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Research Article

Effect of lime and Grape fruit extract as coagulants on chemical composition of Sudanese white soft cheese during storage

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Abstract

This study was conducted to determine the effects o coagulant type on the chemical composition of Sudanese white cheese. Three batches of lime acid cheese and grapefruit acid cheese were made. Fresh raw cow's milk (20 liters) was heated to 82ºC for 30 minutes, then salt was added at a rate of 4% and lime juice solution pH 3.2 (50% lime juice+ 50% distilled water) was added at the rate of 5%, and grapefruit juice pH 3.7 was added at a rate of 10%, then the mixture was left until complete coagulation occurred the curd pressed over night(700 gm /pressing), then the cheeses were packed into polyethylene bags 100 gm in each, and stored at 5ºC for a month. Chemical analysis was carried out for the cheese samples at day1, day 7, day 14, day 21 and day30. The results of statistical analysis showed that the fat content of the lime cheese and grapefruit cheese samples stored in refrigerator were high, while the fat contents of the same cheese stored in whey at room temperature were low. The protein content of lime cheese stored in refrigerator (19.45±3.06%), and whey at room temperature (16.28±1.29%) was higher than that of grapefruit cheese (17.03±2.83). Total solids (TS) content of the lime cheese samples stored in whey at room temperature increased significantly (P≤0.001) from 45.51±1.31% at week one to 66.94±1.48% at week four. Ash content of lime cheese samples stored in whey at room temperature (1.10±0.26%) was significantly (P≤0.001) higher than those of lime cheese stored in the refrigerator (0.05±0.01%). Acidity of lime cheese stored in whey increased significantly (P≤0.001) . The acidity of lime cheese stored in refrigerator increased from 0.20±0.00% at week one to 0.30±0.00% at week four. Its concluded that the storage period has significant effect on the chemical composition of white cheese made with lime and grape fruit extracts also the method of preservation had clear effect on the chemical composition of the white cheese.

Keywords: cheese, coagulant, lime, grapefruit, chemical composition

Introduction

Sudanese white soft cheese (Gibna Beyda) is the most common cheese in Sudan. It has a strong odor and taste. It is made from raw or pasteurized whole milk, skim milk or reconstituted milk depending on natural lactic acid bacteria; no starter is used and coagulated by rennet enzyme. It salted by adding odium chloride directly to milk (Abdel Razig, 1996).

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 (Dhoul and Hamid, 2014). 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 . Natural cheese should be stored at suitable temperatures to ensure good quality because a high temperature leads to evaporation of moisture and growth of unwanted bacteria and other faults (Ramakant ,2006).

Gibna Beyda (Sudanese white cheese), like most other cheeses, is coagulated using rennet as a coagulating agent. Other types of cheese may also be made using a combination of heat and acid as coagulating agents. A type of cheese made by this process is called Queso Blanco; it is an important domestic white cheese in all parts of Latin America. Covacevich (1981) Found that cottage cheese produced by direct chemical acidification was too low in moisture content and insufficiently firm in texture unless the direct chemical acidification was preceded by fermentation of the milk with starter.

The acid coagulation, which is reached by lactic acid bacteria, which convert the lactose of the milk into lactic acid resulting in decrease of the pH of the row milk from 6.7 to 4.6 and at pH 4.6, the lactic acid effects the casein which starts coagulating. According to Abdalla *et al.,* (2001) the factors affecting acid coagulation are related to dissolve calcium salts, acidity, temperature, quantity of rennet and the heat treatment.

The objectives of the research are to study the effect of direct acidifications using natural acidifiers of different citrus fruit juices extracted from lemon, orange and grapefruit on the chemical and microbiological properties of white cheese.

Materials and Methods

Materials

Three batches of lime acid cheese and grapefruit acid cheese were made.

The experimental procedures were done in the Dairy Processing unit of the Department of Dairy Production. University of Khartoum, during the period from September 2010 – December 2010.

Source of milk

Fresh raw whole-cow's milk (20 liters) was obtained from the farm of College of Animal Production Science and Technology-Sudan University.

Sources of Lime and Grapefruit

Lime (*Citrus aurantifolia*) of 3.2 pH and Grapefruit (*Citrus paradisi*) of 3.7 pH were purchased from Khartoum Fruit central Market and then juices were prepared by mechanical pressing of two dozen of grapefruit and three dozen of lime .

