THE OCCURRENCE OF CERTAIN ELEMENTS IN MILK AND SOME DAIRY PRODUCTS
2 –EFFECT OF MILK PROCESSING ON THE DISTRIBUTION OF ZN, FE, CD AND PB IN THE RESULTANT PRODUCTS

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Abstract

The effect of some milk processes on the distribution of Zn, Fe, Cd and Pb in the resultant products had been investigated. The levels of these elements in used raw milk and the obtained products were estimated (ppm). It was found that a little variation in the levels of Zn, Fe, Cd and Pb in yoghurt as compared with used milk. The values of these metals in yoghurt were 91.89, 89.83, 97.97 and 103 % for Zn, Fe, Cd and Pb as compared with their levels in raw milk. The distribution of respective elements during the separation of raw milk into cream and skim milk were 6.07 and 91.54 % of Zn, 6.12 and 90.28 % of Fe, 3.39 and 95.21 % of Cd and 3.37 and 94.72 % of Pb respectively.

The churning process of cream into butter and butter milk reduced the respect elements in resultant butter. The obtained butter contained 37.47, 41.95, 43.7 and 42.20 % of Zn, Fe, Cd and Pb of the initial elements in used cream respectively, while, butter milk contained 62.55, 58.28, 55.82 and 56.67 % of these metals in the same respect. The levels of these elements in butter as compared with used raw milk were 2.22, 2.55, 1.48 and 1.42 % of Zn, Fe, Cd and Pb respectively. The resultant samna contained only 1.09, 1.51, 1.07 and 0.98 % of Zn, Fe, Cd and Pb levels of the initial elements of raw milk.

The percentage levels of Zn, Fe, Cd and Pb in curds of whole and skimed milk as compared with the initial materials were 83.70 & 85.02; 83.35 & 88.42; 70.97 & 75.47 and 78.22 & 79.91 % respectively. The resultant whey contained only 16.65 & 15.03; 16.94 & 14.69; 28.98 & 24.87 and 19.78 & 18.94 %.

INTRODUCTION

As early as 1968, The International Dairy Federation (IDF) issued information on heavy metals contamination of milk and dairy products followed by further publications. Heavy metals make up on of the most important groups in food supply (Protasowicki, 1992).

In recent years, risks of heavy metals that may pollute different foods have been receiving increased attention. Heavy metals contamination of milk is now considered to be a greater problem than that of pesticides. Newer analytical techniques with higher sensitivity have been employed to determine the levels of these elements in dairy products. (IDF, 1992).

Kolodkin, et al (1979) found that cream 35% fat contained 15% of the Pb as initial milk, yoghurt contained Fe, 98.87 Zn 99.2 and Pb 100% as initials (Abou-Arab 1991).

Separation of whole milk into cream and skim milk reduced the heavy metal potential in the resultant cream and the process was more effective in cows than buffalo's milk (El-Awamry, 1994). Churning of buffalo's cream into butter reduced the heavy metals potential in the obtained butter with about 70% of cream content, while the reduction as compared with milk content was 90%. The calculation of heavy metals content of the resultant samna compared with those of raw milk showed that the reduction value was about 95%. (El-Awamry, 1994).

It was found that the concentration of Pb in cheese made from lead contaminated milk was about six times that in original milk Marletta and Favretto (1983)

During the manufacture of Domiati cheese, Metwally (1993) found that 49.3% of Pb in cheese and 50.7% in whey.

The heavy metal concentration decreased during pickling of Domiati cheese (Abou El-Enein 1998).

The incidence of Zn, Fe, Cd and Pb in raw milk as well as some dairy products had been investigated recently (Mohran, et al 2010).

The aim of present work was to study the effect of some milk processes on distribution of Zn, Fe, Cd and Pb in the resultant products.

MATERIALS AND METHODS

1- Materials

- Raw bulk cow's milk was obtained from the herd of the Faculty of Agriculture, Assiut University.

-Yoghurt starter was obtained from (MIRCEN) Microbial Resources Center, Faulty of Agriculture, Ain Shams University.

- Rennet powder was obtained from Ch. Hansen's Laboratories.

2- Methods of Analysis

The incidence of Zn, Fe, Cd and Pb in raw milk, cream , skim milk, butter, butter milk, samna, morta, yoghurt, white soft cheese curd and its whey as will as

Kareish cheese curd and its whey had been estimated (ppm) according to the method described by James (1995) using atomic absorption spectrophotometer (AA-630-02 Shimadzu-Japan).

