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Development of Traditional Jordanian Low Sodium Dairy Products

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Abstract

The present study aimed to develop new healthy traditional Jordanian dairy products including pasteurized white cheese and labaneh. This aim was achieved by partial replacement of NaCl with KCl salt at 0%, 50% and 75% in pasteurized white cheese and labaneh during processing. Results shows a slight increase in pH values and a decrease in acidity in cheese kept in brine solution that contained higher KCl compared with control. There is a significant difference in pH and acidity between control and KCl treatments in both pasteurized white cheese and labaneh. No significant difference in moisture of pasteurized white cheese and labaneh at 50% KCl salt replacement but a significant difference was found between control and 75% KCl salt replacement. There is a significant difference in taste and overall acceptability between control and KCl salt replacement starts at 75% KCl, but no significant difference between control and 50% KCl salt replacement was seen for pasteurized white cheese and labaneh for the same two attributes. KCl may give similar organoleptic effect of NaCl on Jordanian pasteurized white cheese and labaneh.

Keywords: dairy products, pasteurized white cheese, labaneh, potassium chloride, low sodium healthy products, Jordan

1. Introduction

According to its use, sodium chloride (NaCl) can be considered as a condiment, ingredient or as a foodstuff. It is composed of approximately 40% sodium and 60% chloride. Sodium is a mineral essential to life that cannot be produced by the human body and thus has to be provided by the diet (Whitney & Rolfes, 2011). Salt is traditionally used as a preservative and is added to some dairy products to improve flavor, and to control enzyme activity and bacterial growth (Guinee & fox, 2004; Doyle & Glass, 2010). However, a high level of NaCl in foods contributes to many health problems such as hypertension, cardiovascular disease, kidney stones, osteoporosis (Fitzgerald & Buchley, 1985). The consumer's concern about sodium in processed foods has increased. The average daily sodium intake by most persons in developed countries 4-5 g (10-12 g of NaCl), this quantity which is 10-35 times greater than the minimum adult requirement (2400 mg) is regarded as excessive, by many of those responsible for public health (Abernethy, 1979; Katsiari et al., 2000).

The World Health Organization (WHO) has recommended that food manufacturers decrease NaCl in their products, to be able to reduce the daily NaCl intake by consumers (WHO, 2007). In the western countries, cheeses contribute to about 20% of the total daily intake of sodium (Guinee, 2004). Therefore, there is a higher demand for NaCl-reduced cheeses.

One responsible technological option to decrease sodium content in some dairy products is to replace sodium chloride with potassium chloride and in this sense sensory and chemical analysis should be performed to assess the products quality compared with conventional products with sodium chloride (low sodium cheese) (Gomes et al., 2011). An excess of dietary intake of KCl has no undesirable effect on individuals with Na induced hypertension (Lemann et al., 1993).

It is well documented that NaCl/KCl mixture has been used successfully in various cheeses without negative effects on cheese quality (Fitzgerald & Buckley, 1985; Reddy & Marth, 1995; Reddy & Marth, 1993a) including feta cheese (Katsiari et al., 1997, 2000), kefalograviera cheese (Katsiari et al. 2001), and Cheddar cheese (Reddy & Marth, 1993b). However, there is no data on the effect of salt reduction on Mediterranean cheeses.

Salt (NaCl) used in the production of several Jordanian dairy products such as labaneh, cheeses, shaneneh (fermented butter milk), and Gameed. Salt is added to labaneh at ratio of 0.9-1%. This addition of salt for labaneh and other dairy products has different benefits including flavor improvement, total soluble solids elevation, and for preservation.

The major cheese type produced in Jordan is the soft white cheese (juben balady) (Haddadin, 2005). It includes two types, boiled and pasteurized. Pasteurized cheese differs from boiled one in that the milk used in its production undergo pasteurization. The pasteurized cheese kept in about 7% salt solution after produced from pasteurized milk without cheese boiling step, whereas, boiled cheese is exposed to the boiling process in 15% salt solution after moulding without pasteurization of milk step; Therefore, the pasteurized cheese shelf life is about one-month maximum compared with 6 months for boiled cheese (Haddad, 2011).

According to the Jordanian standards for soft cheese (JS 246, 2006), soft cheeses are defined as unripened soft cheeses ready to eat directly after processing, and its acidity should not exceed 1.9% as lactic acid and should be kept under refrigeration. In Jordan white cheese is usually produced seasonally from ewes or goat milk, or a combination of both, without addition of a starter culture or salt under unmechanized or artisanal conditions and is handled at various stages of manufacture. The method of production could be summarized in coagulating the milk for 40-60 min by rennet after heating to about 35 °C, then pressing in cheese cloth. The cheese is usually directly consumed after production or used in the production of some Arabian confectioneries such as kunafeh. This soft white cheese has a very limited keeping ability even under refrigeration; various types of microorganisms may enter the cheese during manufacture and subsequent handling (Humeid & Tukan, 1986; Humeid et al., 1990; Yamani et al., 1987).

