

Effect of Storage Temperature on Weight Loss, Chemical Composition, Microbiological Properties and Sensory Characteristics of White Cheese (*Gibna Bayda*)

¹Osman A.O. El Owni and ²Omer I. A. Hamed

¹Department of Dairy Production, Faculty of Animal Production, University of Khartoum, Shambat, P.O. Box 32, Khartoum North, Sudan.

²Department of Animal Production Faculty of Agriculture, University of Zalingei, P.O. Box 6, Zalingei, Sudan

Abstract: Effect of storage temperature on weight loss, chemical composition, microbiological properties and sensory characteristics was studied. The cheese was made from fresh raw cow's milk with 6 % salt kept in ant-acid containers with its whey and stored at room (35-37°C) and refrigerator (7°C) temperatures for periods of 0, 60, 120, 180 and 240 days. Weight loss, chemical, microbiological and sensory characteristics were determined after each period. Storage temperature significantly ($P<0.05$) affected weight loss and chemical composition of the cheese. Weight loss, titratable acidity, total solids, crude protein and fat contents of the cheese samples stored at room temperature (35-37°C) were significantly ($P<0.001$) higher than those kept at refrigerator (7°C). Soluble proteins and ash contents of the samples stored at refrigerator were significantly ($P<0.001$) higher than those kept at room temperature. Volatile fatty acids, tyrosine and tryptophane contents were higher in cheese samples stored at room temperature. Total bacterial count of the cheese stored at room temperature was lower than those stored at refrigerator at the end of storage period. Coliforms and *E. coli* counts were not detected at day 60 for the cheese samples stored at room temperature. *Staphylococcus aureus* was completely disappeared at day 60 and through out the storage. Moulds and yeasts were found to decrease in number in cheese stored at refrigerator and they disappeared in samples kept at room temperature at day 120. Color and texture of the cheese stored at refrigerator had higher scores than that kept at room temperature. The flavor and saltiness of the cheese samples were not affected by the storage temperature. Weight loss, chemical composition, microbial contents and sensory characteristics (ripening indices) of *Gibna Bayda* were significantly ($P<0.001$) affected by storage temperature. Storage of *Gibna Bayda* samples at room temperature decreased coliforms, *E. coli*, psychrotrophic bacteria, yeast and moulds counts, while it increased total bacterial count.

Key words: *Gibna Bayda*, storage temperature, weight loss, chemical composition, microbial properties, ripening indices.

INTRODUCTION

In Sudan milk is mainly produced on village farms and rural areas^[18]. Sudanese white cheese (*Gibna Bayda*) is consumed fresh or stored for short period of time^[30,51]. Made from full fat raw milk, high concentrations of sodium chloride are added before renneting^[33]. Salt concentration and storage conditions were significantly ($P<0.05$) affected weight loss, chemical composition microbial content and sensory characteristics of Sudanese white cheese^[11]. Storage temperature affects growth rate of microbes of desirable flora, activity of their enzymes, rennet and starter bacteria^[38]. The microflora was dominated by lactic acid bacteria (LAB) with evident mould and yeast growth. The average microbiological properties were 9.71 log cfu/ml for total bacterial count, 3.28 log MPN/ml

coliforms, 0.70 log MPN/ml *E. coli*, 1.73 log cfu/ml *Staphylococcus aureus*, 5.06 log cfu/ml lactic acid bacteria, 3.72 log cfu/ml streptococci and 4.46 log cfu/ml for yeast and mould counts^[18]. Collombo *et al.*^[9] reported that low temperature was more effective for prolonged cheese storage than high temperature. Crude protein, total solids and ash contents significantly ($P<0.05$) increased from day zero to day 120 then decreased onwards. Soluble proteins, tyrosine, tryptophane and volatile Fatty Acids (VFA) increased^[11]. Cheese made from raw milk received highest organoleptic scores after 60 days at room temperature and after 90 days at refrigerator temperature^[34]. Texture, flavour and colour of the cheese samples significantly ($p<0.05$) improved during storage until day 120 then decreased in scores thereafter^[11].

The objective of this study was to investigate the effect of storage temperature on the weight loss, chemical composition, microbiological and sensory characteristics of the white soft cheese.

MATERIALS AND METHODS

Cheese Manufacture: Studies on the effect of storage temperature on chemical, microbiological and sensory characteristics of *Gibna Bayda* (white cheese) were carried out during January 2004 to September 2004 in the Dairy Technology laboratory of the Department of Dairy Production, Faculty of Animal Production, University of Khartoum. The *Gibma Bayda* manufactured with 6 % salt was prepared from fresh raw cow's milk. The salt was added to the milk before renneting and rennet (Chr. Hansens Lab., Copenhagen, Denmark) were added at the rate of one tablet per 50 liters of milk at 40°C. The milk was stirred for 10 minutes and left undisturbed till coagulation occurred. The curd was cut and left for 30 minutes for the whey drainage. The whey was collected from each type of cheese to be used for its preservation. The cut curd was transferred to clean wooden mould lined with clean cloth and pressed with 36 kg weight overnight. Next day each cheese was removed from the mould and cut into small cubes (5x 5 x 5 cm). The whey of each salt concentration was boiled for 5 minutes for preservation of the particular cheese samples. Cheese samples of each concentration were packed in anti-acid cans and plastic containers in triplicates and stored at room and refrigerator temperatures for periods of 0, 60, 120, 180 and 240 days. Weight loss, chemical, microbiological analysis and sensory characteristics were determined after each storage period.

