PJN
ISSN 1680-5194

PAKISTAN JOURNAL OF NUTRITION

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
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Pakistan Journal of Nutrition 13 (1): 33-37, 2014
ISSN 1680-5194

Utilization of Concentrated Buttermilk in Functional Processed Cheese Manufacturing and Studying Some of its Physicochemical Properties

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Abstract: This investigation was carried out to study the effect of utilizing concentrate butter milk (CBM) which prepared by exposure of butter milk to heat treatment (100 ºC) for different time 15, 30 and 60 min, treatments T1, T2 and T3 respectively in preparing of processed cheese (PC), in addition to control treatment (C) which PC prepared without CBM. The CBM was added to base blend during cooking stage. The prepared samples were analyzed for chemical and sensory properties, at zero time and during storage period of 4 weeks at 6±1ºC. The results reveled that there were significant differences in the chemical composition for fat%, protein%, ash% and moisture% and no significant differences in sensory evaluation which conducted at zero time for color, taste and flavor, texture and bitterness between control and treated PC, while PC treatments stay more acceptable than control PC at all storage periods, especially cheese treatments T2 and T3. The obtained results showed that T2 and T3 treatments were quit low development of both peroxide value (POV) and acid degree value (ADV) of fat during some stages of storage, which have retained their validity according to the scale of accepted level of POV and ADV as even after 4 weeks of storage period. The microbiology study reveled that there was no growth of yeast, Mold and Coliform bacteria in treatments and control PC at all period of storage while the total count of viable bacteria was less in PC of treatments than control PC and all of were in the limited scale of acceptance. Finally using CBM in processed cheese makes this dairy product useful as a functional food.

Key words: Concentrate buttermilk, organoleptic properties, processed cheese

INTRODUCTION

The production of processed cheese started in Europe and could date to the mid-1890s. Natural cheeses have limited shelf-life. The idea of processed cheese originated from a desire to extend the shelf-life of natural cheese or to develop a new type of cheese which was more stable (Tamime, 2011). Around the same period, commercial developments were made in Germany for the export of short shelf-life soft cheese was achieved by heating the cheeses in metal cans, but the process was most successful in Switzerland by using sodium citrate (Berger *et al*., 1989). Essential steps in the manufacture of processed cheese is melting and heating blends of natural cheeses, the addition of emulsifying salts, agitation to produce a homogeneous mixture, followed by packaging and cooling (Tamime, 2011). The application of heat inactivates the starter culture organisms and other bacteria, including the enzymes present in natural cheeses and produces a product with extended shelf-life. Buttermilk is the aqueous phase released during the churning of cream in butter manufacture. It contains all the water-soluble components of cream such as milk protein, lactose and minerals. It also encloses material derived from milk fat globule membrane (MFGM), which is disrupted during the churning and mostly migrates to the buttermilk fraction (Mistry, 2001). Buttermilk contains more phospholipids than milk because of its high content in MFGM material, which is rich in phospholipids that constitute about one-third of the MFGM DM (Mulder and Walstra, 1974). For instance, Elling *et al*. (1996) reported that buttermilk contains phospholipids 7 times more than whole milk, with concentrations equal to 0.89 mg/g and 0.12 mg/g, respectively. The released (MFGM) material from buttermilk and/or butter serum is collected by microfiltration (Morin *et al*., 2007). Two fractions, the soluble supernatant and the milk fat globule membrane (MFGM) pellet, are obtained by ultracentrifugation. Precipitation of milk fat globule membrane (MFGM) fragments at low pH were done by Fong *et al*. (2007). The high content of phospholipids in buttermilk makes this dairy ingredient interesting for use as a functional ingredient because of the emulsifying properties of phospholipids (Wong and Kitts, 2003). In addition, phospholipids have been shown to possess biological activity. Moreover, several studies have shown the beneficial effects of these components on human health (Fong *et al*., 2007; Noh and Koo, 2006; Spitsberg, 2005). Some studies have demonstrated the anticarcinogenic potential of phospholipids, especially against colon