The objective of the study was developing of new healthy dairy products utilizing traditional Jordanian dairy products by partially replacing NaCl salt with KCl. It also aims to examine the effect of replacing NaCl with KCl on chemical, physical, and organoleptic properties during refrigerated storage of these products.

2. Materials and Methods

2.1 Milk Characterization

Fresh Cow's milk was bought from Jordanian farms in Al-Salt city of Jordan which used to make our dairy products and was analyzed to guarantee its quality. The analysis of raw milk was performed in dairy processing lab of our University using milk analyzer (Milkana^{TM}). The results of the analysis of milk samples were measured in replicates. This milk was used in processing two of the most popular salted dairy products consumed in Jordan (white cheese and labaneh). The study included replacing NaCl by KCl at (0%, 50%, and 75%) to select the best quality and organoleptic properties of cheese and labaneh without undesirable bitterness of KCl. A replacement by 100% KCl salt was excluded as it gives undesirable bitterness in labaneh and pasteurized cheese.

2.2 Processing Steps

2.2.1 Pasteurized White Cheese

Pasteurized white cheese was produced using method of Humeid and Tukan, 1986. Ten kg of raw milk were filtered in a clean white cloth, and then pasteurized at 72 ^{o}C for 15 Second. Rennet was dissolved in small amount of distilled water and added for each Kg of milk and incubated at ambient temperature for 30 min until the milk was coagulated. The curd was cut using knife and pressed in cheese mould containing cheese cloth after reformed and shaped well. The cheese was then cut into square shape pieces (6 × 4 cm) and soaked and preserved in 400 ml jars brine solution of 7% (wt./vol.). The 7% salt added was divided into sodium chloride and potassium chloride in three ratios: 100% NaCl: 0% KCl (1:0); 50% NaCl: 50% KCl (1:1); 25% NaCl and 75% KCl (1:3). The jars then cooled at room temperature for 1 week for equilibrium, the cheese treatments were analyzed physicochemically, microbiologically and sensory.

2.2.2 Labaneh (Strained Yogurt)

Labaneh was produced using Yamani and Abujaber (1994) method. So, first ten kg of milk were used to make yogurt which then converted to labaneh using straining and 1% salt. Three treatments were made using different combinations of (NaCl:KCl) the same as done in pasteurized cheese in which KCl was replaced partially instead

of NaCl alone. These treatments include the following replacement ratios 100% NaCl: 0% KCl (1:0); 50% NaCl: 50% KCl (1:1); 25% NaCl and 75% KCl (1:3). The 3 yogurts of different salt treatments were converted to labaneh by straining in white cloth for whey expulsion overnight. The labaneh was ready for testing and sensory evaluation. The three treatments of labaneh were analyzed physicochemically, microbiologically and sensory.

2.3 Approximate Analysis

Approximate analysis was done according to Hooi et al. (2004). Two replicates were made for each sample. The following tests were executed: Moisture, pH, titratable acidity (lactic acid%), fat by Gerber, ash, and protein by kjldahl method.

2.4 Microbiological Tests

Sample homogenate was prepared using 25 g of cheese and labaneh samples and buffered peptone water.

2.4.1 Coliform Count

Coliform count was performed according to Davidson et al. (2004). Violet red bile Agar (Oxoid) was prepared and sterilized and pour plate method was used to count coliform bacteria in cheese and labaneh samples. The dishes were incubated at 32±1 ^{o}C for 48±3 h. The number was calculated and expressed as CFU/ml.

2.4.2 Yeast and Mould Count

Yeast and mould count was performed according to Frank and Yousef (2004). Acidified Potato dextrose agar (Oxoid) was prepared and sterilized and pour plate method was used to count the yeast and mould. The dishes were incubated at 25 ^{o}C or for 5days. The number was calculated and expressed as CFU/ ml.

