THE OCCURRENCE OF CERTAIN ELEMENTS IN MILK AND SOME DAIRY PRODUCTS
3- EFFECT OF STORAGE PERIOD ON THE DISTRIBUTION OF ZN, FE, CD AND PB IN SOFT CHEESE AND STORED WHEY

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Abstract

The effect of storage period on the distribution of Zn, Fe, Cd, and Pb in soft cheese and respective storage whey was investigated. The level of above elements in whole milk were 4.168, 2.084, 0.434, and 0.326 ppm respectively, while the resultant soft cheese contained 17.424, 4.280, 1.540 and 1.275 ppm of Zn, Fe, Cd and Pb respectively. The fresh whey characterized with levels of 2.055, 0.218, 0.157 and 0.085 for the examined elements in the same respect. During storage period up to 60 days the levels of the foregoing elements are changed in the both cheese and storage whey. The concentration of these elements was decreased in cheese after 15 days of storage and the lowest value was found in cheese stored for 60 days. Vice versa in storage whey, the levels, of these elements are increased and the highest values obtained after 60 days of storage.

Defatted curd made from skim milk contained 4.11, 2.03, 0.445 and 0.333 ppm of Zn, Fe. Cd and Pb respectively. The obtained fresh cheese and whey were characterized with 20.64, 10.227, 1.990&1.573 and 0.744, 0.358, 0.133& 0.076 ppm of the above elements respectively. The behavior of investigated elements in defatted curd and respective whey during storage period up to 60 days the same as in full cream cheese in the case of Zn and Fe, while the values of both of Cd and Pb showed an increase by prolongation of storage period. It was concluded that the investigated elements had different distributions in both cheese and whey and in soft cheese and defatted curd.

INTRODUCTION

Cheese is a generic term for a diverse of milk –based food products. It produced through the world in wide – ranging flavors, texture and forms. It is valued for its portability, long life and high content of fat, protein, calcium and phosphorus. Domiate and Kareish cheese are the most popular soft cheese varieties in Egypt (Abou-Donia, 1991). They are consumed either fresh or after pickling in salted whey (Abou El-Enein 1998) .Pollution of feed and food with heavy metals represent a severe risk for their long term toxicological effects.

The toxic metals content of milk and dairy products is due to several factors i.e. environmental conditions, the manufacturing process and the possible contamination during several steps of the manufacturing processes. (Liobet, et al.2003).

Domiati and Kareish are cheese are consumed either fresh or after pickling in salted whey (Abou El-Enein 1998) found that the Cd content of Domiati cheese during pickling is ranged from 1.4 ppm to a 55 ppm after 45 days and till the end of storage period (90 days).

Fe level decreased gradually and reduced to 26.9% of that in fresh cheese after 90 days of pickling, which where the concentrated in whey increased with the increase of pickling period. Both of Pb and Zn decreased during pickling period. Their contents reduced at the end of pickling period to 63.9% and 68% of fresh cheese respectively.

Recently Mohran et al (2010a) investigated the level of Zn, Fe, Cd, and Pb in raw milk and some dairy products.

They also investigated the effect of milk processes on the distribution of Zn, Fe, Cd, and Pb in resultant dairy products Mohran et al (2010b). Limited studies had been done on the effect of storage on the levels of heavy metals in white soft cheese. The present study is planed to investigate the effect of storage period on the distribution of Zn, Fe, Cd, and Pb in soft cheese and storage whey.

MATERIALS AND METHODS

1- Materials

- Fresh cow's milk was obtained from Animal Production Department, Fac. of Agric. Assiut Univ.
- Rennet powder was obtained from Chr. Hansen's Laboratories.

2- Experimental procedures

Soft cheese was manufactured from unsalted cow's milk after heating at 70 ^{0}C/5 min, cooled to 35 ^{0}C according to ElGendy (1970). Coagulation of unsalted milk produced defatted curd.