Chemical Analysis: Titratable acidity, total solids, crude proteins and ash contents were determined according to AOAC [6]. Fat contents were determined according to Foley *et al.* [13]. Soluble proteins were determined according to Ling [25]. Volatile fatty acids were determined according to Kosikowski [23]. Tyrosine and tryptophane contents were determined by the method of Vakaleris and Price [37].

Microbiological Analysis: Culture media were prepared according to manufacturers instructions. Eleven grams of each cheese type were weighed aseptically into sterile blender jar (Moulinex 719), then 99 ml of sterile 2 % aqueous solution of sodium citrate warmed at 45°C was added and blended for 2 minutes to make 10⁻¹ dilutions. Tenfold dilutions were made using 0.1% peptone water as diluents. Plate count agar was used for enumeration of total bacteria and psychrotrophic bacterial counts according to FDA [14] and Frank *et al.* [15], respectively. Mac Con key broth

and Brilliant green lactose bile broth were used for enumeration of coliforms and *E. coli* most probable numbers according to Marshall [26]. Mannitol salt agar was used for *Staphylococcus aureus* count according to Rayman *et al.* [32], while Sabouraud dextrose agar was used for enumeration of yeasts and moulds according to Harrigan and Mc Cance [20].

Sensory Evaluation: The quality of the cheese was judged by 10 untrained panelists for color, flavor, texture and saltiness.

Statistical Analysis: SPSS programme version 10 was used. General Linear Models were used to estimate the effect of storage period on weight loss, chemical composition, microbiological and sensory characteristics of Sudanese white cheese. Duncan's Multiple Range tests were carried out for mean separation between the treatments.

RESULTS AND DISCUSSION

Results in Table 1 show the weight loss of the cheese (Gibna) stored at room temperature was 27.44±21.83 while the weight loss of cheese kept at refrigerator increased was 13.27±10.17.

Titrate acidity of the cheese samples kept at room temperature was higher (1.18 ± 0.79%) in comparison with that stored at the refrigerator temperature (0.97 ± 0.45%).

Total solids content of cheese stored at refrigerator temperature were significantly (P< 0.001) higher (41.39 ± 3.67%) than those stored at the room temperature (40.94±7.87%).

The protein and fat contents of the cheese samples stored at room temperature were higher (15.01 ± 6.9% and 20.29 ± 9.18%, respectively) than those stored at the refrigerator temperature (14.71 ± 2.21% and 19.73 ± 4.14%, respectively).

Soluble proteins and ash contents of the cheese samples stored at refrigerator temperature (0.55 ± 0.24% and 3.63 ±0.60%, respectively) were higher than that stored at the room temperature (0.46 ± 0.26% and 2.68 ± 1.18%, respectively).

Volatile fatty acids were affected significantly (P<0.001) by the storage temperature. The cheese samples stored at room temperature had higher [14.12 ± 3.09 (0.1 N ml NaOH/100 gm cheese)] VFA in comparison with those stored at refrigerator temperature (10.95±6.25).

Tyrosine and tryptophane contents of the cheese samples stored at room temperature were higher (48.68 ± 5.49 mg/100 gms cheese and 133.08±11.58 mg/100 gms cheese, respectively) than those stored at refrigerator (44.82±5.28 mg/100 gms cheese and 106.86±71.81 mg/100 gms cheese, respectively).

The weight loss of the cheese samples stored at the room temperature was increased to $39.80 \pm 7.8\%$ at day 120 then decreased to $26.25 \pm 22.03\%$ at day 240 (Table 2). While the weight loss of the cheese (*Gibna*) kept at the refrigerator temperature increased to $25.13 \pm 3.8\%$ at day 240. The higher weight loss was obtained by the cheese stored at the room temperature at day 120.

Titrateable acidity of cheese stored at room and refrigerator temperatures increased significantly ($P < 0.001$) with increased storage time from day zero until day 120 for the cheese samples stored at the room temperature and up to day 180 for those stored at refrigerator temperature. Significant differences were found between titrateable acidities of the cheese samples from day 60 until day 240.

Total solids content of the cheese samples stored at room temperature increased significantly from $42.38 \pm 1.81\%$ at day zero to $48.65 \pm 3.9\%$ at day 120 then decreased gradually to $25.24 \pm 6.4\%$ at day 240. Whereas the total solids of the cheese kept at refrigerator temperature increased from $42.38 \pm 1.81\%$ at day zero to $44.03 \pm 3.2\%$ at day 180 then decreased to $43.57 \pm 2.1\%$ at day 240.

Protein contents of the cheese samples stored at room temperature significantly ($P < 0.001$) increased from $15.08 \pm 0.56\%$ at day zero to $19.99 \pm 2.7\%$ at day 120, then decreased to $11.52 \pm 7.5\%$ and $9.55 \pm 0.9\%$ at days 180 and 240, respectively. The protein contents of the cheese kept at refrigerator temperature decreased from $15.08 \pm 0.56\%$ at day zero to $13.20 \pm 1.42\%$ at day 60 then the values fluctuated until day 240.