2.5 Sensory Evaluation

Cheese and labaneh samples were placed on shallow dishes. They were coded with random numbers and served in identical presentation style. Water and bread slices were served in order to change the mouth feel, and as neutralizing agent between samples. The tests were conducted in a sensory evaluation laboratory of the department of nutrition and food processing. Thirty panelists were participated in evaluation; those including 15 males and 15 females. Each panelist evaluated all samples of white cheese and labaneh at different replacement ratios of KCl (0%, 50%, and 75%). Hedonic scale for points from 9 to 1 of preference test was used for evaluating sensory and organoleptic properties of different dairy product samples. Parameters of appearance, smell, consistency, taste, and overall acceptability were assessed through the test.

2.6 Statistical Analysis

The data obtained were subjected to SAS program version 9.2. ANOVA using F test and t test (LSD) was performed. The results were considered statistically significant and non-significant when the P values were < 0.05 and more than 0.05, respectively.

3. Results and Discussion

3.1 Raw Milk Analysis

The results of the analysis of raw milk samples measured in replicates were calculated as averages in Table 1. The results were conformed to the Jordanian standard of raw milk (JS 4, 2003).

Table 1. The approximate analysis of fresh milk used in a production of low sodium dairy products.

Analysis	Result
Fat	4.1%
Density	1.031%
Lactose	4.52%
Solid non fat	8.29%
Protein	3.17%
Water added	0%
Temperature	17.6 ^{o}C
Freezing point	-0.578 ^{o}C
Ash	0.6
PH	6.52

3.2 Physical and Chemical Results

The results of physical and chemical tests including pH, acidity, moisture, protein, fat, ash and carbohydrates (by difference) in white cheese and labaneh in three different proportions of KCl salt were shown in Table 2.

3.2.1 pH & Titratable Acidity

pH and titratable acidity of pasteurized white cheese and labaneh samples of three different replacement concentrations of KCl instead of NaCl (0%, 50%, and 75%) were shown in Table 2. A pH of pasteurized white cheese was ranged between 6.2 and 6.8 with an average 6.6. The lowest pH was in control whereas the highest was in 50% and 75% KCl salt replacement cheese. A pH of processed labaneh samples were ranged between 3.6 and 4.4 with an average of 3.9. The lowest pH was seen in 50% replacement KCl labaneh whereas the highest was in 75% KCl salt replacement labaneh. These results agree with other results obtained by other researchers (Ayyash & Shah, 2010).

Acidity of pasteurized white cheese was ranged between 0.31% and 0.41% with an average 0.36%. The lowest acidity was in 75% KCl salt replacement cheese whereas the highest was in control cheese. Acidity of labaneh was ranged between 1.30 and 1.56 with an average 1.40. The lowest acidity was for 75% KCl salt replacement labaneh whereas the highest was for control labaneh. It was noticed that there was a highly significant difference in pH and acidity ($P < 0.0001$) between the samples. There is a significant difference in pH and acidity between control and KCl treatment in both pasteurized white cheese and labaneh. Our results of acidity were agreed with each of Lindsay et al. (1982); Fitzgeralld and Buckley (1985); Katasiari et al. (1998); Karagozlu et al. (2008); Johnson et al. (2009); Gomes et al. (2011), who have been reported that cheeses containing KCl having less acidity, more bitter flavor and softer body.

Table 2. The averages of the approximate analysis of low sodium pasteurized white cheese and labaneh

Analysis	Pasteurized white cheese			Labaneh		
	C	50% P, 50% S	75% P, 25% S	C	50% P, 50% S	75% P, 25% S
pH	6.2^{a}	6.8^{b}	6.7^{b}	3.7^{a}	3.6^{a}	4.4^{b}
Titratable Acidity% L.A.	0.41^{a}	0.36^{b}	0.31^{c}	1.56^{a}	1.35^{b}	1.30^{b}
Moisture	46^{a}	46.7^{a}	47.9^{b}	65.7^{a}	65.31^{ab}	64.3^{b}
Protein	16.3^{a}	16.4^{a}	16.3^{a}	12.6^{a}	12.4^{b}	12.7^{a}
Fat	23.7^{a}	24.2^{b}	22.1^{c}	13.6^{a}	13.9^{a}	14.7^{b}
Carbs	5.6^{a}	4.5^{b}	5.5^{a}	6.4^{a}	6.6^{ab}	6.6^{b}
Ash	8.4^{a}	8.2^{b}	8.2^{c}	1.6^{a}	1.8^{b}	1.7^{ab}

Note. C: Control (0% KCl, 100% NaCl); P: KCl; S: NaCl. Data are presented as the mean ± SD. For each parameter, values with the same letter are not significantly different as determined by $LSD_{0.05}$ test.

