Vitamin C and minerals contents of Sudanese white soft cheese made from milk with different levels of Cassava powder (*Manihot esculent*)

[1]Koc Ruben Ramzi Dhuol and [2]Omer Ibrahim Ahmed Hamid

1. Department of Dairy Production, Faculty of Animal Production, Upper Nile University, Malakal, South Sudan. E-mail: kocruben @hotmail.com
2. Departments of Dairy Sciences and Technology, College of Animal Production Science and Technology, Sudan University of Science and Technology Khartoum North, Sudan.

Corresponding Author: omerhi30@sustech.edu

Abstract

This study was done to determine the Vitamin C and some minerals of Sudanese White soft Cheese Calcium (Ca), Phosphorous (P) , Sodium (Na) and Potassium (K) made from milk with different levels of Cassava powder (*Manihot esculenta*), the aim of the Study is to investigate the effect of storage period and different levels of cassava powder on the Vitamin C and the minerals contents of the manufactured cheese .One hundred twenty (120) liters of fresh cow's full cream milk were used in this study. Four treatments were carried out as follows: First treatment is the control in which fresh cow's milk was made into cheese, while in the second (Cw1), third (Cw2) and fourth (Cw3) treatments; 0.5 %, 0.75% and 1 % of cassava powder were added respectively to cheese milk before pasteurization. Statistical analysis showed that cassava powder significantly ($p<0.05$) affected the Vitamin C, Ca and P, while there were no significance ($p<0.05$) effect on Na and K contents of the white cheese. The statistical analysis also showed that there were significance effect ($p<0.05$) by the storage period in all the characteristics under the investigation (vitamin C, Ca, P, Na and K). The results showed that there were significance differences($p<0.05$) between control cheese and the other with 0.5, 0.75 and 1 percent respectively in vitamin C, Ca and P, while there were no significance ($p<0.05$) in Na and K contents.

Key words: Sudanese white soft cheese, cow milk, Vitamin C, Ca, P, Na, K, Cassava powder.

{**Citation:** Koc Ruben Ramzi Dhuol, Omer Ibrahim Ahmed Hamid. Vitamin C and minerals contents of Sudanese white soft cheese made from milk with different levels of Cassava powder (*Manihot esculent*). American Journal of Research Communication, 2014, 2(1): 108-117} www.usa-journals.com, ISSN: 2325-4076.

Introduction:

Cheese can be defined as the fresh or ripened product obtained after coagulation and whey separation of milk, cream or partly skimmed milk, buttermilk or a mixture of these products Law (1999) and Fox *etal*. (2000). white soft cheese is the one of most widespread type of cheese produced in Sudan, locally known as (Gibna Bayda). It is a pickled soft cheese that is stored under anaerobic conditions in air tight containers filled with whey Kur, L.L.A. (1984).

The real beginning of cheeses-making is unrecorded in history. However, it must have occurred within few centuries after the domestication of the cows and other mammals about 8000 B.c. (John, 1975) . Warsama *et.al* (2006) reported that Sudanese white soft cheese contained 47.8% total solids, 14.0% fat, 15.9% protein and 6.2% ash , and it is locally known in Sudan as (Gibna Bayda) or Gibbna which is the most famous name , and it is usually stored in containers filled with whey (Kur, 1984).

Cheese plays an important role in the Sudanese diet, and many people eat a certain amount of cheese with at least twice per week in one of their meals, most of the cheese is consumed either directly or with bread. Like most dairy products, cheese is a rich source of minerals, protein, vitamin, fat and carbohydrate .In general, cheese supplies a great deal of calcium and phosphorous. Sudanese white soft cheese contains most of the skim milk constituents including protein, lactose small amount of sugar, some water soluble vitamins and most of calcium and phosphorus. The quality and composition of Sudanese white soft cheese may vary considerably due to such factors as the quality and composition of the clotted skim milk, the method of manufacture, the time required to complete the whey drain, the quality of salt added and the method of handling of the finished cheese. Birghila *et al*. (2008) and GEMS (2003).

The Cassava crop is originated in the American tropics but it is now grown through the tropical world. (William, 1989) and its very essential crop for food security in the humid and sub humid tropics of Africa Thottapilly(1992). There are many varieties of cassava and it is classified as sweet or bitter cassava (Ravindran, 1991). The cassava tuber flesh is composed of about 61 % water , 35 % carbohydrate , 1-2 % protein 0.3 % fat 1-2 Fiber , and 2 % minerals. Especially cassava roots are very rich in minerals and contains significant amounts of calcium (50 mg/100g), phosphorus (40 mg/100g) and vitamin C (25 mg/100g) (Olsen, 1999).