The obtained values (ppm) were multiplied by the quantity of product to give the total amounts of respective elements and calculated its distribution.

3- Experimental procedure

A total of 25 Kg of raw milk were divided as follows:

a) One Kg was heated at 90 ^{0}C for 30 min and used for making yoghurt using yoghurt starter supplied from (MIRCEN).

b) 14 Kg milk was warmed at 35^{0}C and separated to cream (1.0kg) and skim milk (13.0kg). Resultant cream was churned into butter and butter milk (500g. of each). The obtained butter was converted to samna by boiling which gave 375g samna and 100g of morta.

c) 10 kg milk was heated at 70^{0}C for 2-3 min, cooling to 35^{0}C and unsalted milk was renneted to make white soft cheese according to El-Gendy. (1970) (2 kg of cheese and 8kg of whey). Defatted milk curd also was obtained from the unsalted forgoing skim milk to give 2.2 kg curd and 10.8 kg whey.

RESULTS AND DISCUSSION

The distribution of Zn, Fe, Cd and Pb in some dairy products as affected by manufacture processes, are shown in Fig.1-5.

1. Effect of fermentation during manufacture of yoghurt

Fig (1) illustrate the distribution of the tested trace elements in milk and yoghurt. It could be observed that little variation in the quantities of Zn, Fe, Cd and Pb between resultant yoghurt and used milk. The content of Zn in the obtained yoghurt was 3.83 ppm which represent (91.89 %) of initial raw milk. The Fe content was lower than that of Zn (1.87 ppm) which represents about (89.83 % of initial milk). Approximately no differences were found in the cases of Cd and Pb. Resultant product contained about 97.97 % of Cd and 103.68 % of Pb as compared with their levels in used milk. The same finding was reported by Abou-Arab (1991) and El-Awamry (1994).

2. Effect of processes used for manufacture of milk fat products

Fig (2) represents the distribution of respective elements during the separation of raw milk into cream and skim milk. It was found that 6.07, 6.12, 3.39 and 3.37 % of Zn, Fe, Cd and Pb of initial quantities in raw milk are separated with cream, while, skim milk was found to contain 91.54, 90.28, 95.21 and 94.72 % of respective metals. From the foregoing results it could be observed that more than 90 % of pollutant elements separated with skim milk.

This finding may be due either to the binding of these elements with caseins or to their solubility in milk serum. Roh (1975) reported that 96%of Cd in whole milk was associated with the skim milk. The obtained results are inagreement with Mathur and Roy (1978) who stated that 90.4% of Zn in whole buffalo's milk was in skim milk. The distribution of Pb in skim milk and cream was reported also by Kolodkin, et. al (1979) who found that 15% of Pb as initial milk were detected in cream fraction . El-Awamry(1994) concluded that separation processes reduce the heavy metals potential in the resultant cream.

The manufacture of butter from cream showed that the churning process reduced the respect elements pollution in the resultant butter. As shown in Fig (3), the obtained butter contained 37.47, 41.95, 43.7 and 42.20 % of Zn, Fe, Cd and Pb, found in used cream respectively. On the other hand butter milk was found to contain the great portion of these metals compared with the butter. The percentages of the removed metals in butter milk were 62.55, 58.28, 55.82 and 56.67 of Zn, Fe, Cd and Pb respectively. The distribution of investigated metals between butter and butter milk was in agreement with that reported by Abou-Arab (1991). El-Awamry (1994) reported also that the churning of cream into butter reduced the heavy metal potential in obtained butter with 68.5, 73.1, 65.7 and 75.0%for Fe, Cd, Zn and Pb, respectively, as compared with the quantities of these elements in used cream.

If the percentage levels of these elements in butter are calculated as compared with that of raw milk, higher reductions of the content of these elements were found. The respective percent of these elements levels are 2.22, 2.55, 1.48 and 1.42 % for Zn, Fe, Cd and Pb respectively.

The conversation of butter to samna showed some variation in the contents of these elements in the obtained products (Fig 4). Zn is distributed between samna and murta with the ratio of approximately 49.84 and 50.23 %. On the other hand, samna contained 59.06, 68.42 and 69.23% of Fe, Cd and Pb, respectively and murta found to be contained, 30.87, 36.84 and 38.46 % of these metals, in the same respect.

