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Chemical and Microbiological Properties of Sudanese White Soft Cheese Made by Direct Acidification Technique

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Abstract: The chemical and microbiological properties of Sudanese white soft cheese made by direct acidification technique were investigated. Three kinds of acidulant, namely lemon, orange and grapefruit juices were used to assess some quantitative and qualitative properties of white soft cheese. The parameters evaluated included yield of cheese, physicochemical composition and microbiological analyses. Cheese made by the use of lemon juice recorded the highest yield (18.5%), but values of 16.0 and 14.8% were obtained for orange and grapefruit juices, respectively. Both kinds of acidulants and storage period imparted negative effects by causing highest loss of weight (28.35%), using lemon juice; lowest (25.79%) in case of grapefruit. The loss of weight (27.03%) accounted for orange juice occurred at an intermediate position. Storage period significantly ($p \leq 0.05$) caused loss of weight that showed a trend of gradual increase until the end of the storage period, being the lowest (26.40%) after 15 days and highest (38.23%) after 60 days. The total solids recorded 53.32, 51.70 and 49.48%, for lemon, orange and grapefruit juices, respectively. Similarly, the storage period caused significant ($p \leq 0.05$) and consistent increase as the storage period progressed. The protein content indicated significant amount being 22.91, 22.51 and 22.10%; for lemon, orange and grapefruit and interrupted by decrease after 45 days of storage, before that a steady increase was attained. Significant increase in the fat content occurred at highest level (23.82%) when lemon juice was used but 22.10 and 20.08% were recorded for orange and grapefruit. The significantly enhanced fat concentration occurred from 19.38% at the beginning to 23.77% once the time elapsed after 60 days. The orange and grapefruit juices had similar leftover ash content lower than that obtained from lemon. The ash content increased with time until the end of the storage period. The highest pH-value (3.74) was recorded by adding grapefruit juice; other values got less 3.48 and 3.28 for orange and lemon, respectively. The storage period has given the highest pH-value (5.20) at the beginning and lowest (2.73) at the end. The total bacterial count decreased during storage of the three types of cheese, while the coliform, yeast and mould and *Staphylococcus aureus* recorded nil in all cheese samples during storage.

Key words: Sudanese white soft cheese, storage, acidified milk

INTRODUCTION

Acidified milk gels are one of the oldest and most popular foodstuffs produced throughout the entire world. The popularity of fermented milk products such as fresh acid-coagulated cheese varieties (cream cheese, Cottage cheese, Quarg, tvorog and frais) and yoghurt, is due to various health claims and curative benefits. Awide variety of acidified milk products is produced. Some of the main products are fresh acid-coagulated cheese. Hot milk has been directly acidified in several countries for the production of a family of cheeses. This popular cheese is consumed in a corn bread sandwich, as a fried snack, in cooking main dishes and as a major ingredient of desserts.

Sudanese white soft cheese (Gybna Bayda) is the most common cheese in the Sudan. It has a strong odour 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 is salted by adding sodium chloride directly to milk and packed in tin cans (Abdel-Razig, 1996).

No previous attempt has been made to investigate the production of Sudanese white soft cheese by direct acidification technique. The objectives of the present work were to study the effect of direct acidification using natural acidifiers of different citrusfriut juices extracted from lemon, orange and grapefruit on the chemical and microbiological properties.

MATERIALS AND METHODS

Fresh raw cow's milk was obtained from Rara factory at Hellat Kuku, Khartoum North. Fine powder salt (sodium chloride), lemon, grapefruit and orange were obtained from the Khartoum North and Lacquer tin cans were obtained from Saeed factory in Khartoum North.

Cheese manufacture: Fresh raw cow's milk, was cleaned, divided into three equal volumes of 40 litre each and kept into three separate tanks. Every tank

heated to 82°C by live steam. Three acidifying agents namely lemon juice (4.48% acidity), orange juice (1.28% acidity) and grapefruit juice (1.10% acidity) were added in three portions, to the respective milk samples and then shaked every 5 min for 15 min. After draining, the whey was generally around 75°C. Salt at 1% was mixed with the curd. The curd was transferred to clean wooden molds lined with cheese cloth and pressed overnight. Next day, the curd was removed from the molds and cut into rectangular cubes.