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cancer (Schmelz *et al*., 1996, 1998), as well as their protective effect against bacterial toxins and infection (Rueda *et al*., 1998; Sprong *et al*., 2002). The high phospholipids content of buttermilk makes this dairy ingredient interesting for use as a functional ingredient (Sodini *et al*., 2006) Phospholipids are integral components of the cell membrane in human and they are major constituents of the brain, nerve tissue, heart, muscle, liver and sperm (Renner *et al*., 1989). The high content of phospholipids in buttermilk makes it an important functional ingredient in an array of food products (e.g., chocolate, cheese seasonings, ice cream mixes and yoghurt (Rombaut *et al*., 2006). The aim of the present study was to demonstrate the effect of addition concentrate buttermilk as a functional ingredient in the fortification of processed cheese and study some of its chemical and physical properties.

MATERIALS AND METHODS

White soft cheese and Fresh sweet buttermilk were obtained from dairy plant College of agriculture College-Baghdad University, emulsifying salt from (Rhone-Poulenc Chime, France).

Preparation concentrates of buttermilk (CBM): Milk samples were separated using a cream separator then the cream was held overnight at 5°C and mechanically churned to obtain butter and an aqueous phase (buttermilk) is formed. Buttermilk was heated at 100°C for different time 15, 30 and 60 min. the treated butter milk was collected, cold and used during processed cheese cooking.

Manufacture of processed cheese (PC): Three different treatments (T1, T2 and T3) of PCS with control were manufactured. Minced soft cheese weighed, in addition to control processed cheese. Soft cheese weighed and placed into the processing batch. Balanced amounts of emulsifying salt 3% added. The CBM was added to the treated PCS, while water was to control instate CBM to base blend during treatments cooking, then the samples agitated for 8 min at 85-90° using direct injection steam at pressure of 1.5 bar. The hot product of each treatment of PC was manually filled into 150 mL sterilized glass cups covered with aluminum foil, then rabidly cooled and stored for 4 weeks at 6±1°C. The PCS samples were analyzed for fat, total nitrogen, ash content and pH values as described by Ling (2008). also peroxide value (POV) and acid degree value (ADV) of fat were determined at zero time and during the storage period according to AOAC (2004) and Deeth and Fitz-Gerard (2006), respectively.

Sensory evaluation: The samples were evaluated for color, flavor, texture and bitterness according to forma mentioned by Nelson and Trout (1964) directly after processing at zero time and during storage period for 4 weeks at 6±1°C.

Microbiological examination

Enumeration of total count plate: Nutrient agar was used for enumerated of total bacteria. Plates were incubated at 30°C for 72 h (ISO No. 4833, 2003).

Enumeration of total yeast and molds: Potato Dextrose Agar BDA was used for enumerated yeast and mold count. Plates were incubated at 25°C for 5 days (ISO No. 6611, 2004).

Enumeration of total coliform: MacConkey agar was used for enumerated coliform. Plates were incubated at 37°C for 24 h (ISO No. 4832, 2005).

Statistical analysis: All data were analyzed using Statistical program (SAS, 2004) Statistical Analysis System.

RESULTS AND DISCUSSION

Chemical composition of processed cheeses: The chemical compositions of PC treatments C, T1, T2 and T3 are presented in Table 1. It illustrated that there is significant differences in the moisture, fat, protein and ash% between control and treatments of PC. the protein, fat and ash% were higher in T1, T2 and T3 treatments than C treatment, it may be due to addition of CBM to treated PC which its rich in casein, whey proteins and fat, while in C treatment water was added. The result which obtained in this study was in the limited mentioned by other researcher, Kapoor *et al*. (2007), Pinto (2007) reported that PC should be contains a rang of 13-37% Fat, 12.82-22.6% Protein, 38.2-64.21 Moisture, 1.33-4.82% Ash, 1.33-1.60% Titratibal Acidity and 4.4-6.3 pH value, depending upon the quality of raw materials which used in manufacturing of PC. Also moisture% of samples was similar to that found by Suleiman *et al*. (2011), while the result for protein, fat, ash% and pH values were similar that found by El-Sayed *et al*. (2010), Al-husine (2011), Ali and Al-Dhhan (2013).