The fat contents of the cheese samples stored at room temperature increased from $18.90 \pm 0.78\%$ at day zero to $25.90 \pm 3.9\%$ at day 120 then decreased to $13.38 \pm 4.6\%$ at day 240, while those of the samples kept at the refrigerator temperature increased from 18.9 ± 0.78 at day zero to $21.67 \pm 5.5\%$ at day 180 then decreased to $21.23 \pm 4.6\%$ at day 240.

Soluble protein contents of the cheese samples stored at room temperature significantly ($P < 0.001$) increased from $0.20 \pm 0.03\%$ at day zero to $0.66 \pm 0.06\%$ at day 120 then gradually decreased to $0.42 \pm 0.14\%$ at day 240 and those of the samples kept at refrigerator temperature increased from $0.20 \pm 0.03\%$ at day zero to $0.75 \pm 0.23\%$ at day 240.

The ash contents of the cheese samples stored at room temperature decreased from $3.35 \pm 0.19\%$ at day zero to $2.45 \pm 1.5\%$ at day 180 then increased to $2.61 \pm 0.60\%$ at day 240. The contents of the cheese kept at refrigerator temperature increased from 3.35 ± 0.19 at day zero to $4.10 \pm 0.47\%$ at day 60 then declined gradually to $3.40 \pm 0.47\%$ at day 180 and increased to $3.61 \pm 0.60\%$ at day 240.

Volatile fatty acids of the cheese stored at room and refrigerator temperatures showed significant ($P < 0.001$) differences from day 60 to day 120. Non-significant variations were also observed in the cheese samples at day 180.

Tyrosine contents of the cheese samples stored at room temperature increased significantly ($P < 0.001$) to 254.08 ± 63.73 mg/100 gms cheese at day 240. The tyrosine contents of the cheese stored at refrigerator increased from $14.38 + 3.60$ at day zero to 207.10 ± 42.4 mg/100 gms cheese at day 240.

Tryptophane contents of the cheese stored at the room temperature significantly ($P < 0.001$) increased in values from 5.55 ± 1.96 at day zero to $88.04 \pm 9.10\%$ mg/100gms cheese at day 240. The values of the cheese stored at refrigerator were lower (46.95 ± 13.90 mg/100 gms cheese) when compared with those stored at the room temperature at day 240.

Total bacterial count of the cheese (*Gibna*) samples stored at room temperature revealed significant ($P < 0.001$) increase from 7.52 ± 1.10 Log cfu/ml at day zero to 7.65 ± 0.21 Log cfu/ml at day 60 then gradually decreased to 3.43 ± 0.58 Log cfu/ml at day 240. Whereas those of the cheese stored at the refrigerator temperature decreased up to day 120, then rose at day 180 and declined to lower levels at day 240 (Table 3).

Storage temperature significantly ($P < 0.001$) affect coliforms count in the cheese samples during storage. At day 60 they were not detected in the samples kept at room temperature and that was the situation until day 240. Coliforms of the cheese stored in refrigerator decreased significantly at day 180 and completely disappeared by day 240.

Escherichia coli count of the cheese sample at day zero were 2.18 ± 0.17 Log MPN/ml which were absent throughout the emaining storage period. *Escherichia coli* of the cheese stored at the refrigerator temperature decreased from 2.18 ± 0.17 Log MPN/ml at day zero to 0.32 ± 0.18 Log MPN/ml at day 120 then disappeared at days 180 and 240.

Staphylococcus aureus count at day zero was 3.03 Log cfu/ml for the cheese samples. It was completely disappeared in day 60 onward and throughout the storage period for both storage temperatures.

Psychrotrophic bacterial count of the cheese stored at room temperature at day zero was 6.35 ± 0.08 Log cfu/ml. The organisms were not detected at day 60 till day 240. Psychrotrophic bacterial count of the cheese kept at refrigerator temperature increased significantly ($P < 0.001$) from day zero to day 60 then fluctuated before they decline at day 240 (Table 3).

Storage temperature significantly ($P < 0.001$) affected yeasts and moulds of the cheese. As shown in Table 3, as the storage time increased yeasts and moulds count decreased. Yeasts and moulds counts of cheese stored at room and refrigerator temperatures at day zero were higher than those at day 60. Yeasts and moulds of the cheese kept at the room temperature disappeared from day 120 onwards, while that of the cheese stored at refrigerator temperature decreased at day 240.

The colour of the cheese (*Gibna*) samples kept at refrigerator temperature (5.82 ± 0.65) was significantly ($P < 0.001$) better in comparison with that stored at the room temperature as shown (Table 4). The flavour and the saltiness of the cheese samples were not affected by the storage temperature (Table 4). Texture of the cheese kept at refrigerator temperature had significantly higher scores (6.14 ± 1.02) than that of cheese kept at the room temperature (4.66 ± 2.06).

Results in Table 5 illustrate changes in sensory characteristic of the cheese samples as affected by storage temperature. The results indicated that colour scores of the cheese samples kept at room and refrigerator temperatures show non significant variations in the colour scores at day zero and day 60. After 120 days of storage, the colour of cheese samples kept at refrigerator temperature was significantly better (6.26 ± 0.28) than of that stored at the room temperature (5.84 ± 0.55). At day 240, the colour scores of the cheese samples kept at room temperature were significantly higher (6.36 ± 0.47) than of those stored at refrigerator temperature.

