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X-ray Fluorescence Determination of Element Contents of Different Types of Raw Milk in Aljazeera Farms (Sudan)

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ABSTRACT

This study aims to identify the concentration of the chemical elements of different types of milk in Aljazeera Farms using X-ray Fluorescence, and to monitoring of the concentration of these elements for different dairy products of milk producers (quality control). Also study the effect of change in different temperatures on those elements. The study was conducted on 16 milk samples taken from four types of cattle (cow-camel- goat- sheep) in the Elnuba area of ElJazeera governorate. The samples were heated at different temperatures (0, 30, 60, 100) °C using the X-ray fluorescence technique to detect the ratios of some milk constituents and the comparison of milk types. The results showed high calcium, iron and barium at temperature (0) °C, and low heating elements (30, 60, 100) °C in cow's milk. Calcium and manganese at (0) °C and low element ratios at 30, 60, 100 in camel milk, On iron, calcium and manganese at a temperature of (0) °C with a slight decrease of the rest of the elements at (30, 60, 100) °C in goats' milk. The milk of the sheep obtained the highest percentage of iron, calcium and manganese at (0) °C and the low percentage of elements at the level (30, 60, 100) °C, and comparing the types of milk with elements at different temperatures and low component ratios with the increase in heating. Temperature (0) °C for the containment of the highest ratios of the beneficial elements of the human body.

Keywords : X-Ray Fluorescence, Aljazeera, Raw Milk, Elements.

I. INTRODUCTION

The analysis of milk is important because milk is an indicator of environmental contamination, a significant pathway for toxic metal intake by humans and a source of essential nutrients. Essential elements required by the human body include the four basic elements H, C, N and O; the quantity elements Na, Mg, K, Ca, P, S and Cl; and the essential trace elements Mn, Fe, Co, Ni, Cu, Zn, Mo, Se and I. Other trace elements include B, Ba, Co, Cr, Cu, Fe, Li, Mn, Mo, Ni, Sb, Se, Sn, Sr, V, W and Zn. These elements were detected previously in liquid milk and powdered milk using neutron activation analysis. The importance of trace elements in nutrition is widely recognized as essential for growth and development of human beings, especially during infancy. On the other hand, several elemental deficiency syndromes have been reported over the past decades. Children in particular are susceptible to the effects of a trace element deficiency. The determination of trace element levels in food stuffs, especially milk could play an important role in understanding a number of deficiency related diseases, Galina V. Pashkova(2009) determination of element contents in milk and dairy products using X-ray fluorescence analysis The concentrations of minerals (Na, Mg, P, S, Cl, K, and Ca) and trace elements (Mn, Fe, Ni, Cu, Zn, Rb, Sr, and Br) in different types of milk, dairy products, and infant formulas have been determined using wavelength-

dispersive X-ray fluorescence analysis (WDXRF). Freeze-dried samples pressed as tablets of 4 g have been analyzed. Calibrations have been established using both plant and milk standard reference materials. The matrix correction method based on the power function of Compton scattered intensity was applied. The paper provides calibration data, detection limits for each element, and testing the accuracy of the proposed technique. The elemental compositions of the samples obtained by WDXRF were compared with the previously reported data from different countries, Jason and Peter T. Palmer (2013) determination of calcium in powdered milk via X-ray fluorescence using external standard and standard addition based methods a handheld energy-dispersive X-ray fluorescence (XRF) analyzer was used to determine calcium in powdered milk. Quantification was performed using two different methods (external standards and the method of standard additions) to illustrate a matrix effect as well as a means for compensating for it. Both methods require calibration of the XRF analyzer using authentic standards prepared by mixing known masses of calcium carbonate into known masses of cellulose or dry milk. The use of XRF for this application requires analysis times on the order of 1 min per sample, provides linear calibration curves, and gives good precision with %RSDs of 4% or less. External standard based calibration gave erroneously low results due to the attenuation of calcium fluorescence by potassium in the sample, whereas the method of standard additions gave 1.29% calcium, which is very close to the manufacturer's equivalent concentration of 1.3%. This experiment is well suited for an analytical chemistry course and provides an excellent example of the advantages and limitations of these two calibration methods for addressing matrix effects and deriving accurate quantitative results,Abeer Abdelrhman Ibrahim(2017) detection of some elements in Kapo powder milk and Nedo powder milk by using X-ray fluorescence device. This study deals with the applications of spectroscopy, which is the detection of some elements of the Nedo powder milk and Kapo powder milk and the concentration of these elements by X-ray fluorescence device and the comparison between them and to see the pH of the two samples, in milk Nido element chromium and its concentration 0.03%, manganese element, concentration 0.00%, iron element and its concentration was 0.11%, nickel element, its concentration <0.001%, copper element, its concentration 0.00%, zinc element , its concentration 0.02%, and lead element and its concentration was 0.00%, and the PH of Nedo powder milk was 6.25. In Kapo powder milk sample this elements were found also but in different concentrations; which found chromium element, its concentration was 0.02%, manganese element, concentration 0.02%, Iron element and its concentration was 0.02%, nickel element, its concentration <0.00%, copper element, its concentration 0.00%, zinc element, its concentration 0.00%, and lead element and its concentration was 0.01%, and the PH of Kapo powder milk was 6.39.

II. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Nubia, in the state of Al-Jazeera, located 50 km south of Khartoum, Sudan. This region was chosen as a proposal to represent the island's state as it contains the largest dairy project in the island and its surrounding areas, and raising them for different kinds of cattle from cows, goats and others.

2.2 Raw Material

The different types of milk were collected in a sterile and direct way from livestock to the sterilized plants of the dairy project in al- Jazeera farms south of Khartoum, Sudan and taken for analysis.

2.3 Concentrations of Elements

The sample was divided into sixteen parts. The first four samples were used and obtained for the control sample exposed to the x-ray spectrometer. Each sample was subjected to a 9-minute analysis with a weight of 2 ml per sample. The other four samples were heated to 30 ° C and subjected to X-ray diffraction wavelengths. The other four samples were heated to 60 ° C and subjected to x-ray diffraction wavelength. The other four samples were heated to 100 ° C and subjected to x-ray fluorescence Waveform for 9 minutes.

Concentration of different types of milk was calculated at different temperatures (calcium, barium, magnesium, zinc, manganese, iron).

The results showed that some elements decrease with increasing temperature while some increase with non-concentration of some elements

III. RESULTS AND DISCUSSION

Obtained results showed the effect of the wavelength dispersive X-ray fluorescence spectrometer on the different kinds of milk at different temperature, The elements in sixteen samples were found in different concentrations, which in first four sample referred as control (cow,camel,sheep,goat), and The other four samples were heated to 30°C and were exposed to wavelength dispersive X-ray fluorescence, The other four samples were heated to 60°C and were exposed to wavelength dispersive X-ray fluorescence, The other four samples were heated to 100°C and were exposed to wavelength dispersive X-ray fluorescence for 9 minutes result showed that some elements decrease with increasing temperature and others increase with no concentration of some elements.

Table (1): XRF data of the chemical element concentration Ba,Ca,Mg,P,Zn,Fe, and Mn, for milk in Room Temperature (R.T)

Elements	Cow Milk	Camel Milk	Goat Milk	Sheep Milk	Unit
Barium(Ba)	0.0322	0.0322	0.0322	0.0322	Wt%
Calcium(Ca)	0.1606	0.1572	0.1438	0.1565	Wt%
Magnesium(Mg)	0.0000	0.0005	0.0017	0.0000	Wt%
Phosphorus(P)	0.0296	0.0425	0.0425	0.0000	Wt%
Zinc(Zn)	0.0000	0.0000	0.0000	0.0000	Wt%
Iron(Fe)	0.0721	3.7030	0.9780	0.9600	Wt%
Manganese(Mn)	0.0640	0.4640	0.3480	0.2780	Wt%

Table (2): XRF data of the chemical element concentration Ba,Ca,Mg,P,Zn,Fe, and Mn, for milk in 30°C Temperature .