Graduated measuring cylinder:

This was used to measure the required lime and grape juices in ml.

Cloth filter:

This cloth filter was used to filter lime and grape juices and salt.

Salt:

White fine table salt was purchased from local market.

Cheese manufacture:

Fresh raw cow's milk (20 liters) was heated to 82ºC for 30 minutes, then salt was added at a rate of 4% and lime juice solution pH 3.2 (50% lime juice+ 50% distilled water) was added at the rate of 5%, and grapefruit juice pH 3.7 was added at a rate of 10%, then the mixture was left until complete coagulation occurred (about 15 seconds), then the curd of each treatment was transferred to a mould lined with cheese cloth and pressed over night(700 gm /pressing) , it was removed from the mould and cut into square cubes of 100 gm each, then the cheeses were packed into polyethylene bags 100 gm in each, and stored at 5ºC for a month. Chemical analysis was done for the cheese samples at day 1, 7, 14, 21 and 30 intervals.

Chemical analysis

Titratable acidity, Total solids content, protein contents, ash and fat contents were determined according to AOAC (1990)..

Statistical analysis

The SPSS program, version 10 was used. General linear models were used to estimate the effect of storage periods on the chemical composition of white cheese. Least Significance Difference (LSD) was used for mean separation between the treatments.

Results

Cheese yield

The average yield of acid white soft cheese was affected by the kind of acidulant. The average yield of

cheese made by lime juice (15%) was lower than the average yield of grapefruit cheese made by grapefruit juice (17%). This might be due to the high volume used in case of using grapefruit juice.

Effect of coagulant type and preservation method on chemical composition of white cheese:

Table (1) shows the main effects of preservation method on chemical composition of acid cheeses. Fat, protein, total solids, ash and titratable acidity content of lime cheese.

Fat content

The fat content of lime cheese stored in the refrigerator (15.25±4.14%) showed highly significant value during storage (Table 1) Similarly the fat content of lime cheese stored in whey at room temperature (14.58± 3.68%), showed high significantly value (P≤0.001), moreover the fat content of grapefruit cheese stored in refrigerator (11.67±3.92%) revealed highly significant value than that of lime cheese stored in whey at room temperature and refrigerator for different storage periods showed no significant difference compared to that of grapefruit cheese stored in whey at room temperature and refrigerator (Table 1).

Protein content

The protein content of lime cheese (Table 1) stored in refrigerator (19.45±3.06%), and whey at room temperature (16.28±1.29%) was higher than the protein content of grapefruit cheese (17.03±2.83, 13.76±3.15 respectively). Protein content of lime cheese samples stored in whey at room temperature decreased significantly (P≤ 0.001); from 18.13 ± 0.91% at week one to 16.30± 0.35% at week four (Table 3). However the protein content of the same cheese stored in the refrigerator increased to19.40±0.30% at week one to 24.20±0.69% at week four. It was also decreased significantly (P≤ 0.001) in grapefruit cheese stored in whey at room temperature from 17.07±0.32% at week one to 16.30±0.35% at week four. Those samples kept in the refrigerator increased from 15.97±0.23% at week one to 21.67± 0.58% at week four (Table 3). The protein content of grapefruit cheese stored for one week in the refrigerator decreased from 15.97 ± 0.23 % to 15.00 ±0.00% at week three, compared with week four 21.67 ±0.58 %. The protein content of lime cheese 17.07±0.32 preserved in whey for one week decreased significantly (P≤ 0.001) to 10.10 ± 0.00 % in week two, however it increased from 11.57± 1.03 % at week three to 16.30 ± 0.35 % at week four (Table 3) .

Total solids content

Total solids content of lime cheese (53.55$\pm$11.25%) stored in whey at room temperature were higher than the total solids of grapefruit cheese (36.85$\pm$9.09%) stored in whey. However the total solids of grapefruit cheese stored in refrigerator showed higher values (Table 1).

Total solids (TS) content of the lime cheese samples stored in whey at room temperature increased significantly (P≤0.001) from 45.51±1.31% at week one to 66.94±1.48% at week four. Then it was also increased significantly (P≤0.001) in lime cheese preserved in the refrigerator from 42.77±1.90% at week one to 43.79±1.64% at week four. However the TS decreased significantly (P≤0.001) in grapefruit cheese stored in whey at room temperature 48.01±1.29% at week one compared to week four 30.63±0.87%. Similarly the TS decreased significantly (P≤0.001) in cheese stored in the refrigerator from 55.12±0.72% at week one to 30.63±0.87% at week four (Table 4).