The texture scores of the cheese stored at the refrigerator temperature significantly increased ($P < 0.001$) from 5.32 ± 0.43 at day zero to 6.93 ± 1.45 at day 240, while those of the cheese kept at the room temperature increased from 5.32 ± 0.43 at day zero to 6.13 ± 0.54 at day 120 then gradually decreased to 2.16 ± 2.18 at day 240.

The flavour of the cheese (*Gibna*) samples during storage were significantly affected by the storage period (Table 5). Significant differences ($P < 0.001$) were observed in the flavour scores within and between the cheese samples from day 60 until day 240. The highest flavour scores were secured by cheese stored at the room temperature at day 120 then followed by the cheese kept at refrigerator temperature which improved in flavour at day 180 (5.41 ± 1.17), while that of cheese kept at the room temperature deteriorated in quality at day 180 and 240.

Storage temperature did not affect the saltiness of the cheese samples significantly ($P < 0.05$) during storage. The saltiness of the cheese kept at the room temperature increased slightly from 3.20 ± 0.25 at day

zero to 3.85 ± 0.92 at day 120 then decreased to 2.00 ± 0.19 at day 240, while that of the cheese kept at refrigerator temperature gradually increased from 3.23 ± 0.25 at day zero to 4.42 ± 2.15 at day 180 then decreased to 3.53 ± 0.77 at day 240.

Discussion: Weight loss of the cheese stored at room temperature was higher than that stored at refrigerator temperature. Our findings agreed with those of El Owni and Hamid, ^[11], Nofal *et al.* ^[27] and Nuser ^[30]. The increase in weight loss of the cheese stored at room temperature could be explained by rapid loss of moisture from the curd due to contraction of curd as a result of lactic acid development ^[3,27,2].

The higher acidity of the cheese stored at room temperature might be attributed to increase level of lactic acid due to activation of lactic acid forming bacteria by room temperature, while the low acidity of the cheese stored at refrigerator might be explained by the fact that low temperature inhibited growth and activity of lactic acid bacteria consequently lowering the rate of acid development ^[17,27].

The increase in total solids content of the cheese stored at refrigerator temperature might be due to inhibition of proteolytic and lipolytic activities of microorganisms by low storage temperature. During the storage period from day zero to day 120 the total solids content of the cheese stored at room temperature were higher probably due to low moisture content as a result of high acidity of the cheese ^[34,938].

The increase in crude protein contents 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, while the low crude protein contents of the samples in the refrigerator were possibly attributed to absorption of high level of moisture by the curd ^[39,17,27].

The high fat contents of the cheese samples stored at room temperature could be attributed to the loss of degradation products in the pickling whey ^[21,27,2].

The results in this study regarding soluble protein contents were in accordance with the findings of El Owni and Hamid ^[11], Nuser ^[30] and Abdalla ^[1], who reported that the decrease of protein content during storage was the direct result of protein degradation leading to formation of water soluble compounds. The higher soluble protein contents of the cheese stored at room temperature during early stages of ripening could be due to continuous proteolysis in the cheese proteins ^[4] while the high soluble protein contents of the cheese samples stored at the refrigerator temperature at latter stages was possibly due to increased proteolytic activity of psychrotrophic bacteria at low storage temperature ^[12].

Table 1: Effect of temperature on weight loss and chemical composition of the processed white cheese (*Gibna Bayda*) during storage.

Weight loss and chemical composition (%)	Storage temperature	
	RT	CT
Weight loss	27.44 ± 21.83 ^a	13.27 ± 10.17 ^b
Titrateable acidity	1.18 ± 0.79 ^a	0.97 ± 0.45 ^b
Total solids	40.94 ± 7.87 ^a	41.39 ± 3.67 ^a
Crude protein	15.01 ± 6.9 ^a	14.71 ± 2.21 ^b
Fat	20.29 ± 9.18 ^a	19.73 ± 4.14 ^b
Soluble protein	0.46 ± 0.26 ^b	0.50 ± 0.24 ^a
Ash	2.68 ± 1.18 ^b	3.63 ± 0.6 ^a
VFA (0.1 N mL NaOH/100 gms cheese)	14.12 ± 3.09 ^a	10.95 ± 6.25 ^b
Tyrosine mg/100 gms cheese	48.68 ± 5.49 ^a	44.82 ± 5.28 ^b
Tryptophane mg/100gms cheese	133.08 ± 11.58 ^a	106.86 ± 7.81 ^b
Level of significant	***	

In this and the following tables mean values bearing different superscripts within rows are significantly different (P < 0.05).