Elements	Cow Milk	Camel Milk	Goat Milk	Sheep Milk	Unit
Barium(Ba)	0.0322	0.0322	0.0322	0.0322	Wt%
Calcium(Ca)	0.1421	0.1154	0.1188	0.1985	Wt%
Magnesium(Mg)	0.0020	0.0000	0.0000	0.0052	Wt%

Phosphorus(P)	0.0245	0.0245	0.0336	0.0582	Wt%
Zinc(Zn)	0.0000	0.0000	0.0000	0.0000	Wt%
Iron(Fe)	0.0250	2.9630	0.3120	0.8298	Wt%
Manganese(Mn)	0.1520	0.4030	0.4551	0.2330	Wt%

Table (3): XRF data of the chemical element concentration Ba,Ca,Mg,P,Zn,Fe, and Mn, for milk in 60°C Temperature

Elements	Cow Milk	Camel Milk	Goat Milk	Sheep Milk	Unit
Barium(Ba)	0.0322	0.0322	0.0322	0.0322	Wt%
Calcium(Ca)	0.1163	0.1985	0.1209	0.1506	Wt%
Magnesium(Mg)	0.0000	0.0048	0.0015	0.0000	Wt%
Phosphorus(P)	0.0177	0.0574	0.0368	0.0253	Wt%
Zinc(Zn)	0.0000	0.0000	0.0000	0.0001	Wt%
Iron(Fe)	0.0012	2.1130	0.1053	0.0060	Wt%
Manganese(Mn)	0.3312	0.2341	0.3019	0.2139	Wt%

Table (4):
XRF data of the chemical element concentration Ba,Ca,Mg,P,Zn,Fe, and Mn, for milk in 100°C Temperature

Elements	Cow Milk	Camel Milk	Goat Milk	Sheep Milk	Unit
Barium(Ba)	0.0322	0.0322	0.0322	0.0322	Wt%
Calcium(Ca)	0.1501	0.1144	0.1286	0.2007	Wt%
Magnesium(Mg)	0.0000	0.0000	0.0015	0.0020	Wt%
Phosphorus(P)	0.0254	0.0177	0.0366	0.0575	Wt%
Zinc(Zn)	0.0001	0.0000	0.0000	0.0000	Wt%
Iron(Fe)	0.0000	1.7820	0.0000	0.0000	Wt%
Manganese(Mn)	0.2117	0.1845	0.1522	0.0988	Wt%

3.1 Estimation the concentration of elements for cow milk

Frequencies

Table 1: statistical analysis of some elements in cow's milk in room temperature

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	1.0000	1.0000	.032200	.160600	.000000	.029600	.000000	0.07210000	.0640000

Frequencies

Table 2: statistical analysis of some elements in cow's milk at temperature 30°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	1.0000	2.0000	.032200	.142100	.002000	.024500	.000000	0.02500000	.1520000

Frequencies

Table 3: statistical analysis of some elements in cow's milk at temperature 60°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	1.0000	3.0000	.032200	.116300	.000000	.017700	.000000	0.0012000	.3312000

Frequencies

Table 4: statistical analysis of some elements in cow's milk at temperature 100°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	1.0000	4.0000	.032200	.150100	.000000	.025400	.000100	0.00000	.2117000

Figure 1 Summarizes the relation between some elements according to the different temperature of cow milk.