Ash content

Ash content of lime cheese stored in whey at room temperature was 0.64 ± 0.43 %, while ash content of grapefruit cheese stored in refrigerator was 0.42$\pm$0.32 % (Table 1).

Table (5) shows the effect of preservation method and storage period on ash content of white cheese made by lime and grapefruit juices. Ash content of lime cheese samples stored in whey at room temperature (1.10±0.26%) was significantly (P≤0.001) higher than those of lime cheese stored in the refrigerator (0.05±0.01%). Also the ash content of grapefruit cheese stored in the refrigerator (1.20±0.10) was significantly (p≤0.001) higher than those of cheese stored in whey at room temperature (0.47±0.55).

Acidity

Acidity of lime cheese stored in whey at room temperature and refrigerator were 1.09 ± 0.26 % and 0.25± 0.05 % respectively, the acidity content of grapefruit cheese stored in whey at room temperature and refrigerator were 0.89± 0.19 % and 0.41± 0.33 % respectively. (Table 1).

Table (6) showed the effect of preservation method and storage period (week) on acidity level of white cheese made by lime and grapefruit juices. Acidity of lime cheese stored in whey increased significantly (P≤0.001) from 0.80±0.00 % at week one to 1.47±0.12% at week four. The acidity of lime cheese stored in refrigerator increased from 0.20±0.00% at week one to 0.30±0.00% at week four. Also the acidity of grapefruit cheese stored in whey and refrigerator were increased with the increase of storage period. It revealed 0.90±0.00% at week one and 1.00±0.00% at week four for cheese stored in whey, it revealed 0.20±0.00% at week one and 0.37±0.06% at week four for cheese stored in refrigerator (Table 6).

Discussion

The fat content of the lime cheese and grapefruit cheese samples stored in refrigerator were high, while the fat contents of the same cheese stored in whey at room temperature were low. Generally fat content of lime cheese was higher than fat content of grapefruit cheese. Hofi *et al.* (1976), Nofal *et al.* (1981) and Abdel Razig (1996) reported that the high fat content of the cheese samples stored at room temperature could be attributed to the loss of degradation products in the pickling whey. This finding is lower than those of Babiker (1987) and Kosikowski (1967). However the present result is in the range stated by SSMO (2002) that cheese fat content should be between 15-20 %.

Generally protein content of lime cheese was higher than protein content of grapefruit cheese; this is explained by the low TS and high moisture content of the grapefruit cheese, this result agrees with Abdel Razig and Babiker (2009) who found that the protein content of Quso Blanco lime cheese is higher than that of grapefruit cheese. The lower protein content of lime cheese and grapefruit cheese were found for samples stored in whey at room temperature, while the higher protein content was for cheese samples stored in the refrigerator. This could be due to inhibition of proteolytic activities of microorganisms in low storage temperature (Abdel Razig and Babiker (2009), Hamid (1998) and Nofal *et al.*, (1981) claimed that the increase in the crude protein content of the cheese stored at room temperature could be due to low moisture content and high acidity in the curd which inhibited the growth of proteolytic bacteria. The low crude protein content of the samples stored in the refrigerator was possibly attributed to absorption of high level of moisture by the curd (Zaki *et al.* 1974) . This result agrees with Alla Gabo (1986), Makki (1987), SSMO (2002) and Kosikowski (1967) who reported 22.6%, 23.6-25.6%, 15% (as lowest limit), and 24.9% respectively. The protein content of lime cheese stored in the refrigerator and whey was higher than those of grapefruit cheese stored in the same conditions.

The total solids content of the grapefruit cheese was higher than lime cheese. This result disagreed with Abdel Razig and Babiker (2009) who found that total solids content of lime cheese is higher than that of grapefruit cheese. The present finding agreed with El Owni and Hamid (2008) who found that the total solids increase with time, it also agreed with Alla Gabo (1986) who reported 38.85% total solids. However it disagrees with Nuser (2001) who found that the total solids decrease with time due to proteolytic and lipolytic effect of microorganisms. The high total solids content was in the grapefruit cheese stored in refrigerator, while the low total solids content was in the grapefruit cheese stored in whey at room temperature.