Sensory evaluation of PC: Table 2 shows the results of sensory evaluation for treated and control PC at zero time and during storage period for 4 weeks at 6±1°C, as evidenced by the results there was no significant differences in sensory evaluation studied represented of the color, flavor, textures and bitterness between the C and (T1, T2, T3) at zero time, this confirms that fortification of PC with CBM shows no undesirable sensory impact on the consumer accessibility for all treatments contains CBM exposure to different time of heating. But after 1 week of storage, treated PC got highest scores specially T2 and T3 in terms of flavor,

Table 1: Chemical composition of processed cheeses at zero time

Treatment	Moisture (%)	Fat (%)	Protein (%)	Ash (%)	pH
C	51	17	21.5	3.11	5.71
T1	49.4	18.9	22.7	3.49	5.7
T2	49.33	19.5	23.1	4.95	5.7
T3	49.23	21.1	24.4	5.39	5.65
L.S.D	1.30*	0.80*	1.10*	0.50*	ns

Ns = Non significant, * = Significant p<0.05

Table 2: Sensory evaluation of PC during storage for 4 wks at 6±1°C

ST (wks)	Trt.	Color	F & T	Tex.	Bitter-ness	Total 40
0	C	10	10	10	10	40
	T1	10	10	9	10	39
	T2	10	10	9	10	39
	T3	10	10	10	10	40
1	C	10	9	9	10	38
	T1	10	9	9	10	38
	T2	10	9.5	9	10	38.5
	T3	10	9.9	9.5	10	39.4
2	C	9	8	8	8.4	33.4
	T1	9	8.5	8.7	8.6	34.3
	T2	9.5	9.5	9	9	37
	T3	9.5	9.7	9.7	9.5	38.4
3	C	8	6	6	5.5	25.5
	T1	8	7.5	6.5	6	28
	T2	9.5	9	8.5	9	36
	T3	9.5	9.5	9	9.2	37.2
4	C	8	5	6	5	24
	T1	8	7	6	5	26
	T2	9	9	8	9	35
	T3	9.5	9	9	9	36.5
	LSD	0.78*	1.12*	2.00*	2.50*	4.15*

*p<0.05. ST : Storage time Trt: Treatment. F & T: Flavor and Taste. Tex. : Texture

texture and bitterness than C treatment, these results are belong to that the butter milk contains different biologically active compounds, such as whey protein (lactofrrin and transferrin) in addition to phospholipids which acts as anti-bacterial and antioxidants in which inhibit the growth of microorganisms, especially psychrophilic bacteria which is responsible for cheese lipolysis and proteolysis during storage (Rueda *et al*., 1998; Sprong *et al*., 2002; Sodini *et al*., 2006) and to the chemical changes that occur in fat and protein of C treatment like hydrolysis degradation of fats (fat rancidity) and degradation of protein (proteolysis) as a result of lipase and protease secretion by psychrophilic bacterial which leads to lipolysis of triglycerides and release of short chain fatty acid in concentrations enough to give the rancid flavor, which are undesirable by the consumer as well undesirable products which is accompanied by the accumulation of oxidative stress (Cogan, 1980), also break down of proteins produce low molecular peptide characterized by bitter taste, the subsequent periods of storage notes that all types of treated PC was trod the same behavior the previous period of storage until the 4 weeks storage and were acceptance in all the period of storage specially T2 and T3 treatments, while C treatment became sensory unacceptable. The overall results indicates that the addition of CBM prolong the period of validity of PC and T3 treatment gave the best results.

Peroxide value (POV) of PC: The changes in POV of C, T1, T2 and T3 treatments of PC during storage periods for 4 weeks at 6±1°C was illustrated Table 3. as seen from the results there was no difference in the initial values of POV for all PC treatments at zero time of storage which range of (4.4-4.5) meq/fat and this Value comply with Iraqi Standard Specification (1990; 2000) for PC, which required that POV should be less than 10 meq/kg fat. and there was a slightly increased in its value after 1 week of storage period. During storage for 4 week, the POV of all treatments was increased and reached to 10 meq/kg fat in C treatment, the less POV increment (9.5,8.9 and 8.1 meq/kg fat) was found in T1, T2 and T3, respectively. These results indicate that addition of CBM provide some of natural antioxidant compounds which reduce development of POV, This is consistent with finding that C treatment has become unacceptable and treatments T1, T2 and T3 still in acceptance limits.