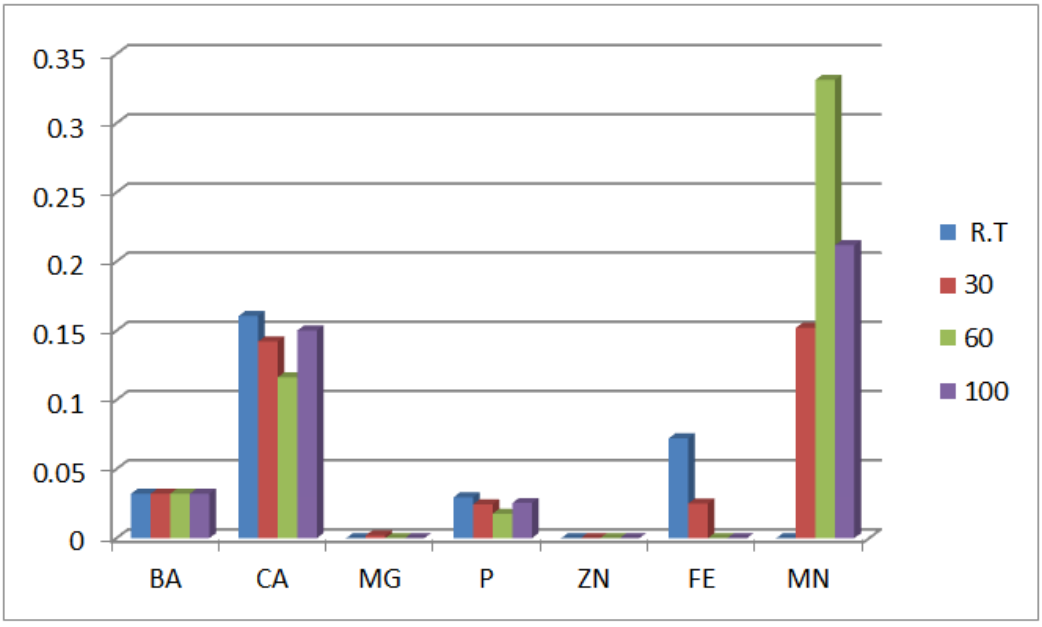

Figure1. Cow milk in relation to the means of elements according to the different temperature.

The highest concentration of elements in manganese, calcium and less in the element AL barium and phosphorus and iron with the disappearance of the concentration of elements in both zinc and magnesium, and this is identical to the study conducted in New Zealand and published in the magazine American Journal of Clinical Nutrition ,In other words, The milk is rich in calcium concentration with the disappearance of iron, and calcium is useful for building bones especially in children, while eating milk rich in iron is often the commercial or the presence of iron meat products and you do not have iron in fresh milk and advises the World Health Physicians to eat cow's milk fresh for containment High elements of calcium and some minerals, and in its natural form is important for building bones that lose after exposure to heating.

3.2 Estimation the concentration of elements for camel milk

Frequencies

Table 5 : statistical analysis of some elements in camel's milk in room temperature

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	2.0000	1.0000	.032200	.157200	.000500	.042500	.000000	3.703000	.4640000

Frequencies

Table 6: statistical analysis of some elements in camel's milk at temperature 30°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	2.0000	2.0000	.032200	.115400	.000000	.024500	.000000	2.963000	.4030000

Frequencies

Table 7: statistical analysis of some elements in camel's milk at temperature 60°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	2.0000	3.0000	.032200	.198500	.004800	.057400	.000000	2.113000	.2341000

Frequencies

Table 8: statistical analysis of some elements in camel's milk at temperature 100°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	2.0000	4.0000	.032200	.114400	.000000	.017700	.000000	1.782000	.1845000

Figure 2 summarizes the relation between some elements according to the different temperature of camel milk.

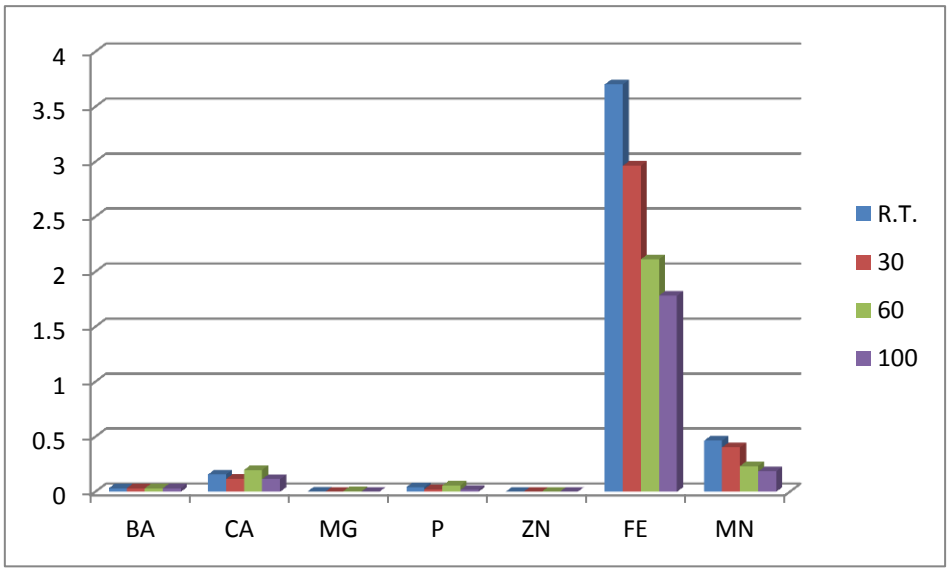

Figure 2. Camel milk in relation to the means of elements according to the different temperature.