RT = Room temperature (35-37°C)

CT = Refrigerator temperature (7°C)

*** = Significence at (P > 0.001).

Table 2: Effect of storage period and temperature on chemical composition of the white cheese (*Gibna Bayda*)

Storage period in day	Chemical composition									
	Weight loss %		Titra.acidity %		Total solids %		Crude protein %		Fat %	
	RT	CT	RT	CT	RT	CT	RT	CT	RT	CT
0.0	0.0 ^a	0.0 ^a	0.39± 0.08 ^a	0.39± 0.08 ^a	42.38± 1.81 ^a	42.38± 1.81 ^a	15.08± 0.56 ^d	15.08± 0.56 ^d	18.9± 0.78 ^c	18.9± 0.78 ^c
60	36.95± 10.3 ^b	8.35± 5.4 ^a	1.51± 0.59 ^f	0.66± 0.21 ^f	49.47± 3.2 ^a	37.29± 3.4 ^b	18.93± 2.01 ^b	13.20± 1.42 ^c	25.0± 4.3 ^b	18.43± 4.5 ^f
120	39.80± 7.8 ^a	12.70± 3.97 ^f	1.55± 0.30 ^a	0.92± 0.20 ^a	48.65± 3.9 ^b	39.69± 2.8 ^f	19.99± 2.7 ^a	15.72± 2.9 ^e	25.90± 3.9 ^a	18.42± 3.1 ^f
180	34.21± 21.7 ^a	20.18± 8.4 ^a	1.46± 0.91 ^b	1.55± 0.09 ^a	38.96± 23.8 ^a	44.03± 3.2 ^c	11.52± 7.5 ^e	13.20± 2.1 ^e	18.28± 12.3 ^f	21.67± 5.5 ^e
240	26.25± 22.03 ^d	25.13± 3.8 ^d	1.00± 1.02 ^d	1.33± 0.14 ^c	25.24± 6.4 ^d	43.57± 2.1 ^d	9.55± 0.9 ^a	15.65± 2.4 ^e	13.38± 4.6 ^c	21.23± 4.6 ^f
Level of sign.	***									

Table 2: Contd.

storage period in days	Chemical composition									
	Soluble prot. %		Ash %		VFA (0.1 N mL NaOH/100gm ch.)		Tyrosine (mg/100gms ch.)		Tryptophane (mg/100gms ch.)	
	RT	CT	RT	CT	RT	CT	RT	CT	RT	CT
0.0	0.20± 0.03 ^a	0.20± 0.03 ^a	3.35± 0.19 ^f	3.35± 0.19 ^f	4.68± 0.30 ^f	4.68± 0.30 ^f	14.38± 3.60 ^f	14.38± 3.60 ^f	5.55± 1.96 ^e	5.55± 1.96 ^e
60	0.43± 0.09 ^a	0.33± 0.11 ^f	3.14± 0.57 ^f	4.10± 0.47 ^a	14.57± 6.80 ^f	7.25± 0.89 ^a	120.90± 41.7 ^f	61.35± 23.90 ^b	25.08± 8.20 ^f	10.62± 7.04 ^e
120	0.66± 0.06 ^b	0.56± 0.09 ^a	3.03± 0.53 ^f	3.70± 0.06 ^a	27.96± 16.20 ^a	9.56± 1.35 ^d	202.53± 60.00 ^a	102.75± 12.80 ^e	47.57± 10.80 ^a	22.82± 15.02 ^f
180	0.60± 0.30 ^a	0.67± 0.05 ^b	2.45± 1.50 ^b	3.40± 0.47 ^a	16.64± 13.40 ^b	16.39± 8.40 ^b	173.51± 118.20 ^a	148.71± 25.00 ^a	76.99± 48.84 ^a	38.18± 15.70 ^f
240	0.42± 0.14 ^a	0.75± 0.23 ^a	2.68± 1.20 ^b	3.61± 0.60 ^a	6.73± 2.20 ^c	168.8± 2.57 ^a	254.84± 63.73 ^a	207.1± 42.40 ^a	88.04± 9.10 ^b	46.95± 13.90 ^f
Level of sign.	***									

Table 3: Effect of storage temperature on the microbiological quality of white cheese (*Gibna Bayda*)

Storage period in days	Microbiological analysis											
	Total bacterial count (Log cfu)		Coliforms count (Log MPN/ml)		<i>E. coli</i> count (Log MPN/ml)		<i>Staph. aureus</i> count		Psychrotrophic count (Log cfu/ml)		Yeasts and moulds count (Log cfu/ml)	
	RT	CT	RT	CT	RT	CT	RT	CT	RT	CT	RT	CT
0.0	7.52± 1.10 ^a	7.52± 1.10 ^a	4.04± 1.05 ^a	4.04± 1.05 ^a	2.18± 0.17 ^a	2.18± 0.17 ^a	3.03	3.03	6.35± 0.08 ^b	6.35± 0.08 ^b	2.65± 0.48 ^b	2.65± 0.48 ^b
60	7.65± 0.21 ^b	7.47± 0.21 ^c	ND	2.25± 0.15 ^b	ND	1.49± 0.90 ^b	ND	ND	ND	6.55± 0.57 ^a	0.79± 0.13 ^c	2.38± 0.49 ^c
120	6.51± 0.72 ^c	6.98± 1.56 ^d	ND	0.48± 0.88 ^c	ND	0.32± 0.18 ^c	ND	ND	ND	4.04± 2.6 ^c	ND	2.49± 0.6 ^c
180	4.97± 2.94 ^d	7.95± 0.63 ^a	ND	0.28± 0.51 ^d	ND	ND	ND	ND	ND	5.04± 3.1 ^c	ND	1.14± 0.1 ^c
240	3.43± 0.58 ^e	7.53± 0.76 ^c	ND	ND	ND	ND	ND	ND	ND	3.11± 0.34 ^c	ND	1.74± 0.14 ^d
Level of sign.	***	***	***	***	***	***	***	***	***	***	***	***

Table 4: Effect of storage temperature on sensory characteristics of white cheese (*Gibna Bayda*)

Sensory characteristics	RT	CT
Colour	4.77±2.10 ^b	5.82± 0.65 ^a
Flavour	4.80±2.23 ^a	4.89±0.80 ^{ab}
Texture	4.66±2.06 ^b	6.14±2.02 ^a
Saltiness	3.17±1.60 ^a	4.81±1.02 ^a

Table 5: Changes in Sensory characteristics of the white cheese (*Gibna Bayda*) during storage as affected by temperature.