Salt (6% w/v) was added to the collected whey and then the whey was pasteurized at 72°C for 1 min (Abdel-Razig, 1996), cooled and added to cheese curd into cans. Cans were sealed and stored at room temperature (38±2°C) for 60 days. Chemical and microbiological analyses were determined at on intervals of 0, 15, 30, 45 and 60 days (Fig. 1).

Chemical procedure: The total solids, protein, fat and ash contents were determined according to AOAC (1990), while the pH-value was determined according to Newlander *et al.* (1964).

Microbiological analysis: Coli form bacteria, yeast and mold were enumerated according to Christen *et al.* (1993). Viable bacterial counts were recorded according to Richardson (1985), while the *staphylococcus aureus* were enumerated acorccding to Flowers *et al.* (1993).

Statistical analysis: Statistical analyses were done using the statistical analysis system (SAS, 1997).

RESULTS AND DISCUSSION

Yield of cheese: The yield of Sudanese white soft cheese was significantly ($p \leq 0.05$) affected by the kind of acidulant. The yield of cheese made by the lemon juice (18.50%) was the highest, followed by that made by the orange juice (16.60%) and the lowest yield was recorded by the grapefruit juice (14.80%).

The increase in yield of cheese could be explained by the denaturation and precipitation of whey proteins and/or by the higher retention of water in the soft curd formed (Zaki *et al.*,1974; Abdel-Razig, 1996). Makki (1987) found the yield of queso blanko cheese made under Sudan condition ranged between 14-16.5%. Dariani *et al.* (1980); Babiker (1987) and Ahmed and Khalifa (1989) reported a high yield of milk cheese between 19-19.2%.

Loss of weight: The losses of weight of cheese during storage period was affected by the kind of acidulant and the storage period. The losses of weight of the cheese made by the lemon juice was the highest (28.35%) and the grapefruits juice was the lowest (25.79%), while being at on intermediate position (27.03%) with the cheese made by orange juice (Table 1).

The data in Table 1 and Fig. 2 showed the effect of storage period on weight loss of the cheese. Storage period significantly ($p \leq 0.05$) affected the weight loss. The loss of weight increased gradually till the end of the storage period. The lowest loss of weight (26.40%) was obtained after 15 days of storage, while the highest (38.23%) was obtained after 60 days. Results are in agreement with those reported by Saleem and Abdel-Salam (1979), Nofal *et al.* (1981) whom have reported a decrease in cheese weight during storage at room temperature. The decrease in cheese weight during ripening could be attributed to the loss of moisture content as a result of curd contraction and water expulsion and to the diffusion of fat and total soluble solids from the curd into the pickling whey (Bilal, 2000; Nuser, 2001; Aly and Galal, 2002; El-Owni and Hamid, 2008).

Chemical composition of white soft cheese: The kind of acidulant seems to have a significant effect ($p \leq 0.05$) on total solids of the resultant cheese (Table 1). The white soft cheese made by the lemon juice gave the highest total solids (53.32%) followed by orange juice (51.70%) and the lowest total solids were recorded by grapefruit juice (49.48%). The total solids content of cheese gradually increased throughout the storage period (Table 2 and Fig. 3). The storage period significantly affected ($p \leq 0.05$) total solids content of the cheese. The highest value (54.05%) was obtained at the end of the storage period, while the lowest (47.23%) being at the beginning of the storage period, similar results were obtained by El-Owni and Hamid (2008) whom they found the total solids of Sudanese white soft cheese increased during storage period. The increase in total solids of cheese was attributed to continuous loss of moisture (Aly and Galal, 2002). Nuser (2001) and Hayaloglou *et al.* (2005) found the total solids decrease during storage period due to proteolytic and lipolytic effect of microorganisms on proteins and dissolution of fats into pickling. Salama *et al.* (1982) found the moisture content of cheese decreased during pickling, a phenomenon attributed to curd contraction and expulsion of whey as a result of acid development.

The protein content of the cheese made by the lemon juice recorded the highest value (22.91%) and was significantly higher ($p \leq 0.05$) than both values for orange juice (22.10%) and the grapefruit juice (21.51%).