Acid degree value: Table 4 shows the ADV values of C, T1, T2 and T3 treatments of PC during storage periods for 4 weeks at 6±1°C. The results revealed that there was non-significant differences in initial ADV for all which range of (1.21-1.60) meq/fat, these values are with acceptable limits for ADV scale. After 1 week of storage the results showed that there was a development in ADV a highest development of ADV occurs in treatment C compared to treatment, this is due to the role of buttermilk, which help in preventing the development of the ADV values that induced by heat resistance lipase (lipoprotein lipase) produced by psychropilic bacteria (Cogan, 1980). These results are related to the effect of calcium on increasing aggregation the milk proteins and reducing the pore size the protein network thus reducing separation whey from the net work. After 4 weeks of storage ADV was trod has the same behavior of the previous period the values of all treatments were rising and reached to 2.25.2.0,2.0,1.96 meq/100 gm fat for C, T1, T2 and T3, respectively, PC of treatments T2 and T3 still in the acceptable standard for ADV which refers to that the values of ADV should be not exceed than 2.0 meq/100 gm fat, while a control PC became refused by standard scale values of ADV, Although cheese of T1 was at the broader of acceptance, It became unacceptable by panelists that can many of them able to distinguish the rancid flavor when ADV arrival higher than 2.0 meq/100 gm fat, which is due to release short chain free fatty acids like Butyric and Caproic in concentrations enough to appeared rancid flavor (Deeth and Fitz-gerard, 2006). The obtained results encourages to use buttermilk in prolonged the shelf life of PC.

Microbiological properties of PC: The contain of total count bacteria, the count of psychrophilic, yeasts and molds and coliform bacteria in PC treatments shown in Table 5. At zero time the number of total count bacteria

Table 3: Peroxide value of PC during storage for 4 weeks at 6±1°C

	POV (meq/kg fat)				
	Period of storage (weeks)				
Treatment	0	1	2	3	4
C	4.5	5.5	8	9.5	10
T1	4.4	5	7	9	9.5
T2	4.4	5	6	7.5	8.9
T3	4.4	5	6	7	8.1
LSD	ns	ns	0.10*	0.41*	0.76*

*p<0.05

Table 4: Acid Degree Value of PC during storage for 4 weeks at 6±1°C

	ADV (meq/100 g fat)				
	Period of storage (weeks)				
Treatment	0	1	2	3	4
C	1.6	1.81	1.98	2	2.25
T1	1.27	1.44	1.69	1.98	2
T2	1.23	1.32	1.6	1.88	1.98
T3	1.21	1.3	1.45	1.75	1.9
LSD	ns	0.14*	0.10*	0.09*	0.14*

*p<0.05

Table 5: No. total count bacteria, psychrophilic, coliform and mold and yeast of PC during storage for 4 weeks at 6±1°C

Storage time (wks)	Treatment	Total count bacteria cfu/g	Psychropilic bacteria cfu/g	Mold and yeast cfu/g	Coliform bacteria cfu/g
0	C	7×101	0	0	0
	T1	7×101	0	0	0
	T2	7×101	0	0	0
	T3	7×101	0	0	0
4	C	1×102	6×101	0	0
	T1	7×101	0	0	0
	T2	7×101	0	0	0
	T3	7×101	0	0	0

in all type of PC was $7x10^1$ cfu/g, which was within the allowed limits by Iraqi standard specification for PC. Also the results reveled to that all types of PC were free from psychrophilic bacteria, molds and yeasts and coliform this is due to the heat treatment used during manufacture of PC. While after 4 weeks of storage a slightly increase in the total count bacteria and Psychropilic bacteria in control to reach to $1x10^2$, $6x10^1$ cfu/g, respectively, this number was in the limited scale of Iraqi standard specification for PC, this result consistent with results found by Al-Khalayleh and Taefor (2011); Ali and Al-dahhan (2013). The results indicate that there was no any growth appear for all types of bacteria and mold and yeast in treated PCS this is due to the active compound in buttermilk which act as anti bacterial agent.

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