For the making of cassava flour, the fresh roots are peeled, washed, and cut into large or small slabs. The slabs are then allowed to dry under the sun, and when the flour (powder) is needed the dry slabs can be milled to produce grayish white flour which can be used for producing many type of food. (John, 1978).

In Sudan South the people depend mainly t on Cassava as stable food due to the lack of available quantities of fluid milk and to improve the quality characteristics of the white cheese.

In this study different level of Cassava powder were added to the milk to show their effects on the chemical characteristics of white soft cheese during storage.

Materials and Methods:

The present study was conducted during 2013 at the Laboratory of Dairy Science and Technology Department, College of Animal Production Sciences and Technology, Sudan University of Science and technology. In this Study four treatments were carried out as follows: First treatment is a control in which fresh cow's full cream milk cheese had no additive. In the second (Cw1), third (Cw2) and fourth treatment (Cw3) 0.05, 0.75 and 1 % of cassava powder were added respectively to the fresh cow's full cream milk cheese before pasteurization.

Materials:

One hundred twenty liters (120 liters) of fresh cow's full cream milk were purchase from a private farm at Khartoum north and then divided into four equal groups (15 liters each) . Cassava roots were brought from Konyo-Konyo market at Juba and then were cut into small pieces and dried under the sun light for 1-3 days , then grinded to a fine powder (flour) before added to the milk. A fine commercial Salt (Sodium Chloride NaCl) was purchased from the local market at Haj Yousif Shikila . Rennet powder of one gram per 50 liters of milk was obtained from Hassan El-said center for veterinary services at Hellat Kuku Khartoum North – Bahary. Calcium Chloride Powder was purchased from Lab line International Company. Khartoum – Sudan. Commercial starter (*Streptococcus thermophillus* and *Lactobacillus bulgaricus*) was purchase from local markets . The Triplicate Sterile plastic buckets of (500 gram) capacity were brought from Hala Plastic Factory – Omdurman.

Cheese manufacturing:

Cheese was manufacture according to the method described by Ibrahim (2003) with some modifications. One hundred twenty liters(120 liters) of fresh clean cow's full cream milk was divided into four equal volumes (15 liters each) and kept into three separate tanks .The first volume was left free without any additive of cassava powder , while in the other three volumes cassava powder was added at the levels of 0.5 , 0.75 , and 1 % to the milk respectively . The different milk samples was laboratory pasteurized at 72^{o}c for 1 minutes. The milk samples was then transferred into stainless steel containers for cheese manufacture and then cooled to 42 ^{o}c. Commercial starter (*Streptococcus thermophillus* and *Lactobacillus bulgaricus*) in the ratio of 1:1% concentrate was added at the level of 1 % (W/v). The milk was stirred gently for 15 minutes to avoid creaming before renneting. Rennet powder (1 gram/50 liters) was dissolved in 50 ml of distilled water and added to milk at 40 ^{o}c. Fine Calcium chloride was added at the levels of 0.02 % immediately. Milk was then stirred for 20 minutes and then left undisturbed for 3 hours to develop curd. The curd was cut into small

cubs (2.5x2.5x2 cm) .After draining, salt at 2% (w/v) was mixed with the curds .The curd was poured into small clean wooden molds lined with cheese cloth and press by (30 kg) weight overnight .

The next day, brine solution was prepared by adding salt to the collected whey (8 % w/v), then pasteurized at 72 ^{o}c for 1 minute and cooled to 40 ^{o}c. The pressed cheese was cut into small cubes and then transferred to the triplicate sterile plastic buckets containers filled with whey. The Containers were sealed and stored at room temperature (38±2) for 90 days .Chemical evaluations of cheese samples were carried out at 0, 30, 60 and 90 days intervals.

Chemical analysis:

The vitamin C was determined according to AOAC 2009, Calcium (Ca), Potassium (K) and Sodium (Na) contents of each cheese sample were determined according to AOAC (2009) using flame photometer . Analysis of phosphorus (P) was carried out according to the method of Champman and Pratt .1961 ,by using spectrophotometer.

Statistical analysis:

Statistical analysis was done by using SPSS (1998) program (version 17). General Linear models were used to estimate the effect of storage periods, Cassava powder and interaction between them on the chemical composition of the cow's milk white soft cheese. Least Significance Difference (LSD) was used for mean separation between the treatments. The level of Significance (0.05) was used in this study

Results:

The average chemical composition of the vitamin C and Minerals of the milk used for cheese making in this study were as follow : 5.21 , 11.72 , 7.61 , 4.30 and 9.23 Mg/L for vitamin C , Ca, P ,Na, and K respectively , while the vitamin C and minerals contents of the Cassava powder used were as follow : 2.75 , 2.59, 3.66, 0.72 and 4.46 Mg/L for vitamin C , Ca, P ,Na ,K respectively .