Sensory Characteristics	Colour		Texture		Flavour		Saltiness	
Storage temperature.								
The storage periods (days)	RT (35 -37°C)	CT (7°C)	RT	CT	RT	CT	RT	CT
0.0	5.03± 0.42 ^f	5.03± 0.20 ^f	5.32± 0.20 ^c	5.32± 0.43 ^c	4.18± 0.43 ^c	4.18± 0.43 ^c	3.20± 0.25	3.20± 0.25
60	5.42± 1.11 ^e	5.48± 0.34 ^e	5.86± 0.60 ^d	6.04± 0.89 ^c	5.86± 0.61 ^b	4.97± 0.31 ^d	3.51± 0.71	3.48± 0.77
120	5.84± 0.55 ^d	6.26± 0.28 ^b	6.13± 0.54 ^c	6.25± 1.09 ^b	6.51± 0.91 ^a	5.01± 0.60 ^d	3.85± 0.92	4.15± 1.18
180	4.46± 2.67 ^a	5.96± 0.53 ^c	3.85± 2.32 ^f	6.15± 1.09 ^c	4.24± 2.53 ^c	5.41± 1.17 ^c	3.28± 2.31	4.42± 2.15
240	3.09± 3.13 ^b	6.36± 0.47 ^a	2.16± 2.18 ^g	6.93± 1.45 ^a	3.23± 3.33 ^f	4.88± 0.74 ^d	2.00± 0.19	3.53± 0.77
Level of sign.	***							

Ash contents of the cheese stored at room temperature were lower than those stored at refrigerator temperature (Tables 2). These results were in agreement with the findings of Abdalla^[1] and Bilal^[8], who found that the ash contents of the cheese stored at the refrigerator temperature were higher than those stored at room temperature. That was attributed to absorption of salt by the curd at the low storage temperature^[39,27,36].

Volatile fatty acids of the cheese samples stored at room temperature were higher than those stored at the refrigerator temperature. That was possibly due to the rapid lipolysis in fats at high temperature, while, the low VFA at the refrigerator temperature might be attributed to suppression of lipolytic agents by the low storage temperature^[27].

Tyrosine and tryptophane contents of the cheese at room temperature were higher than those stored at refrigerator temperature. These results confirmed the findings of Nofal *et al.*,^[27] who reported that low temperature (7°C) causes inhibition in the growth of microorganisms, hence lowering the rate of protein decomposition. Similar results were reported by Coppolla *et al.*^[10], who stated that storage of cheese at low temperature and high salt content decreased the protein degradation.

The higher total bacterial count of the cheese samples stored at room temperature compared to those stored at refrigerator temperature might be due to the effect of high storage temperature on the acceleration of cheese ripening and the number of mesophilic bacteria increased, while those of cheese stored at refrigerator temperature causes inhibition in growth of thermophile and mesophile organisms.

Coliforms were not detected in the cheese samples kept at room temperature because of the high level of acidity which contributed in suppression of their growth^[5]. In cheese stored at refrigerator temperature coliforms decreased gradually till day 180 then completely disappeared at day 240. This could be due

to the fact that coliforms could grow at refrigerator storage and decrease in number as storage time progress because of the low pH in the cheese^[22].

Low storage temperatures slow down both the bacterial and biochemical reaction^[35]. The decrease in *E. coli* count of the cheese samples stored at refrigerator temperature from day zero to day 120 could be due to the effect of low temperature and increased acidity of the cheese. From days 180 to 240 *E. coli* were not detected possibly due to complete inactivation of *E. coli* by high level of lactic acid in the cheese samples. The results in this study were in agreement with those of Hamid and El Owni,^[18] and Park *et al.*^[31].

Staphylococcus aureus was found only at day zero, it was not detected throughout the storage period. That was probably due to their low initial numbers in the cheese which was not expected to survive the high acidity during storage^[23,38].

Psychrotrophic bacteria were not detected in the cheese samples stored at room temperature. That was possibly attributed to the effect of storage temperature on the psychrotrophs^[5]. Their growth in refrigerator support Nour El Daim and El Zubeir^[29].

The reduced growth of yeasts and moulds at room temperature could be due to the unfavourable conditions, which discourage their growth. This supported El Owni and Hamid,^[11] Nour El Daim and El Zubeir^[29] and Ahmed,^[5] who found that yeasts and moulds were not detected in cheese packed in antiacid cans stored at 37°C for period of four months, while those stored at 7°C were decreased from 2.64 Lgo cfu/ml at day zero to 2.15 Lgo cfu/ml at day 15 and was not detected thereafter throughout the the storage period.

The results showed that color scores of the cheese samples stored in the refrigerator was better in comparison with those kept at room temperature. The present findings confirmed those reported by Hamed *et al.*^[16].