Although a high ratio of respective elements are transferred from butter to samna, samna contained only 1.09, 1.51, 1.07 and 0.98 % of Zn, Fe, Cd and Pb found in initial raw milk. From the obtained results it could be concluded that the sequences of processing of raw milk led to reduction the pollution of these elements in fat milk products. Nearly the same findings were reported by Roh (1975), Abou-Arab (1991) Metwally (1993) and El-Awamry (1994).

3- Effect of milk coagulation on the distribution of Zn, Fe,Cd and Pb in resultant curd and whey

The quantities of Zn, Fe, Cd and Pb in the curd obtained after the coagulation of 10 kg cow's milk were34.85, 8.56, 3.08 and 2.55 mg respectively. These amounts represented 83.70, 83.35, 70.97 and 78.22% of the initial levels found in used milk. Fig (5a) showed also that 16.65, 16.94, 28.94 and 19.78% of Zn, Fe, Cd and Pb amounts respectively as compared with the initial quantities in raw milk were removed in whey.

Rennet coagulation of skim milk had been carried out to examine the distribution the investigated elements in the obtained curd and whey. This curd showed approximately the same observations. From Fig. (5b), the resultant curd found to contain 45.42, 22.50, 4.37 and 3.46 mg of Zn, Fe, Cd and Pb respectively. These levels represented 85.02, 88.42, 75.47 and 79.91 % of that polluted the used skim milk respectively. It is evident from Fig. (5b) also the partial removal of investigated metals with whey. The drainage whey found to contain 15.03, 14.69, 24.87 and 18.94 % of Zn, Fe, Cd and Pb respectively found in skim milk.

The concentration of above elements in either full cream milk or skim milk curds may be attributed to that these elements bound strongly with certain casein components (α_{s1}-, α_{s2}-, β- and k-caseins) and /or to casein micelles. The partial resolution of respective elements in whey was reported also by Mathur and Roy (1978) and Zidan et al. (1994). On the other hand the retentive values of these elements in rennet curd of both full cream milk and skim milk are higher than that reported by El-Awamry (1994) for both Domiati and Kareish cheese.

Fig (1) Distribution of certain trace elements in milk during manufacture of yoghurt.