This result agreed with Salama *et al*., (1983); Collombo (1992) and Walstra *et al*. (1999) who explained the increase in total solids content of the cheese stored in refrigerator might be due to inhibition of proteolytic and lipolytic activities of microorganisms by low storage temperature. Nuser (2001) and Hayaloglou *et al.* (2005) found that total solids decrease during storage period due to proteolytic and lipolytic effect of microorganisms on proteins and dissolution of fats into pickling. This result of the lime cheese and grapefruit cheese matched with that found by Salama *et al*., (1983); Colombo *et al*. (1992) and Walstra *et al.* (1999). During the storage period total solids content of the cheese was increasing at room temperature, which were higher that probably might be due to low

Table 1: Effect of preservation method on chemical composition Mean± SD of lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* white cheese (Gibna bayda)

Chemical composition	Lime cheese		Grapefruit cheese		
	Whey/room	Refrigerator	Whey/room	Refrigerator	L.S
Fat (%)	14.58±3.68	15.25±4.14	10.50±3.21	11.67±3.92	**
Protein (%)	16.28±1.29	19.45±3.06	13.76±3.15	17.03±2.83	***
Total solids (%)	53.55±11.25	44.32±1.60	36.85±9.09	57.87±9.59	***
Ash (%)	0.64±0.43	0.50±0.01	0.42±0.32	0.74±0.32	***
Acidity (%)	1.09±0.26	0.25±0.05	0.89±0.19	0.41±0.33	***

Means bearing the same superscripts are not significantly (P<0.05) different
: Significant level at (p≤0.01); *: Significant level at (p≤0.001)

Table (2): Fat content of white cheese (Gibna bayda) made by coagulating milk with lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* juices

Measurements	Lime cheese		Grapefruit cheese		L.S
preservation method / Periods (Week)	Whey/room	Refrigerator	Whey/room	Refrigerator	
1	15.0 ±4.36	15.00±5.20	12.33±4.93	12.67±4.62	***
2	14.67±4.62	16.00±5.20	10.67±2.89	13.33 ± 4.04	***
3	14.67±4.62	15.67± 4.62	8.33±3.21	9.33± 4.04	***
4	14.00± 3.46	14.33±4.04	10.67±1.16	11.3 ± 0.04	***

Means bearing the same superscripts are not significantly (P<0.05) different
***: Significant level at (p≤0.001)

Table (3): Protein content of white cheese (Gibna bayda) made by coagulating milk with lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* juices

storage Period (Week)	Preservation method				
	Lime cheese		Grapefruit cheese		L.S
	Whey/Room	Refrigerator	Whey/Room	Refrigerator	
1	18.13 ± 0.91	19.40 ± 0.30	17.07±0.32	15.97± 0.23	***
2	15.00 ±0.00	16.90 ±0.69	10.10 ± 0.00	15.00±0.00	***
3	15.70 ±0.35	17.30 ± 0.00	11.57 ± 1.03	15.00±0.00	***
4	16.30 ±0.35	24.20 ± 0.69	16.30 ± 0.35	21.67±0.58	***

Means bearing the same superscripts are not significantly (P<0.05) different

Table (4): Total solid content of white cheese (Gibna bayda) made by lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* juices

Storage period Week)	Treatments				
	Lime cheese		Grapefruit cheese		L.S
	Whey/Room	Refrigerator	Whey/Room	Refrigerator	
1	45.51±1.31	42.77± 1.90	48.01±1.29	55.12± 0.72	***
2	40.91±1.80	45.58 ±0.31	42.24± 1.59	49.13 ± 1.24	***
3	60.86±1.84	45.16 ±0.53	26.51± 1.05	53.96± 0.28	***
4	66.94 ±1.48	43.79 ±1.64	30.63±0.87	30.63± 0.87	***

Means bearing the same superscripts are not significantly (P<0.05) different
***: Significant level at (p≤0.001)

Table (5): ash content of white cheese (Gibna bayda) made by coagulating milk with lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* juices

Measurement	Lime cheese		Grapefruit cheese		
Preservation method / Periods (Week)	Whey/Room	Refrigerator	Whey/Room	Refrigerator	L.S
1	0.50 ±0.00	0.05± 0.01	0.57±0.06	0.63± 0.25	***
2	0.70±0.01	0.03 ±0.31	0.57±0.06	0.43 ± 0.06	***
3	0.90 ±0.00	0.05± 0.01	0.07±0.03	0.70 ± 0.00	***
4	1.10 ±0.26	0.05± 0.01	0.47±0.55	1.20 ± 0.10	***