Flavor and saltiness scores of the cheese samples were not affected by storage temperature. The non-significant variations in flavor of the cheese samples stored at room and refrigerator temperature might be due to prolonged storage which have reduced variation in flavours and saltiness Nour El Daim and El Zubeir [29]. Hamed *et al.*, [16] reported that quality of the cheese stored at refrigerator temperature was better than those stored at room temperature.

Colour of the cheese samples kept at room and refrigerator temperatures remained relatively constant from days zero to 60, while those stored at refrigerator temperature improved in colour by day 240.

Changes were observed in texture during storage from day zero till day 120 then decreased in scores. Our results were in agreement with those reported by Nour El Daim, *et al.* [29] and Hamed *et al.*, [16]. The high texture scores of the cheese kept at refrigerator temperature was probably due to continuous proteolysis in protein contents through the storage period while those stored at room temperature the presence of high level of lactic acids causes suppression in growth of proteolytic agents [38]. Flavour of the cheese samples stored at room temperature was better in comparison with those stored at refrigerator temperature from day zero to day 120. This could be attributed to the effect of high storage temperature on speeding flavour production at early stage of cheese ripening while refrigeration storage causes retardation of lipolytic and proteolytic processes. Saltiness of the cheese samples was not affected by storage temperature during storage. The present results were in agreement with those reported by Nuser [30]. The slight increased in saltiness of the cheese samples stored at refrigerator temperature could be attributed to absorption of salted whey during cold storage.

Weight loss, chemical composition, microbial contents and sensory characteristics of *Gibna Bayda* were significantly ($p < 0.001$) affected by storage period. Storage of *Gibna Bayda* samples at room temperature decreased coliform, *E. coli*, psychrotrophic bacteria, yeast and moulds counts while it increased total bacterial count. Presence in *Gibna Bayda* of pathogenic microorganisms rise concerns about the safety of this cheese and indicate the necessity of developing specific requirements for quality of raw milk, sanitation and handling. The application of good manufacturing practice and implementation the HACCP requirements will ensure the control of the manufacture process and consequently the safety of the *Gibna Bayda*.

REFERENCES

1. Abdalla, M.O., 1992. *Effect of Processing Conditions on the Microbiological and Chemical Properties of White Soft Cheese*. Ph.D. thesis, University of Tennessee, Knoxville, U.S.A.
2. Abdel Razig, A.K., 1996. *Production of White Soft Cheese from Different Milk Sources*. M.Sc. Thesis, University of Khartoum, Sudan.
3. Abdel-Salam, M.H., M.M. El-Abd, M.R. Nagmouh and R.M. Saleem, 1978. Effect of salt concentration and calcium chloride added on the composition of the pickling solution of white soft cheese. *Egyptian J. Dairy Sci.*, 6:221 – 228.
4. Abdel-Salam, M.H., 1987. Domiati cheese and feta type cheeses. In P.F. Fox, (Editor), *Cheese*. El Sevier Applied Science, London, pp: 277 – 309.
5. Ahmed, A.M., 1985. *Bacteriological and Chemical Characteristics of Sudanese White Cheese Produced and Stored under Different Conditions*. Ph.D. Thesis, University of Khartoum, Sudan.
6. AOAC, 1990. *Official Methods of Analysis*, 15th edition Association of Official Analytical Chemists. Washington, D.C., U.S.A.
7. Banwart, J.G., 1981. *Basic Food Microbiology* avi, Publishing Company Inc. West port, Connecticut.
8. Bilal, A.M., 2000. *Effect of Partial Substitution of Soymilk on the Chemical Composition and Sensory Characteristics of White Soft Cheese*. Thesis, Univ. of Khartoum, Sudan.
9. Collombo, M., M. Spahni and R. Badertscher, 1992. Optimizatin of storage conditions for laboratory cheese sample with acid of the chemical analysis. *Schweizerische Mil. Mil. Chevirstschaft Liche Forshuny.*, 21(1): 6 – 11.
10. Coppolla, R., E. Sorrention, L. Cinquanta, F. Ross, M. Lorrizoo and L. Garzia, 1995. Shelf life of Mozzarella cheese samples packaged with out liquid and stored at different temperatures. *Ital. J. Food Science*, 7(4): 351-359.
11. El Owni O A O and Hamid, O.I.A., 2008. Effect of storage period on weight loss, chemical composition, microbiological and sensory characteristics of Sudanese White cheese (*Gibna Bayda*), *Pakistan Journal of Nutrition*, 7(1): 75-80
<http://www.pjbs.org/pjnonline/fin857.pdf>
12. Fairbairn, D.G. and B.A. Law, 1986. The effect of nitrogen and carbon source on proteinase production by *Pseudomonas fluorescens*. *J. Appl. Bacteriol.*, 62: 105 – 113.
13. Foley, J., J. Buckley and M.F. Murphy, 1974. *Commercial Testing and Product Control in The Dairy Industry*, University, College, Cork.
14. FDA, 1980. *Bacteriological Analytical Manual for Foods*. Food and Drugs Administration ed. Washington, D.C.
15. Frank, J.F., G.L. Christen and L.B. Bullerman, 1992. In R.T. Marshall, (ed.) *Standard Methods for Examination of Dairy Products*. APHA, Washington, D.C., pp: 271 – 286.