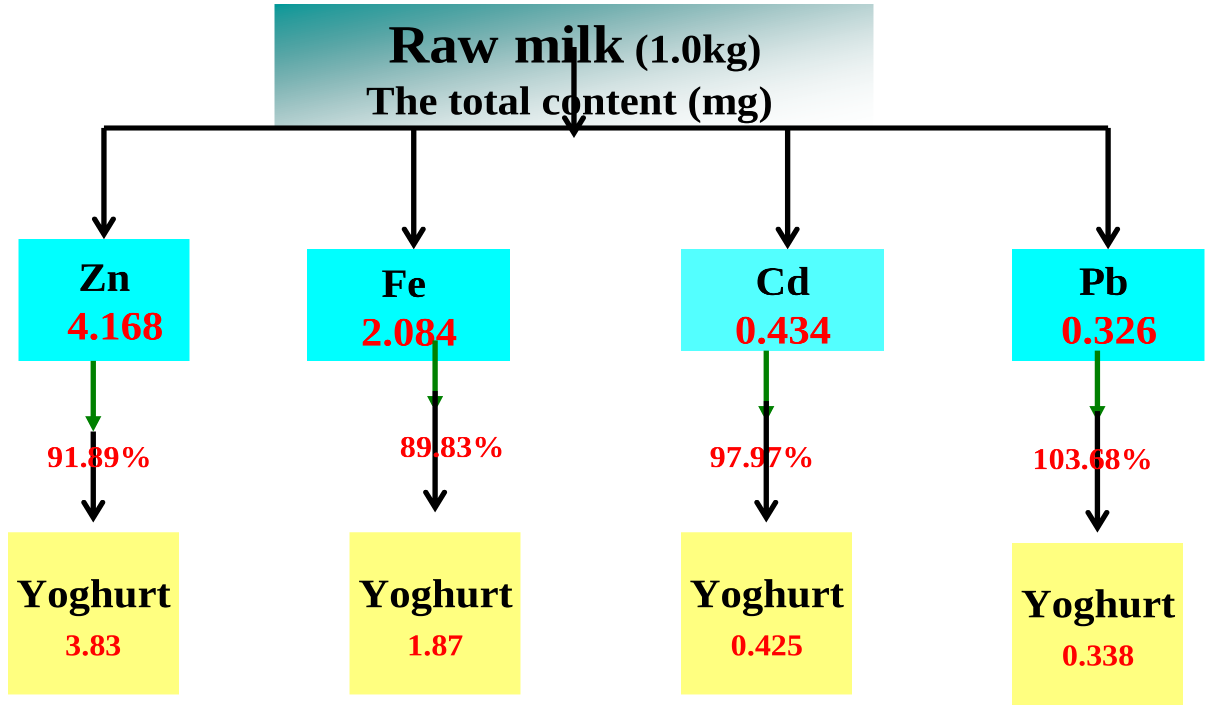


Fig (2) Distribution of certain trace elements in milk and resultant