Means bearing the same superscripts are not significantly (P<0.05) different
***: Significant level at (p≤0.001)

Table (6): Effect of preservation method and storage period (week) on acidity of white cheese (Gibna bayda) made by lime (*Citrus aurantifolia*) and grapefruit *(Citrus paradisi)* juices

Treatment	Lime cheese		Grapefruit cheese		L.S
Preservation method / Period (Week)	Whey/Room	Refrigerator	Whey/Room	Refrigerator	
1	0.80 ±0.00	0.20± 0.00	0.90± 0.00	0.20± 0.00	***
2	1.10±0.00	0.23 ±0.06	1.07±0.06	0.83 ± 0.46	***
3	1.00 ±0.00	0.27± 0.06	0.60±0.00	0.23 ± 0.06	***
4	1.47 ±0.12	0.30± 0.00	1.00±0.00	0.37 ± 0.06	***

***: Significant level at (p≤0.001)

moisture content as a result of high acidity of the cheese. The result also agreed with that recorded by Abdel Razig and Babiker (2009) and El Owni and Hamid (2008) who found that the total solids of Sudanese white soft cheese increased during storage period. The variations during storage period in the grapefruit cheese stored in whey at room temperature, Table (4) showed the decrease in total solids of cheese. This was attributed to continuous loss of moisture. Nuser (2001); Aly and Galal (2002) and Hayaloglou *et al.* (2005) attributed the total solids decrease during the storage period could be due to proteolytic and lipolytic effect of microorganisms on proteins and dissolution of fats into pickling.

Ash content of grapefruit cheese is higher than those of lime cheese. The ash contents of lime cheese samples stored in whey at room temperature increased from 0.50±0.00% at week one to 1.10±0.26% at week four. Then they were constant in cheese stored in refrigerator during storage period. Also the ash content of grapefruit cheese samples stored in whey at room temperature were decreased from 0.57±0.06% at week one to 0.47±0.55% at week four. The grapefruit cheese stored at the refrigerator showed ash content of 0.63±0.25%, 0.43± 0.06 %, 0.70±0.00% and 1.20±0.10% from week one to week four (Table 5). The ash content of the lime cheese samples stored in whey at room temperature was found to increase during storage period. However the ash was stable in cheese stored in refrigerator. This agreed with El Owni and Hamid (2008) who reported that ash content increases during storage period due to decrease in moisture content.

In this study the ash content of lime cheese was higher in cheese stored in whey at room temperature, while ash content was lower in cheese stored in refrigerator. This finding disagreed with Abdalla (1992) and Bilal (2000) who found that the ash content of the cheese stored in refrigerator were higher than those stored in room temperature.

Zaki *et al.* (1974); Nofal *et al.* (1981) and Tayar (1995) justified that the absorption of salt by the curd at the low storage temperature. Although results of ash content of grapefruit cheese stored in refrigerator agreed with Abdalla (1992) and Bilal (2000) . The result obtained is lower than that of Alla Gabo (1986); Ali (1987) who reported 5.2% and 6.85, respectively. On the other, hand the SSMO (2002) stated 5% as the lowest limit.

In the current study the higher acidity was obtained for the lime cheese and grapefruit cheese stored in whey at room temperature, while the lower acidity was in cheese stored in refrigerator. This finding agreed with Hamid and El Owni (2007) and Nofal *et al.* (1981) who showed that the higher acidity of the cheese stored at room temperature might be attributed to increase level of lactic acid, which could be due to the activation of lactic acid bacteria in room temperature. The low acidity of cheese stored in refrigerator might be explained by the fact that low temperature inhibited growth and activity of lactic acid bacteria, which consequently lower the rate of acid development (El Owni and Hamid 2007 and Nofal *et al.* 1981).

Conclusion

It was noticed from the results the chemical composition of the lime cheese was better than grapefruit cheese; quick milk coagulation at high temperature (82ºC). Using these fruits; the produced cheese would be of high quality if processing conditions and handling procedures are satisfactorily achieved.The study concluded that the average yield of grapefruit cheese was higher than that of lime cheese.

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