16. Hamed, A., A. Nafisa and S. Farag, 1992. Effect of pasteurization and storage conditions on the microbiological, chemical and organoleptic properties of Domiati cheese during pickling. Egyptian J. Dairy Sci., 10: 177-190.
17. Hamid, O.I.A., 1998. Effect of Processing Conditions on Yield, Chemical Composition and Sensory Characteristics of White Soft Cheese. M.Sc. Thesis, University of Khartoum, Sudan.
18. Hamid, O.I.A., O.A.O. El Owni, 2007. Microbiological properties and sensory characteristics of white cheese (Gibna Bayda) collected in Zalingei area, West Darfur State. Research Journal of Animal and Veterinary Sciences, 2: 61-65.
19. Hamid, O.I.A., O.A.O. El Owni and M.T. Musa 2006. Effect of salt concentration on weigh loss, chemical composition and sensory characteristics. International Journal of Dairy Science, 3(2): 79 -85.
20. Harrigan, W.F. and M.E. McCance, 1976. Laboratory Methods in Food and Dairy Microbiology. Academic Press Inc. London.
21. Hofi, A.A., A.M. Rabie, S.E. Farahat, W.M. Abu El-Ella and S. El-Shibiny, 1976. The yield and chemical composition of Domiati cheese from buffaloes and soy milk mixture. Egyptian J. Dairy Sci., 4: 141 – 145.
22. Karakus, M. and I. Alperden, 1992. Beyaz peynirin olgunlasma surecinde mikrobiyolojik ve kimyasal ozelliklerindeki degismeler. Gida Sanayi, 6 2): 363 – 369. in Hayaloglu, A.A., A.M. Guven, P.F. Fox, 2002. Microbiological, chemical and technological properties of Turkish white cheese 'Beyaz Peynir' Inter. Dairy J., 12(8): 643-648.
23. Kosikowski, F.V., 1982. Cheese and Fermented Milk Food. Edwards Brothers, Inc., Ann. Arbor., Michigan, USA.
24. Kur, L.L.A., 1992. Effect of Storage on the Quality and Chemical Composition of Sudanese White Cheese. M.Sc. Thesis, University of Khartoum, Sudan.
25. Ling, E.R., 1963. Textbook of Dairy Chemistry. Vol. 2 Chapman and Hall Ltd. London.
26. Marshall, R.T., 1992. Standard Methods for Examinations of Dairy Products. 16th ed. APHA Washington DC., 20005.
27. Nofal, A., M. Elhami, H. El Gazzar, H. Abu-El-Kheir, A. Gazzar, A.A. H. and Kheir, 1981. Studies on acceleration of manufacturing Domiati cheeses. III. Effect of storage on yield and properties of cheese manufactured by the suggested method. Agricultural Research Review., 59(6): 301-312.
28. Nour El Daim, M.S.A. and El Zubeir, E.M. Ibtisam, 2007. Yield and sensory evaluation of the processed cheese from Sudanese white cheese . Research Journal of Animal and Veterinary Sciences, 247-52.
29. Nour El Daim, M.S.A. and E.M. Ibtisam El Zubeir, 2006. Comparison Of microbiological quality of processed and non processed Sudanese white cheese. Research Jopurnal of Microbiologym 1(3): 273-279.
30. Nuser, S.N.M., 2001. The Effect of Cooking and Vacuum Packaging on the Quality of White Soft Cheese. M.Sc. Thesis University of Khartoum, Sudan.
31. Park, H.S., E. Marth and N.E. Olson, 1976. Fate of enteropathogenic strain of *Escherchia coli* during the manufacture and ripening of camembert cheese, J. Milk and Food Technol., 36(11): 543 – 546.
32. Rayman, K., N. Malik and G. Jarvis, 1988. Performance of four selective media for enumeration of *Staphylococcus aureus* in corned beef and in cheese. J. Food Prot., 51: 878 – 888.
33. Osman, A.O., 1987. The technology of the Sudanese white cheese "Gibna Bayda" in: bulletin of the Int. Dairy Federation, pp: 113-115.
34. Salama, F.A., A.A. Ismail, A.M. Yousif and S.A. Salem, 1982. Comparative studies on white pickled Brinza cheese made from cows' and buffaloes milk in Egypt. II. Effect of pickling conditions. Egyptian J. Dairy Sci., 101: 243 – 252.
35. Scott, R., 1986. Cheese Making Practice: Second ed. Elsevier Applied Science publisher at Essex IGIIJU, England.
36. Tayar, A., 1995. The chemical and microbiological changes occurring during ripening period of white cheeses. Food. 20: 97-101. Vakaleris, D.G. and Price, V.V. (1959). A rapid spectrophotometric methods for measuring cheese ripening. J. Dairy Sci., 42: 264 – 267.
37. Vakaleris, D.G. and V.V. Price, 1959. A rapid spectrophotometric methods for measuring cheese ripening. J. Dairy Sci., 42: 264 – 267.
38. Walstra, P., T.J. Geurts, A. Noomen, A. Jellema and M.A.J.S. Nan Boekel, 1999. Dairy technology principles of milk properties and processes. Marcel Dekker, Inc. New York.
39. Zaki, M.H., N.H. Metawally and L.A. Koussy, 1974. Domiati cheese stored at room temperature as affected by heat treatment of milk and different salting levels. Agric. Res. Rev., 52: 217-231.