products during separation process.

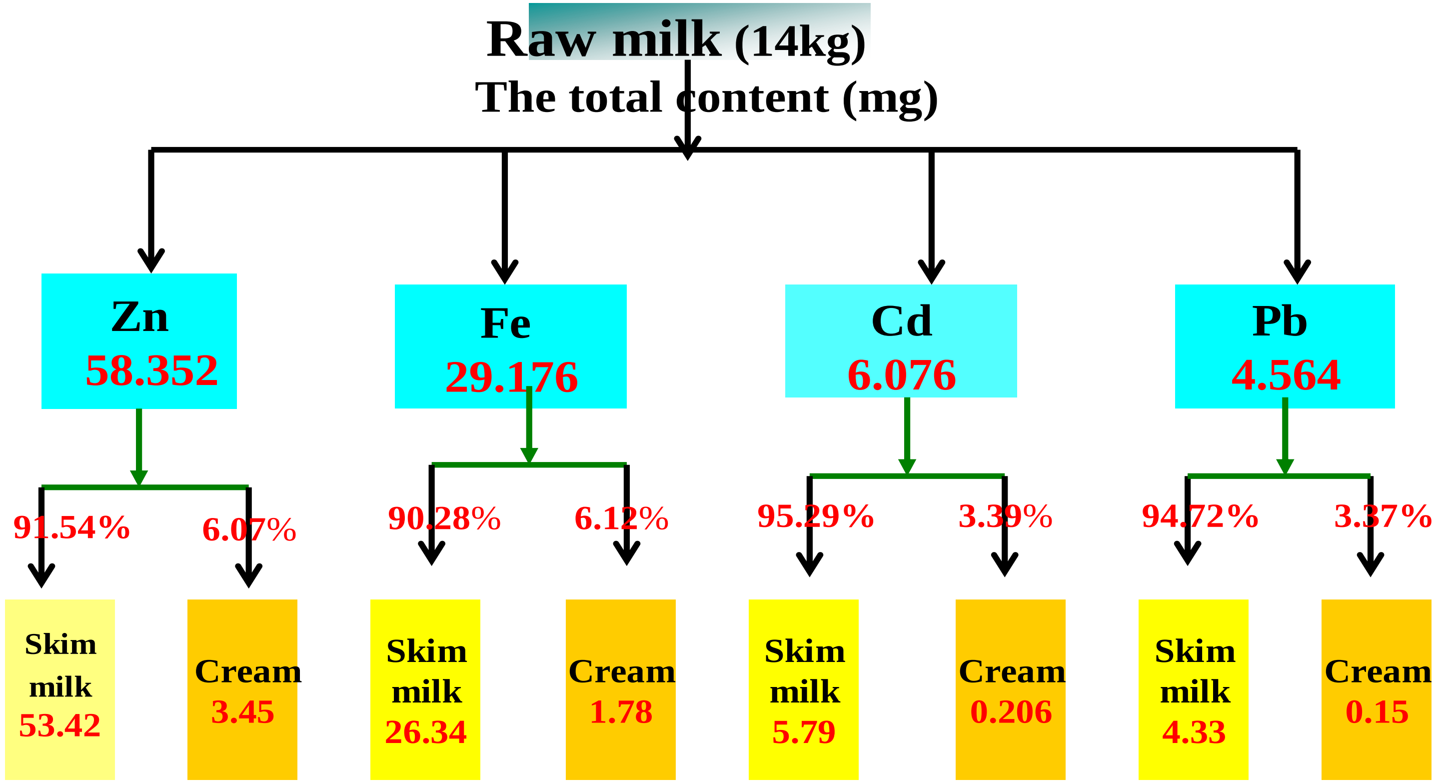
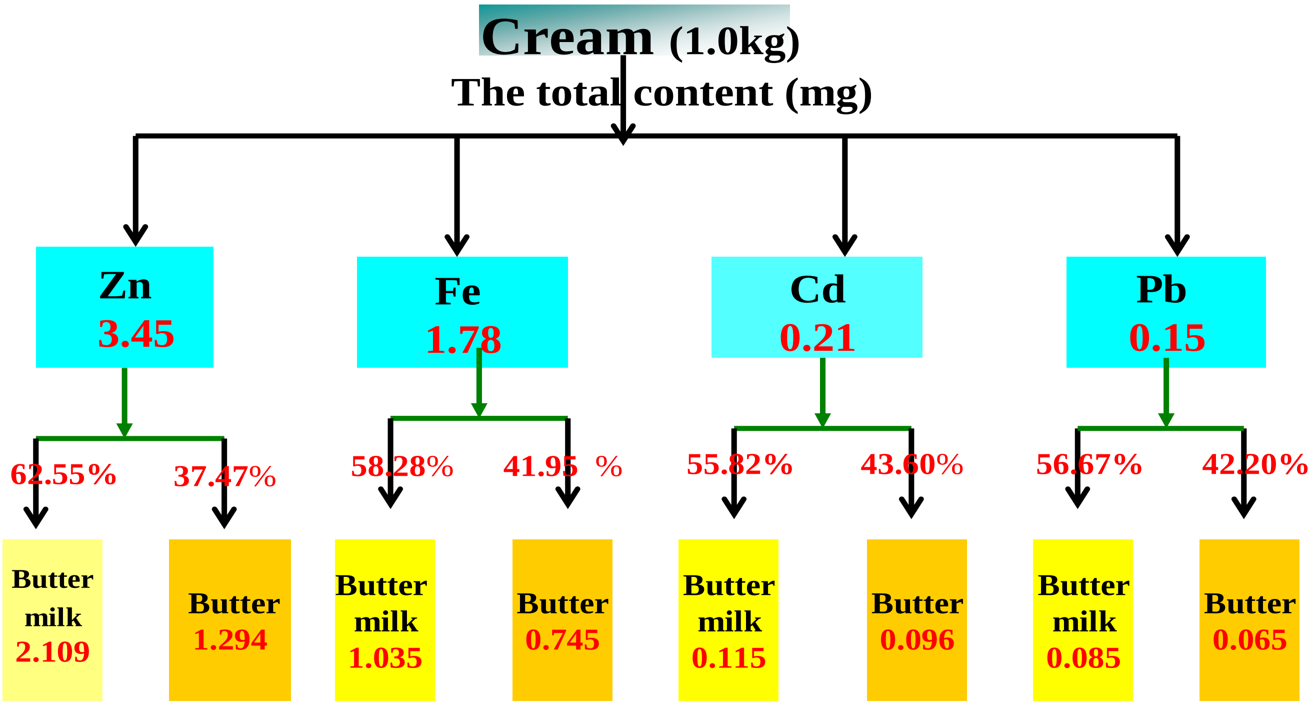