The highest concentrations of iron, fume, and extract were complex in both zinc and magnesium, because milk and calcium were high in iron. In a study by the Food and Agriculture Organization of the United Nations (FAO), camel milk was found to be more than three times the amount found in cow's milk Other species are also rich in calcium**,** Therefore, it is always recommended that people with anemia should eat camel milk fresh from the camels immediately because it contains a large amount of iron but after heating it is noted in the results that the iron ratios started to decrease, and also contains phosphorus and barium which are also important and useful elements for human and infant children even if milk is not available Mother advises doctors to take infant camel milk to similar components of breast milk, but it is low in lactose, and also works camel milk as an anti-cancer, especially the colon.

3.3 Estimation the concentration of elements for goat milk

Frequencies

Table 9: statistical analysis of some elements in goat's milk in room temperature

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	3.0000	1.0000	.032200	.143800	.001700	.042500	.000000	0.9780000	.3480000

Frequencies

Table 10: statistical analysis of some elements in goat's milk at temperature 30°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	3.0000	2.0000	.032200	.118800	.000000	.033600	.000000	0.3120000	.4551000

Frequencies

Table 11: statistical analysis of some elements in goat's milk at temperature 60°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	3.0000	3.0000	.032200	.120900	.001500	.036800	.000000	0.1053000	.3019000

Frequencies

Table 12: statistical analysis of some elements in goat's milk at temperature 100°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	3.0000	4.0000	.032200	.128600	.001500	.036600	.000000	.00000000	.0152200

Figure 3 summarizes the relation between some elements according to the different temperature of goat milk.

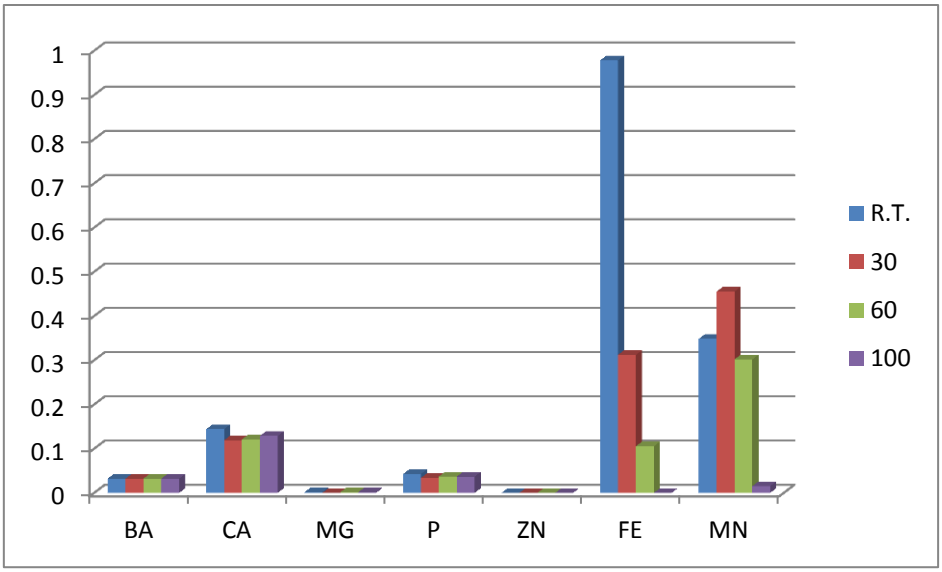

Figure 3. goat milk in relation of the means of the elements according to the different temperature.

The concentration of elements in manganese iron and calcium and less in the element AL barium and phosphorus with the disappearance of the concentration of elements in both zinc and magnesium, and this is similar in minerals and salts of cow's milk, but goat's milk has a higher proportion of calcium by 13%, and also contains a higher amount of zinc by 400%.

There are two important things: The amount of cholesterol in each cup of goat milk is 30% less than in cow's milk, the second is that the amount of saturated and unsaturated fat in goats' milk is 10% less than in cow's milk and better quality. The most important characteristic in goat's milk is that its fat is easy to digest and does not accumulate easily.