The protein content (Fig. 4) gradually increased till day 45 and then decreased till the end of the storage period ($p \leq 0.05$). The highest total protein (22.75%) contents were obtained after 45 days of the storage, while the lowest (21.18%) were recorded at the beginning of the storage period.

The protein content decreased during storage period due to the degradation of protein and loss in pickling whey. However the increase in the protein content that

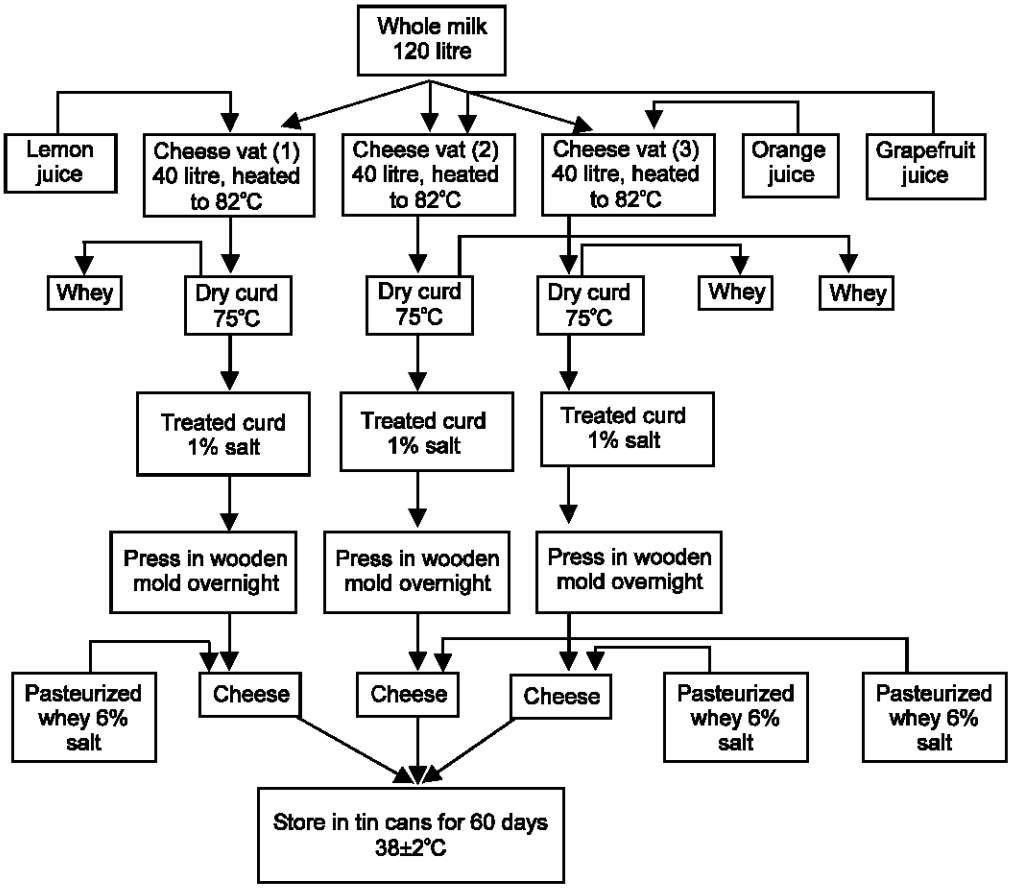

Fig. 1: Flow diagram for manufacture of Sudanese white soft cheese

Table 1: Effect of natural acidulants on chemical properties* of Sudanese white soft cheese

	Acidulant source		
Item	Lemon juice	Orange juice	Grapefruit juice
Weight losses (%)	28.35^{a}±0.60	27.03^{b}±0.62	25.79^{c}±0.53
Total solid (%)	53.32^{a}±0.16	51.70^{b}±0.15	49.48^{c}±0.09
Total protein (%)	22.91^{a}±1.21	22.10^{a}±1.18	21.51^{b}±1.14
Fat (%)	23.82^{a}±0.09	22.10^{ab}±0.08	20.08^{b}±0.07
Ash (%)	3.12^{a}±1.22	2.84^{b}±1.16	2.64^{b}±1.19
pH	3.28^{b}±1.1	3.48^{ab}±0.09	3.74^{a}±1.13

*Mean±SD values having different superscript letters in rows are significantly different ($p \leq 0.05$).