3- Methods of Analysis

The incidence of Zn, Fe, Cd, and Pb in fresh raw cow' s milk , full cream milk curd (fresh cheese) and its whey as well as skim milk curd (fresh defatted curd) and its whey had been detected (ppm) using the method described by James (1995) using atomic absorption spectrophotometer (AA-630-02 Shimadzu-Japan). .

The distribution of the above elements in cheese and storage whey has been also detected during storage period up to 60 days to investigate the effect of storage period.

RESULTS AND DISCUSSION

Table (1) represents the concentration of Zn, Fe, Cd, and Pb in fresh whole cow' s milk and the resultant separated skim milk which was used for manufacturing of full cream milk soft cheese and defatted curd respectively. The levels of the above elements in whole milk were 4.168, 2.084, 0.434 and 0.326 ppm respectively, and the respective values of full cream soft cheeses were 17.424, 4.280, 1.540 and 1.275 ppm in the same levels. Skim milk contained these elements with levels of 4.11, 2.03, 0.445 and 0.333 ppm and the obtained defatted curd had 20.64, 10.227, 1.990 and 1.573 ppm for Zn, Fe, Cd and Pb respectively.

Table 1. The levels of Zn, Fe, Cd and Pb (ppm) in whole cow's milk, skim milk and the resultant soft cheese and defatted curd.

Elements	Whole milk	Soft cheese	Skim milk	Defatted curd
Zn	4.168	17.424	4.11	20.64
Fe	2.084	4.280	2.03	10.227
Cd	0.434	1.540	0.445	1.990
Pb	0.326	1.275	0.333	1.573

Table (2) shows the change in the concentration of investigated elements in full cream soft cheese during storage period up to 60 days. Fresh cheese characterized with levels of 17.424, 4.280, 1.540 and 1.275 ppm for Zn Fe, Cd and Pb respectively. On the other hand, the levels of these elements in obtained fresh whey were 2.055, 0.218, 0.157 and 0.085 ppm in the same order. The levels of Zn, Fe, Cd, and Pb in resultant fresh cheese were about four times, than that in used milk while Fe was more than double times (Table 1).This indicated that most of these elements are bounded to casein which formed the cheese curd.

As seem from Table (2), the levels of the foregoing elements in both cheese and whey used as storage solution are changed through storage period. Zn was increased during the first 15 days from 17.424 to 20.891 ppm. The level of Zn was gradually decreased by prolongation of storage period up to 60 days which that showed 16.561 ppm at the end of storage period. The rate of Zn reduction was 5%.

The concentration of Zn in whey decreased during the first 15 days, then after it increased to reach 8.251 ppm at the end of storage period. The rate of increment was about four times more than that of fresh whey. The decrease of Zn, content in storage cheese and its increase in storage whey may be due to hydrolyses of casein components and release soluble peptides bound the metal in storage solution.

The levels of Fe in stored cheese and whey are shown in table (2). Fe concentration in cheese decreased gradually throughout the storage period in which old cheese contained about 65.6% of the metal content of fresh cheese that was at the end of storage. The same finding was reported by El-Awamry (1994)

On the other hand, the concentration of Fe in whey increased with the increase of storage period.

The level of Fe in whey at the end of pickling period was about twenty times more than that of the content in fresh whey.

Table (2) illustrates the distribution and changes in Cd concentration in cheese and whey during storage period. The level of Cd in cheese decreased during storage from 1.540 to 0.413 ppm after 60 days. The same finding was reported by Abou- El-Enain (1998). The reduction in Cd level at the end of storage period was 73.2 %. El-Awamry (1994) who reported that the reduction of Cd concentration in cheese pickled for 90 days was 60.7%. The concentration of Cd in whey increased with increasing the storage period. At the end of storage period the level was more than two times of the level in fresh whey.