Fig (3) Distribution of certain trace elements in cream and butter during the manufacture of butter.



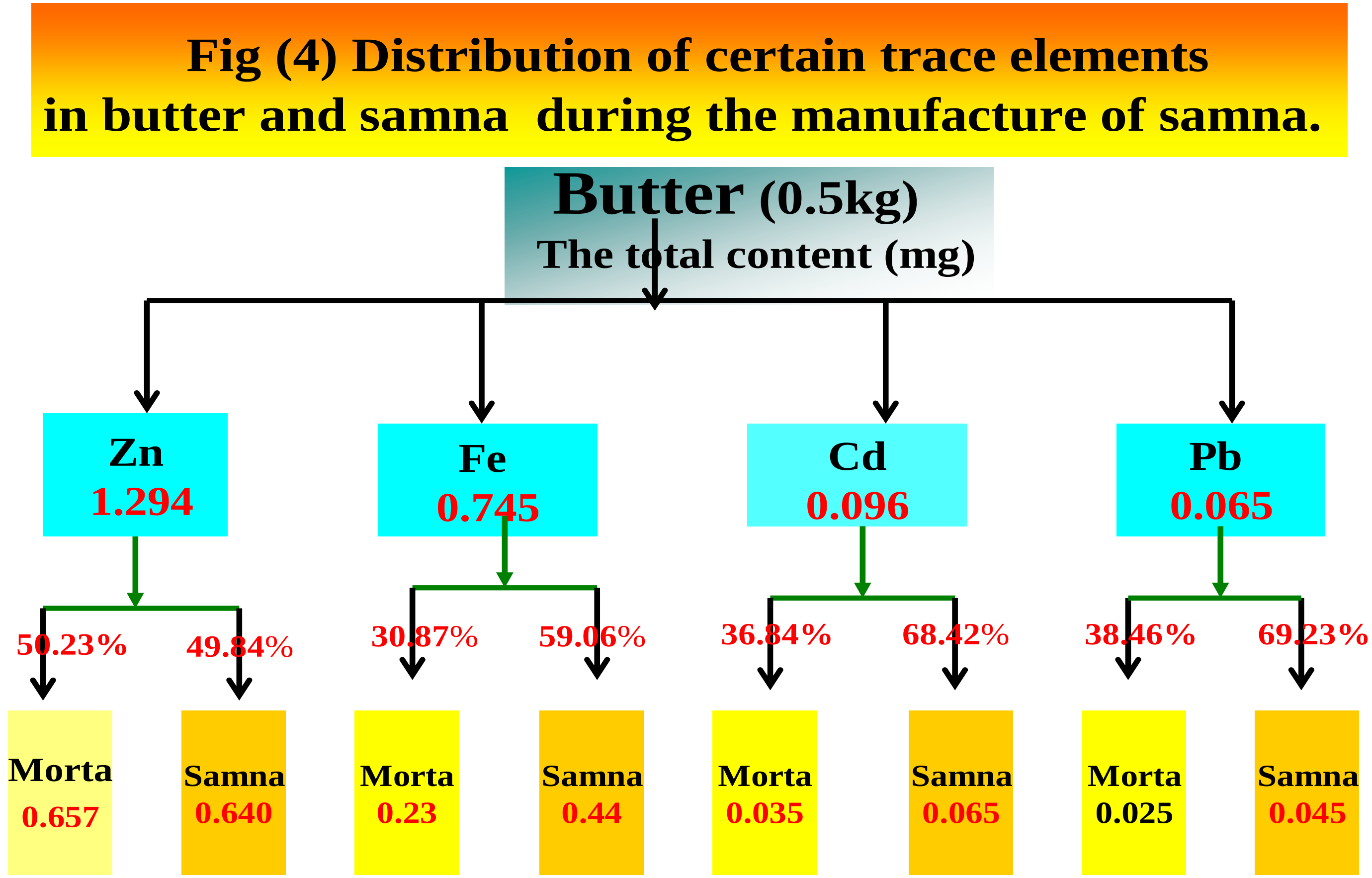
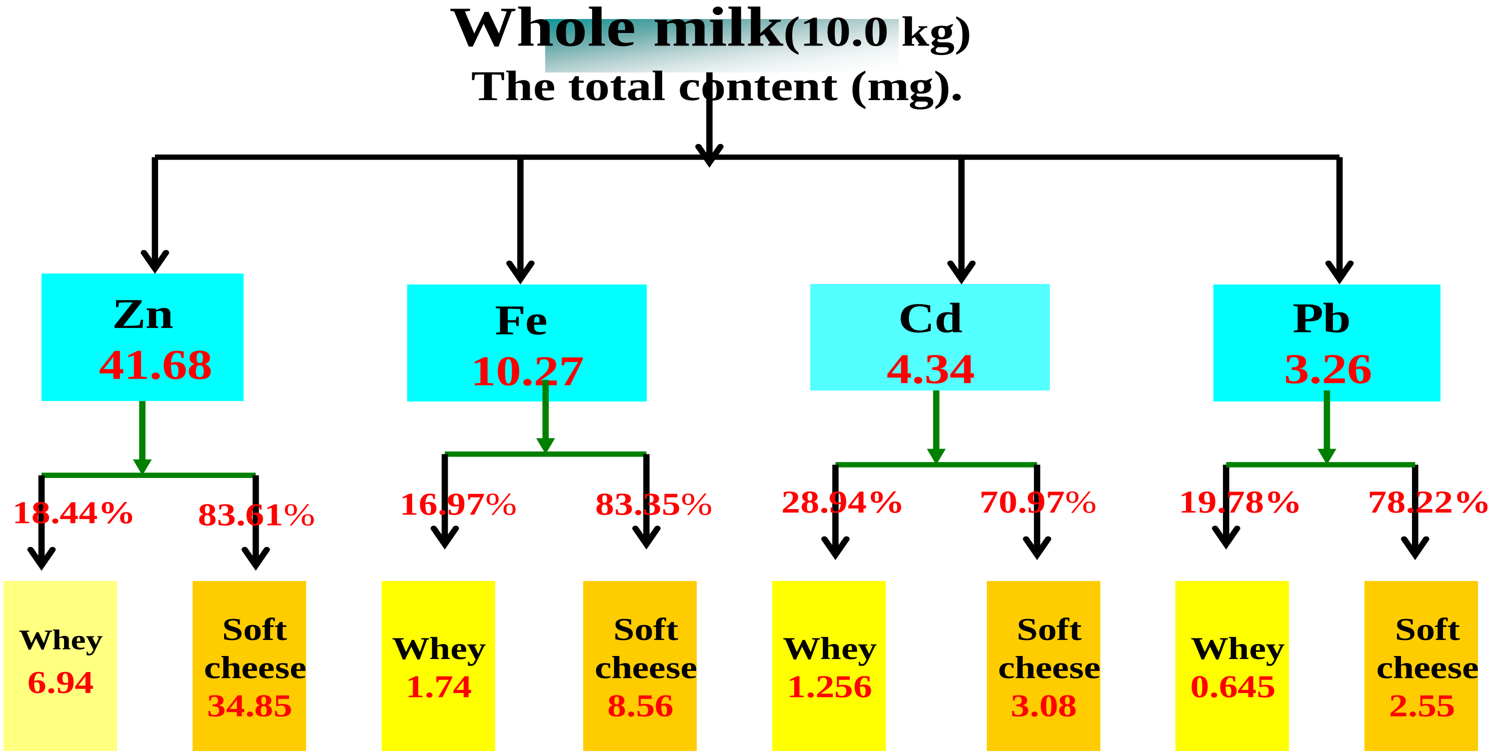
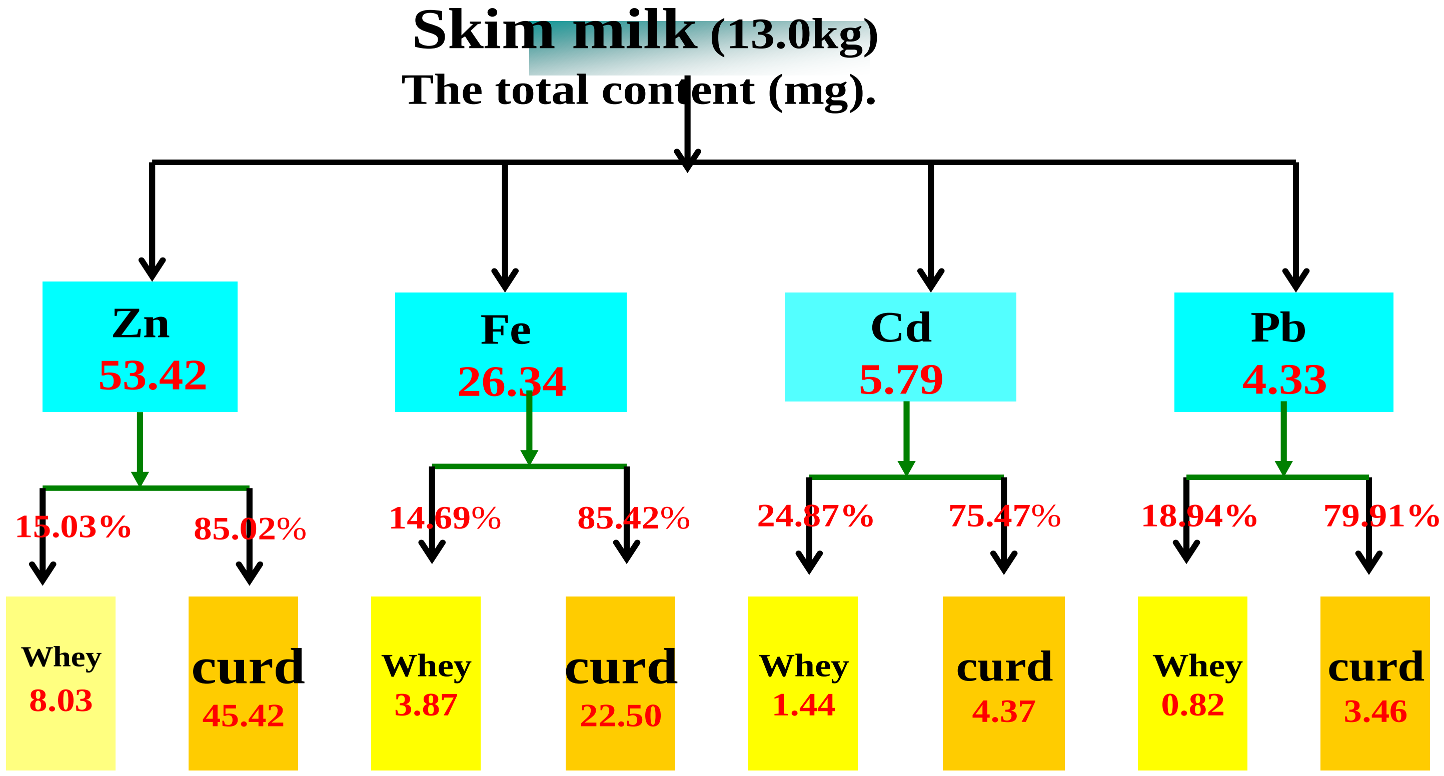