Effect of the storage period on the vitamin C and minerals contents of the cow's white soft cheese:

Results in table 1 show the main effect of storage period on the vitamin C and minerals contents of cow's soft cheese. All the characteristics under investigation (vitamin C, Ca, P, Na and K) were significantly ($p<0.05$) affected by the storage period and decreased with the advanced in the storage period.

The results indicated that the vitamin C contents of the cheese was affected significantly ($p<0.05$) by the storage period. It was decreased from 5.13±0.24 Mg/L at the day zero to 2.31±0.12 Mg/L at day 90 (Table 1).

Based on the results obtained in table 1 the Calcium (Ca) content of the cow's milk cheese was affected significantly ($p<0.05$) by the storage period. It was decreased from 11.92±0.20 Mg/L at the day zero to 8.59±0.25Mg/L at the day 90 of the storage period.

According to the Data presented in table 1 the Phosphorous (P) content of cow's milk cheese was significantly ($p<0.05$) decreased from 6.48±0.16 Mg/L at the day zero to 3.62±1.17 Mg/L at the day 90 of the storage period.

It was observed that (Table 1) the Sodium (Na) content of the cheese was significantly ($p<0.05$) affected by the storage period it was decreased from 53.91± 0.51 Mg/L at the day zero to 50.41±0.20 Mg/L at the day 90.

It was clear (Table 1) that the Potassium (K) contents of the cheese decreased significantly ($p<0.05$) with the storage period. It was decreased from 9.83±0.10 Mg/L at the day zero to 6.41±0.82 Mg/L at the day 90 of the storage period.

Table 1: Effect of the Storage period on Vitamin C and Minerals contents of white cheese

Storage Period	Vitamin C and Minerals contents				
	Vitamin C mg/L	Ca mg/L	P mg/L	Na mg/L	K mg/L
Day 0	5.13±0.24 [a]	11.92±0.20 [a]	6.48±0.16 [a]	53.91±0.51 [a]	9.83±0.10 [a]
Day 30	3.69±0.29 [b]	10.86±0.19 [b]	5.21±0.63 [b]	53.38±0.45 [b]	8.58±0.12 [b]
Day 60	2.91±0.05 [c]	9.46±0.27 [c]	4.42±1.19 [c]	51.51±0.13 [c]	7.31±0.10 [c]
Day 90	2.31±0.12 [d]	8.59±0.25 [d]	3.62±1.17 [d]	50.41±0.20 [d]	6.41±0.82 [d]
LS	***	***	***	***	***

Mean values bearing different superscripts within rows are significantly different ($P<0.05$).

LS= Levels of significance

Effect of different levels of Cassava powder on vitamin C and minerals contents of the cow's white soft cheese:

Data in table 2 illustrated the effects of different levels of Cassava powder on the vitamin C and minerals contents of the cow's soft cheese. Vitamin C, Calcium (Ca) and Phosphorus (P) significantly ($p<0.05$) affected by the different levels of cassava powder, while there were no significance difference ($p<0.05$) on Sodium (Na) and Potassium (K) contents of the white soft cheese.

The results (Table2) indicated that there were significance difference ($p<0.05$) in the vitamin C content between all the treatments. The results showed that the highest vitamin C (3.61±1.09 Mg/L) was in the Cow's milk cheese with 1 % Cassava (Cw3) while the lowest vitamin C (3.24±1.07 Mg/L) was recorded in the Cow's milk cheese without Cassava (Control).

The Calcium (Ca) content of the cow's milk cheese was significantly different ($p<0.05$) between all the treatments. The highest Calcium (Ca) content (10.47±1.27 Mg/L) was for the cow's milk cheese with 1 % Cassava (Cw3) , while the lowest one (9.98±1.33 Mg/L) was found in the Cow's milk cheese without Cassava (Control) .

The Phosphors (P) content of the cheese samples was affected significantly ($p<0.05$) by the different levels of Cassava powder between all treatments. The highest Phosphors (5.07±1.22 Mg/L) was recorded in the cow's milk cheese with 1 % Cassava (Cw3) while the lowest one (4.82±1.86 Mg/L) was found in the Cow's cheese milk with 0. 5 % Cassava (Cw1).(Table 2).

It was clear from the results (Table 2) that there were no significance difference ($p<0.05$) in Sodium (Na) and Potassium (K) contents between all the treatments. The highest Sodium contents 52.50±1.79 Mg/L was found in the Cow's milk cheese with 1 % Cassava (Cw3) while the lowest Sodium (Na) content 52.03±1.03 Mg/L was found in the Cow's milk cheese without Cassava (Control).