The benefits of goat's milk: It is a factor in the treatment of ulcers and anti-acidity and strengthens the immune system and provides a good amount of calcium and is the closest to breast milk, but he drank hot milk flax. This is identical to Rajim magazine and milk chemistry magazine Dr. Yasin Kanaanah. Javad Agbaria. Home / Health / Benefits of goat milk - the difference between goat's milk and cow's milk (2015-Joreey Elnaime)

3.4 Estimation the concentration of elements for sheep milk

Frequencies

Table 13: statistical analysis of some elements in sheep's milk in room temperature

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	4.0000	1.0000	.032200	.156500	.000000	.000000	.000000	0.9600000	.2780000

Frequencies

Table 14: statistical analysis of some elements in sheep's milk at temperature 30°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	4.0000	2.0000	.032200	.198500	.005200	.058200	.000000	.82980000	.2330000

Frequencies

Table 15: statistical analysis of some elements in sheep's milk at temperature 60°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	4.0000	3.0000	.032200	.150600	.000000	.025300	.000100	.006000	.2139000

Frequencies

Table 16: statistical analysis of some elements in sheep's milk at temperature 100°C

	THE MILK	TEMPERATURE	BA	CA	MG	P	ZN	FE	MN
N Valid	1	1	1	1	1	1	1	1	1
Missing	0	0	0	0	0	0	0	0	0
Mean	4.0000	4.0000	.032200	.200700	.002000	.057500	.000000	.0000000	.0988000

Figure 4 summarizes the relation between some elements according to the different temperature of sheep milk.

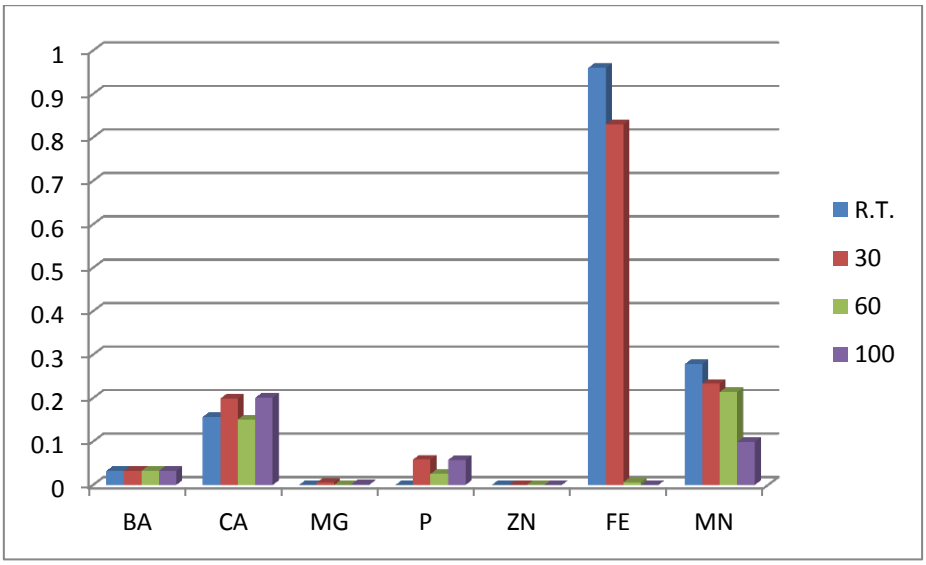

Figure 4. sheep milk in relation to the means of different elements according the different temperature.

The highest concentration of the element, henna and henna in both zinc and magnesium, similar to the milk of the sheep and cursed in some of its properties and minerals because of the same platoon and even in the way of drinking is correct by a drink after the heat to contain a quantity of bacteria Z to ensure its human safety and also find in an interview with a comparison with Goat milk, and this is identical to what was said in and the Journal of Milk Chemistry Dr. Yasin Kanaanah. Javad Agbaria.

IV.CONCLUSION

In this study, different milk samples of cows, camels, goats and sheep were analyzed using the energy-dispersion X-ray fluorescence system. The elements (Ca, Fe, and Mn) showed the highest concentration of the elements at 0°C without heating in all milk, the concentration of the elements in the decrease began to appear with some elements stabilized. At the temperature of (100) °C some elements began to decrease and most of the concentration of the elements ended at the heating. Higher, so answer the different types of milk without high heating so as not to lose those elements value.

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