Table 2: Effect of storage period on chemical properties* of Sudanese white soft cheese

	Storage period (days)				
Item	0	15	30	45	60
Weight losses (%)	0.0^{e}±0.00	26.40^{d}±0.13	33.54^{c}±0.04	37.10^{b}±0.07	38.23^{a}±0.08
Total solid (%)	47.23^{e}±0.09	50.63^{d}±0.04	52.23^{c}±0.05	53.35^{b}±0.03	54.05^{a}±0.06
Total protein (%)	21.18^{b}±1.06	21.88^{b}±0.90	22.45^{a}±0.08	22.75^{a}±0.40	22.60^{a}±0.20
Fat (%)	19.38^{d}±6.99	21.15^{c}±8.71	22.33^{b}±8.80	23.37^{a}±8.32	23.77^{a}±8.41
Ash (%)	2.03^{c}±7.12	2.53^{bc}±8.42	2.93^{b}±8.91	3.30^{a}±8.0	3.53^{a}±8.76
pH	5.20^{a}±0.09	3.70^{b}±0.13	3.03^{b}±0.12	2.83^{c}±0.11	2.73^{c}±0.05

*Mean±SD values having different superscript letters in rows are significantly different ($p \leq 0.05$).

occurred from the beginning until the day 45 of storge period was due to loss of moisture. Those findings are in agreement with those reported by (Khalid, 1991; Abdalla, 1992; Bilal, 2000; Nuser, 2001 and Ceylan *et al*., 2003). Hayaloglou *et al*. (2005) found that, the protein content during pickling was a direct result of protein

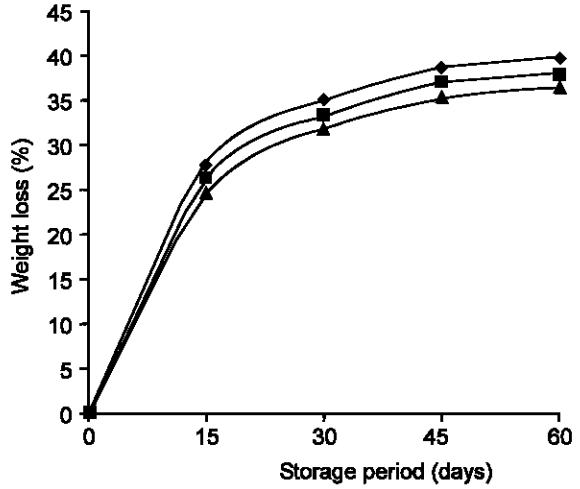

Fig. 2: Effect of storage period on weight loss of Sudanese white soft cheese

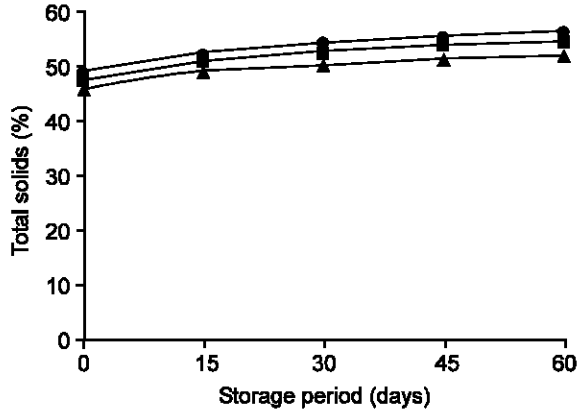

Fig. 3: Effect of storage period on total solids of Sudanese white soft cheese

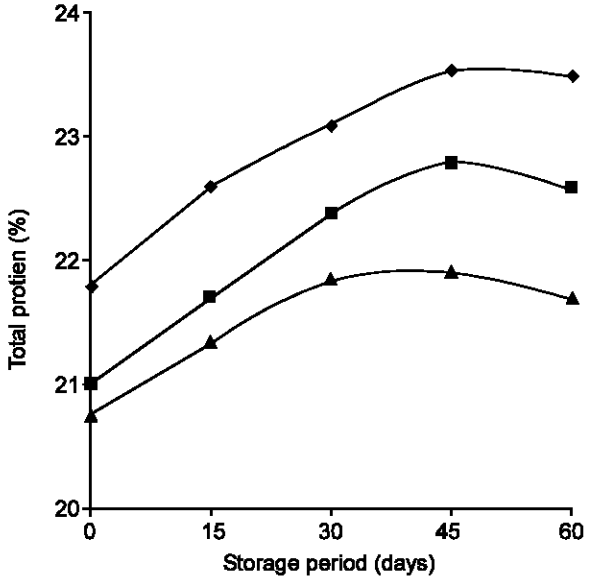

Fig. 4: Effect of storage period on total protein content of Sudanese white soft cheese