Table 2: Effect of the different levels of Cassava powder on Vitamin C and Minerals contents of the white cheese:

Treatments	Physicochemical characteristics				
	Vitamin C mg/L	Ca mg/L	P mg/ L	Na mg/L	K mg /L
Control	3.24±1.07 ^{d}	9.98±1.33 ^{d}	4.88±0.97 ^{c}	52.03±1.03	8.03±1.18
Cw1	3.58±1.11 ^{c}	10.11±1.38 ^{c}	4.82±1.86 ^{d}	50.46±9.76	7.95±1.37
Cw2	3.60±1.11 ^{b}	10.29±1.26 ^{b}	4.97±1.39 ^{b}	52.22±1.56	7.99±1.44
Cw3	3.61±1.09 ^{a}	10.47±1.27 ^{a}	5.07±1.22 ^{a}	52.50±1.79	8.16±1.53
LS	***	***	*	NS	NS

- Mean values bearing different superscripts within rows are significantly different ($P<0.05$)

LS= Levels of significan-

Control = Cheese without Cassava powder

Cw1=Cheese with 0.5 % Cassava powder

Cw2= Cheese with 0.75 % Cassava powder

Cw2= Cheese with 1 % Cassava powder

- NS: Not significance

Discussion:

Effects of Storage period and different levels of Cassava powder on vitamin C and minerals contents of the cow's white soft cheese:

Vitamin C and minerals contents of the cow's white soft cheese was significantly ($p<0.05$) affected by the storage period (Table 1).

Vitamin C contest of the white cheese decreased during the storage period. These decreased of Vitamin C contents could be probably due to the lipolytic activity of microorganisms on Vitamin C resulting in a leakage of some Vitamin C from crude into the pickling whey. Khalid (1991), Abdala (1992) Nofal *et al*. (1981) and (Nusur, 2001).

The calcium (Ca) content of the soft cheese decreased gradually throughout the storage period. Similar Results was obtained by Muna and Fatema , 2013 who founded the Calcium contents of the Sudanese white soft cheese decreased with the storage from the day Zero up to the day 180 of the storage period .These findings also agreed with those obtained by Abdel Razig (2000), who stated that the calcium content of the braided cheese decreased as the storage time progressed. Amer *et al*. (1979) also reported decreased in calcium of Kashkaval cheese during ripening. Wong *et al*. (1988) reported that the solubility of calcium and phosphorus salts in the acidic medium lead to the loss of both of them. The loss in calcium content could be attributed to the increase in acidity (E1 – Abd *et al*., 1982). The decrease of Calcium contents could be explained by the degradation of Calcium or dissolution of Calcium into the pickling solution or absorption of why by curd, Dariani , 1980 (Table 1).

A significant decrease in sodium content of cheese was observed throughout the storage period. These results were in good agreement with that reported by Muna and Fatema, 2013 who reported that sodium contents of the Sudanese white cheese decreased with storage from the day Zero up to the day 180 of the storage period. These results were different from values observed by Abdel Razig (2000) who stated that the sodium content of braided cheese increased significantly ($P \leq 0.05$) with storage time. Abdel Razig (2000) attributed the high sodium content of braided cheese to the high loss in its moisture content. The results obtained coincided the work of Abdel-Moneim *et al*. 2013 who realized similar decreased in Sodium in mozzarella cheese made from cow's, goat's and a combination of 1:1 percent of the two milk.

The Potassium (K) contents of the cheese decreased significantly with the storage period. Similar decreased in Potassium (K) content was found by Abdel-Moneys *et al*. 2013 who studied the minerals contents of Mozzarella cheese made from a milk of cow's, Goat's and mixture of the two milk (1:1 cow's milk: goat's milk). The decrease of Potassium contents could be probably due to the lipolytic activity of microorganisms on Potassium resulting in a leakage of some Potassium from crude into the pickling whey. Khalid (1991), Abbala (1992) Nofal *et al*. (1981) and (Nusur, 2001).

The Phosphorous (P) of the cheese decreased from the beginning till the end of the storage period. Similar findings were obtained by Abdel-Moneim *et al*. 2013 who reported that Phosphorous decreased with the storage period in mozzarella cheese made from Cow's , Goat's and 1:1 mixture of the two milk .The deceased in the Phosphorous might be due to the degradation of Phosphorus and loss of pickling whey. Hayalogolou *et al*. (2005), Khalid (1991), Abdlla (1992), Nofal *et al*. (1981).

Conclusions:

Addition of different levels of Cassava powder were found to improve the quality of Sudanese white cheese, therefore the white soft cheese made from 1 % Cassava powder obtained the highest values in all the characteristics under investigation (Vitamin C , Calcium (Ca) , Phosphorus (P) , Sodium (Na) and Potassium (K).

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