Fig (4) Distribution of certain trace elements
in butter and samna during the manufacture of samna.
Butter (0.5kg)
The total content (mg)
Zn
1.294
Fe
0.745
Cd
0.096
Pb
0.065
50.23%
49.84%
30.87%
59.06%
36.84%
68.42%
38.46%
69.23%
Morta
0.657
Samna
0.640
Morta
0.23
Samna
0.44
Morta
0.035
Samna
0.065
Morta
0.025
Samna
0.045

F(5a)Distribution of certain trace elements in milk and soft cheese during rennet coagulation.



F(5b)Distribution of certain trace elements in curd and whey prepared by rennet coagulation of skim milk .



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2- تأثير بعض المعاملات التكنولوجية للبن على محتوى المنتجات المتحصل عليها من عناصر الزنك و الحديد و الكادميوم و الرصاص.

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تم دراسة تأثير المعاملات التكنولوجية للبن على محتوى المنتجات المتحصل عليها من عناصر الزنك و الحديد و الكادميوم و الرصاص حيث تم تقديرها بالجزء فى المليون (ppm). ولوحظ وجود إنحراف قليل جداً فى مستوى تلك العناصر فى اليوغورت الناتج عن اللبن المستعمل حيث إحتفظ اليوغورت ب91.89، 89.83، 97.97، 103 % من محتوى اللبن من الزنك و الحديد و الكادميوم و الرصاص على التوالى . و أثناء فرز اللبن إلى قشدة و لبن فرز ووجد أن القشدة إحتفظت فقط ب6.07، 6.12، 3.39، 3.37 % من الزنك و الحديد و الكادميوم و الرصاص بينما الغالبية العظمى من تلك العناصر وجدت فى اللبن الفرز و بمعدل 91.54، 90.28، 95.21، 94.72 % على نفس الترتيب .

وعند خض القشدة إلى زبد و لبن خض وجد أن الزبد تحتوى على 37.47، 41.95، 43.7، 42.20 % من الزنك و الحديد و الكادميوم و الرصاص بالمقارنة بالقشدة و الجزء الباقى وجد باللبن الخض و بمعدل 72.55، 58.28، 55.82، 56.67 % لتلك العناصر بالترتيب .

و عند مقارنة محتويات الزبد من تلك العناصر بما يحتوية اللبن الخام المستعمل فى الصناعة كانت نسبة تلك العناصر بالزبد تعادل فقط 2.22، 2.55، 1.48، 1.42 % على نفس الترتيب . كما أن السمن الناتج من غلى الزبد يحتوى 1.09، 1.51، 1.07، 0.98 % من محتوى تلك العناصر باللبن المستعمل .

و أدى تجبن اللبن الكامل أو الفرز الى احتفاظ الخثرة الناتجة بالجزء الاكبر من تلك العناصر بما يعادل 83.70 و 85.02 % للزنك ، 83.95 و 88.42 % للحديد ، 70.97 و 75.47 % للكادميوم و 78.22 و 79.91 % للرصاص لكل من خثرة اللبن الكامل و اللبن الفرز على التوالى و الباقى وجد فى الشرش الناتج من كل منهما.