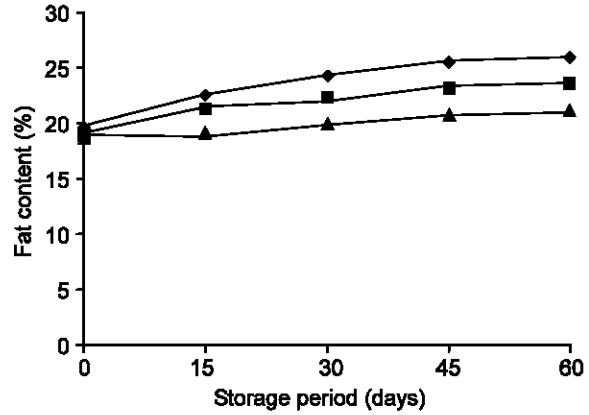

Fig. 5: Effect of storage period on fat content of Sudanese white soft cheese

degradation leading to the formation of water soluble compounds some of which were lost in the pickling solution leading to increase in the nitrogen content of whey. The total protein found in this study was higher than that obtained by El-Owni and Hamid (2008).This may be due to the effect of acid and heat treatment which resulted in denaturation of whey protein and their retention in the curd. Makki (1987) reported that, the protein content of the queso blanco cheese made under Sudan condition ranged between 23.6-25.6%.

Cheese made by the lemon juice secured significantly ($p \leq 0.05$) the highest value in fat content (23.82%), followed by the orange juice (22.10%) and the least (20.08%) was recorded by grapefruit juice (Table 1.). The fat content (Fig. 5) gradually increased till the end of the storage period ($p \leq 0.05$). The lowest fat content (19.38%) was obtained at the beginning of the storage period, while the highest (23.77%) was obtained at the end of the storage period (Table 2.). The increase in fat during pickling could be attributed to the diminution of solids non-fat content due to the partial degradation of proteins and loss by solubility in whey (Nofal *et al*., 1981). Besides, fat content was not practically affected and would be held as such within the cheese body (Zaki *et al*.,1974) and for the loss of moisture content during pickling period.

The findings disagree with Abdalla (1992) and Nuser (2001) who found the fat content in cheese curd decreased over time due to the leakage of some fat curd into the brine solution and agree with that found by Abdel-Razig (1996). Chandan *et al*. (1979) found that, the fat content of Latin American white cheese ranged between 21-22%.

The ash content of cheese produced by the orange juice and grapefruit juice were similar ($p \geq 0.05$) and