As shown Table (2) the concentration of Pb in stored soft cheese and whey changed by the increase the storage period. Pb concentration in cheese increased during 30 days of storage then reduced. The lowest concentration of Pb in cheese was after 60 days of storage. This level was reduced by 40 % of that of fresh cheese. This value of Pb reduction was lower than that recorded by El-Awamry (1994) (63.9%).

The lead level in fresh whey was 0.085 ppm. This level increased with the increase of storage period to reach 0.336 ppm at the end of 60 days. This increasing in Pb level in whey was more than 30 times of the level of fresh whey.

Table 2. Effect of storage period on the levels of Zn, Fe, Cd and Pb (ppm) in full cream soft cheese and stored whey.

Elements	Samples	Storage period (days)				
		0	15	30	45	60
Zn	Cheese	17.424	20.891	19.742	18.652	16.561
	Whey	2.055	1.814	3.072	4.673	8.251
Fe	Cheese	4.280	3.665	3.225	2.856	2.806
	Whey	0.218	2.875	3.082	3.665	4.072
Cd	Cheese	1.540	0.825	0.825	0.416	0.413
	Whey	0.157	0.215	0.225	0.336	0.334
Pb	Cheese	1.275	1.554	1.175	0.902	0.775
	Whey	0.085	0.108	0.263	0.322	0.336

From the forementioned results, it could be seen that the rate of reduction in the levels of Zn, Fe, Cd and Pb in stored cheese are fluctuated. It was 5 % only, 33.77, 73.2 and 40 % for Zn, Fe, Cd and Pb, respectively. Thus it can be concluded that the storage of cheese reduced the heavy metals potential in cheese and thus increase the safety of these products.

In the case of defatted curd, the behavior of the investigated elements during storage was approximately the same as in full cream soft cheese. Table (1) showed the differences in concentrations of Zn, Fe, Cd and Pb in skim milk and the obtained defatted curd. It clear that defatted curd contained about (4-5) times of these elements than that of used skim milk. This indicated the bounding of these elements with casein fraction. Table (3) revealed the changes and distributions of these elements in cheese and whey during storage period up to 60 days.

The level of Zn in fresh defatted curd was 20.64 ppm which increased to 22.093 ppm after 15 days. This may be due to the loss of moisture and raising the concentration of total solids. After 30 days of storage, this value reduced to 19.66 ppm. This reduction was continued to give the lowest value of 12.49 ppm at the end of storage. The reduction ratio was about 40 % of that in fresh cheese. This ratio was higher than that of full cream soft cheese (5 %). This may be due to that the break down of protein in the case of defatted curd was stronger than full cream cheese.

The concentration of Zn in fresh stored whey was 0.728 ppm, which increased gradually to 1.956 ppm at the end of storage. This value was about 3 times than that of fresh whey.

The level of Fe in fresh defatted curd was 10.227 ppm which increased to about 20.0 ppm after 15-30 days of storage. This concentration was reduced to about

12 ppm at the end of storage. As reported in the case of Zn the increase of Fe concentration during the mid of storage period is due to the increase of cheese dry matter, and the reduction showed at the end of storage period may be due to the hydrolysis of cheese caseins and liberation of soluble peptides which attached with Fe.

The reduction of cheese Fe at the end of storage led to increase the concentration of this element in whey (Table 3).

The level of Cd in defatted curd was increased by prolongation of storage period. The highest value (3.752 ppm) was found after 30 days of storage which reduced to 3.362 ppm at the end of storage (Table 3).

The concentration of Cd in whey showed the same behavior as in cheese. The maximum value (0.552 ppm) was found after 30 days of storage then reduced to 0.223 ppm at the end of storage period.

The concentration of Pb in defatted curd was increased with the prolongation of storage period and reached the highest value after 45 days (2.523 ppm). At the end of storage period it recorded value of 1.852 ppm.

On the other hand the level of Pb Table (3) in whey was increased with the increase of storage period and the highest value was found at the end of storage period.

