0.77	1	0.28	1.2	10	0.76	1.1	3	0.76	0.02
C.V. %	1.5	2.3	3.6	8.7	1.4	1.1	4.8	0.74	3	1.7	1.6	1.7	8.4	0.97	2

Mean of 5 samples (dry wt.).
[a] Soil of Allaqi.
[b] Soil of Aswan.

tions of Na, Mg, Fe, Cu, Mn, Ni, Pb, Sr and Ca higher than the milk of grazing goat. The decrease of elements in animal feed will often fail the animals to produce as much milk as the should.[2].

Lead concentration in all milks under study was in the safety limit for human uses[15]. It is worth to mention that lead concentrations in milk of Allaqi goat and ewe are higher than in Aswan as a result of the higher Pb concentration in Allaqi plants (i.e. *Lotonis Platcarps*, 12 $\mu g\ g^{-1}$) compared with the Aswan only (e.g., clover, 8.1 $\mu g\ g^{-1}$). This is consistent with the fact that Pb in Allaqi soil (12 $\mu g\ g^{-1}$) was higher than in Aswan (6.4 $\mu g\ g^{-1}$)[13,14].

Statistical analysis of data

Correlaton coefficients (C.C.). coefficients of variance (C.V.%) and standard deviations (S.D) between element concentrations in the milks and plants were studied and discussed. S.D. were from 0.002–1 and C.V% from 0.5–3.4 for Na, K, Mg and Fe, while for the other elements were from 0.005–4.4 and of 0.4–2.6, respectively. This gives a good accuracy and precision of the analytical results (Tables 2–4).

Results of C.C. between trace elements in the milks of grazing ewe and goat and the pasture plants, i.e. *Indiogefra Argenta* (PM1). *Lotonis Platcarps* (PM2) and *Astragalus Vogellia* (PM3) are given in Table 5 in which a good positive C.C. was found between grazing milk goat and PM2 for Mg, Fe, Ag, Au, Cu, Mn and Pb, while a good positive C.C. with PM3 was obtained for Fe, Ag, Co and Pb, and with PM1 for Au, Cu, Mn and Ni. No correlation was observed for Cr and Sr.

On the other hand, grazing ewe milk exhibit a good positive C.C. with PM1 for elements K, Ag, Mn, Ni, Pb and Sr, with PM2 for elements Fe, Au, Cu and Mn.

Table 5 Correlation coefficient between trace elements in milk of grazing and city animals (goat and ewe) and plants

Elements	GM/PM_1	GM/PM_2	GM/PM_3	EM/PM_1	EM/PM_2	EM/PM_3	GM/C	EM/C
Na mg g^{-1}	−0.18	−0.50	0.32	−0.86	−0.75	−0.002	0.38	−1.0
K	0.032	−0.03	−0.08	0.73	−0.73	0.66	−0.98	−0.75
Mg	−0.61	0.65	−0.17	−0.99	−0.11	−0.84	−0.98	−0.97
Fe	0.11	0.94	0.69	0.11	0.94	0.69	−0.20	−0.32
Ag $\mu g\ g^{-1}$	−0.86	0.59	0.59	0.94	0.21	0.21	−0.94	0.80
Au	0.91	0.65	−0.50	0.28	0.67	0.91	0.93	0.15
Co	0.18	−0.49	0.86	−0.75	0.50	0.86	−0.41	0.18
Cu	0.84	0.64	−0.70	0.50	0.73	−0.68	0.98	−0.40
Cr	−0.91	−0.99	−0.91	−0.80	−0.49	−0.80	0.32	0.65
Mn	0.97	0.97	−0.86	0.96	0.97	−0.86	0.1	0.87
Ni	0.92	0.24	−0.98	0.80	0.00	−0.91	0.99	0.38
Pb	0.50	0.94	0.80	0.99	0.18	−0.11	0.94	−0.53
Sr	0.00	0.09	−0.69	0.86	−0.90	−0.27	0.98	−0.1
Zn	0.09	−0.72	−0.69	−0.91	−0.41	0.90	0.49	0.32

GM: goat milk; EM: ewe milk; C: City clover.
PM: *Indiogefra argenta;* PM_2: *Lotonis platcarps;* PM_3: *Astragalus vogellia.*

PM3 reveals a good positive C.C. for elements K, Fe, Au, Co and Zn. Therefore, the observation of C.C. analysis between trace elements (K, Fe, Ag, Au, Co, Cu, Mn and Pb) in the milks of grazing ewe and goat and in pasture plants PM1, PM2 and PM3 reveals that these elements are present in the milk as a result of feeding with these plants.

Similarly, results of trace elements in milk of Aswan goat and ewe and plant (clover) reveal a good correlation for elements such as Ag, Au, Cu, Mn, Ni, Sr and Zn.

CONCLUSION

The present study was performed to evaluate the relationship between element concentrations in the milk of grazing animals and city animals in order to underline the effect of the environmental conditions on element concentrations in milk, and its health limits for the human uses.

The grazing goat and ewe milks contain higher concentrations of elements than those from the city, depending on the higher element concentrations in grazing plants. Milk of grazing and city animals is also depending on the element concentrations of the soil pasture and the surrounding rocks.

Lead concentrations in all milks under study were in the safety limit for human uses.

Acknowledgements

The author wishes to express his sincere appreciation to professor Dr. R. M. Awadallah, professor of Analytical and Inorganic Chemistry, Faculty of Science, Aswan Egypt for his advices through the work. Also, I like to thank Mr. M. Gaber, Botany Department for his help in the identification of grazing plants.

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