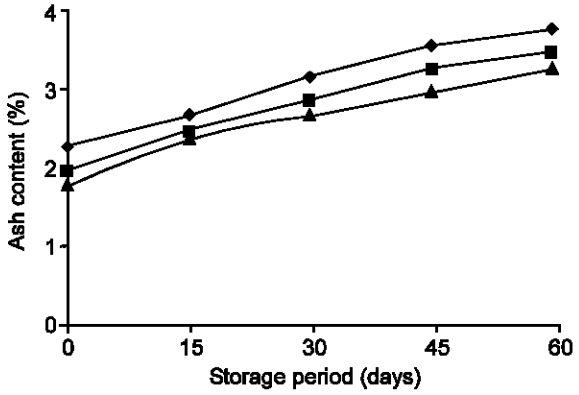

Fig. 6: Effect of storage period on ash content of Sudanese white soft cheese

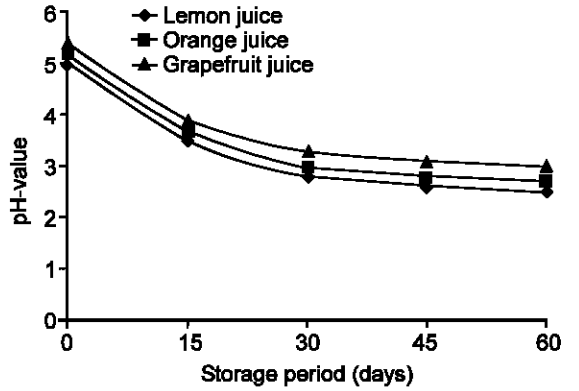

Fig. 7: Effect of storage period on pH-value of Sudanese white soft cheese

significantly lower ($p \leq 0.05$) than that made by the lemon juice (Table 1). The ash content increased with time till the end of the storage (Fig. 6); the lowest ash content (2.03%) was obtained at the beginning of the storage period, while the highest (3.53%) was obtained at the end of the storage period; similar results were obtained by El-Owni and Hamid (2008) who found the ash content of Sudanese white soft cheese increased during storage period. The increase in ash content during pickling may be due to the decrease in moisture content. The pH-value of the cheese made by grapefruit juice (3.74) was the highest, followed by the orange juice (3.48) and the least pH-value (3.28) was made by the lemon juice. The pH of the cheese showed a decreasing trend till the end of the storage period (Fig. 7).The highest value (5.20) was obtained at the beginning of the storage period, while the lowest (2.73) at the end of the storage period. Wahba and El-Abbassy (1982) reported that, the pH values progressively decreased during storage with a pronounced drop in the first month. This might be attributed to the fact that storage at room temperature tends to increase lactose fermentation which lead to a decrease in pH-value.

Microbiological examinations: Table 3 shows the effect of kind of acidulant and storage period on viable bacterial count of Sudanese white soft cheese. The total bacterial count decreased during storage for the three types of cheese due to the effect of acid and heat treatment which suppress the growth of microorganisms. Similar results were obtained by Shakeel-Ur Rehman *et al.* (2000) and El-Owni and Hamid (2008). Ceylan *et al.* (2003) found that, the total bacterial count increased during storage period due to the microbial count of raw milk. The coliform, yeast and mold and *Staphylococcus aureus* recorded nil in all samples of cheese under storage. El-Owni and Hamid (2008) stated that, the *Staphylococcus aureus* was detected on Sudanese white soft cheese only at day zero. Nizamliglu *et al.* (1998) reported that, coliforms were not detected at days 60 and 90 of ripening, while yeast and moulds count increased slightly at day 15 and 30. Gomez-Lucia *et al.* (1992) noticed that *S. aureus* count declined markedly after day 35-42 and was never detected by the end of the ripening period.

Table 3: Effect of natural acidulants and storage period on total bacterial count of Sudanese white soft cheese

Storage period (days)	Acidulant source: Lemon juice	Orange juice	Grapefruit juice
0.0	$2.4x10^4$	$1.5x10^4$	$3.0x10^4$
15	$4.4x10^3$	$5.4x10^3$	$6.3x10^3$
30	$1.8x10^3$	$1.2 x10^3$	$1.6 x10^3$
45	$2.5x10^2$	$7.8 x10^2$	$6.0 x10^2$
60	$1.6 x10^2$	$1.4 x10^2$	$1.5 x10^2$

Barrow and Felthman (1993) concluded that *Escherichia coli* is a member of the family *Enterobacteriaceae* and lives in the intestinal tract of healthy and diseased animals and the regular presence of *E. coli* in the intestine and feces had led to tracking the bacterium in nature as an indicator of faecal pollution and water contamination. Asperger *et al.* (1994) stated that, the sufficient number of *E. coli* cells to produce illness is suggested to be 10^6 cells/ml/g or more. They also found the ranges in mean counts of *E. coli* per milliliter of bulk milk and composite milk to be 8.4×10^3 to $2.010^5\times$ and 2.1×10^1 to 2.0×10^2, respectively. Ahmed (1985) showed that 60% of the cheese samples collected from Khartoum market was contaminated with *S. aureus*. Beshir (1999) reported that total bacterial count, *S. aureus* and yeast and mould from samples collected from various cheese processing plants in El Dueim were 6.1×10^4, 4.9×10^2 and 1.6×10^4, respectively.

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