The forementioned results revealed that the investigated trace elements had different distribution in both cheese and whey than that found in the case of soft cheese. This may be due to that these elements dissolved in water which kept in defatted curd with ratio more than that of full cream cheese. Also more than 90 % of milk polluted elements are separated with skim milk Mohran. et al. (2010b.).

Table 3. Effect of storage period on the levels of Zn, Fe, Cd and Pb (ppm) in defatted curd and pickled whey.

Elements	Samples	Storage period(days)				
		0	15	30	45	60
Zn	Cheese	20.64	22.093	19.66	16.87	12.49
	Whey	0.744	0.795	0.965	1.655	1.956
Fe	Cheese	10.227	20.02	19.66	12.49	11.74
	Whey	0.358	0.302	0.366	0.384	0.406
Cd	Cheese	1.990	3.317	3.752	3.382	3.362
	Whey	0.133	0.092	0.552	0.236	0.223
Pb	Cheese	1.573	1.502	1.802	2.523	1.852
	Whey	0.076	0.136	0.142	0.143	0.203

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تأثير فترة التخزين على توزيع كل من الزنك و الحديد و الكادميوم و الرصاص فى كل من الجبن الطرى و شرش التخزين

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تم دراسة تأثير فترة التخزين على توزيع كل من الزنك و الحديد و الكادميوم و الرصاص فى كل من الجبن الطرى و شرش التخزين . أحتوى اللبن الكامل على ٤,١٦٨ ، ٢,٠٨٤، ٠,٤٣٤ و ٠,٣٢٦ جزء فى المليون من العناصر السابقة على الترتيب . وأحتوى الجبن الطازج الناتج من تصنيع اللبن السابق على ١٧,٤٢٤ ، ٤,٢٨٠ ، ١,٥٤٠ و ١,٢٧٥ جزء فى المليون من الزنك و الحديد و الكادميوم و الرصاص على الترتيب كما أحتوى الشرش على ٢,٠٥٥ ، ٠,٢١٨ ، ٠,١٥٧ و ٠,٠٨٥ جزء فى المليون من تلك العناصر على نفس الترتيب.

خلال فترة التخزين حتى ٦٠ يوم حدث تغيير فى مستوى العناصر السابقة سواء فى الجبن أو شرش التخزين حيث حدث أنخفاض فى مستوى كل العناصر تحت الدراسة بعد مضى ١٥ يوم من التخزين و سجل أدنى تركيز بعد ٦٠ يوم من التخزين و على العكس من ذلك حدث زيادة فى تركيز تلك العناصر فى شرش التخزين و كان أعلى تركيز بعد ٦٠ يوم من التخزين .

ووجد أن ا للبن الفرز يحتوى على ٤,١١ ، ٢,٠٣ ، ٠,٤٤٥ و ٠,٣٣٣ جزء فى المليون من الزنك و الحديد و الكادميوم و الرصاص على الترتيب .

ووجد ان الجبن الناتج يحتوى على ٢٠,٦٤ ، ١٠,٢٢٧، ١,٩٩٠ و ١,٥٧٣ جزء فى المليون من العناصر السابقة بينما كان الشرش الناتج يحتوى تلك العناصر بتركيز ٠,٧٧٤ ، ٠,٣٥٨، ٠,١٣٣ و ٠,٠٧٦ جزء فى المليون على نفس الترتيب .

كما وجد ان سلوك تلك العناصر فى الخثرة منزوعة الدسم يماثل تقريبا ما يحدث فى الجبن كامل الدسم بالنسبة لعنصرى الزنك و الحديد وعلى العكس من ذلك حدث زيادة فى كل من الكادميوم و الرصاص مع تقدم فترة التخزين .

و يستنتج من ذلك أن العناصر التى تم دراستها تختلف فيما بينها من حيث التوزيع بين كل من الجبن و الشرش سواء فى حاله الجبن كامل الدسم أو الخثرة منزوعة الدسم .