3.2.2 Moisture Content

Moisture content of pasteurized white cheese was ranged between 46.0 and 47.9 for control and 75% KCl salt replacement respectively, with an average 46.9. Moisture content of labaneh samples was ranged between 64.3 and 65.7 for 75% KCl salt replacement and control respectively, with an average of 65.1. No significant difference in moisture of pasteurized white cheese and labaneh at 50% KCl salt replacement but a significant difference found between control and 75% KCl salt replacement.

3.2.3 Ash Content

Ash content of pasteurized white cheese was ranged between 8.2% and 8.4% with an average 8.3% of the dried weight. The lowest ash was in 75% KCl salt replacement cheese whereas the highest was in control cheese sample. Ash content of labaneh was ranged between 1.6% and 1.8% with an average 1.7%. The lowest ash was in control labaneh whereas the highest in 50% KCl salt replacement labaneh.

3.2.4 Carbohydrate Content

Carbohydrate content in pasteurized white cheese was ranged between 4.5 and 5.6 with an average 5.2. The lowest carbohydrate was in 50% KCl salt replacement cheese whereas the highest was in control cheese.

Carbohydrate content in labaneh was ranged between 6.4 and 6.6 with an average 6.5. The lowest carbohydrate content was in control labaneh sample whereas the highest in 75% KCl salt replacement labaneh.

3.2.5 Protein Content

Protein content in pasteurized white cheese was ranged between 16.3 and 16.4 with an average 16.4. The lowest protein was in control cheese sample, whereas the highest was in 50% KCl salt replacement cheese. Protein content in labaneh was ranged between 12.4 and 12.7 with an average 12.6. The lowest protein content was in 50% KCl salt replacement labaneh whereas the highest in 75% KCl salt replacement labaneh.

3.2.6 Fat Content

Fat content in pasteurized white cheese was ranged between 22.1% and 24.2% with an average 23.3%. The lowest fat content was in 75% KCl salt replacement cheese, whereas the highest was in 50% KCl salt replacement cheese. Fat content in labaneh was ranged between 13.6% and 14.7% with an average 14.1%. The lowest fat content was in control sample of labaneh, whereas the highest was in 75% KCl salt replacement labaneh.

3.3 Microbiological Count

Table 3 shows the averages of microbiological tests of low sodium pasteurized white cheese and labaneh samples. Table 3 shows the averages of $\log_{10}$ of coliform and yeast and mold count (Y&M) of three replacement ratios of KCl for each of pasteurized white cheese and labaneh.

Table 3. Microbiological tests for low sodium pasteurized white cheese and labaneh samples

Analysis	Pasteurized soft white cheese			Labaneh		
	C	50% P, 50% S	75% P, 25% S	C	50% P, 50% S	75% P, 25% S
Coliform	< 10	< 10	< 10	< 10	< 10	< 10
				< 10	< 10	< 10
Yeast and mould	< 10	< 10	< 10	2.1×10^2	1.6×10^2	2.1×10^2
				2.3×10^2	0.8×10^2	2×10^2

Note. C: Control (0% KCl, 100% NaCl); P: KCL; S: NaCl.

3.3.1 Pasteurized White Cheese

Total coliform count and the count of yeast and mold for pasteurized white cheese was less than 10 CFU/g, so all cheese treatments were acceptable from microbiological requirements according to Jordanian standards of pasteurized white cheese (JS 246, 2006).

3.3.2 Labaneh

Total coliform counts in labaneh were less than 10 CFU/g. The yeast and mold counts in labaneh were ranged between $\log_{10}$ of 2.1 and 2.3 respectively, with an average of 2.2. The highest count was seen in control whereas the lowest was seen in 50% KCl. It was noticed that there was no significant difference ($p > 0.05$) in yeast and mold counts between the Labaneh samples. All these counts of coliform and yeast and mould were met the Jordanian standard of labaneh (JS 108, 2003).

3.4 Sensory Evaluations

From the table of the sensory evaluation (Table 4) we can find that all cheeses and labaneh with different concentrations of KCl were acceptable from different organoleptic properties except the white cheese of KCl 75% replacement of the salt (slightly acceptable in average). The best organoleptic properties for cheese and labaneh was for control (NaCl 100%) and KCl 50% replacement of salt, respectively, whereas the lowest was with KCl 75% replacement of salt for both cheese and labaneh. There is a significant difference in taste and overall acceptability between control and KCl salt replacement starts at 75% KCl, but no significant difference between control and 50% KCl salt replacement was seen for pasteurized white cheese and labaneh for the same two attributes. KCl may give similar organoleptic effect of NaCl on Jordanian pasteurized white cheese and labaneh. These findings on Jordanian cheese are in accordance with those of Katsiari et al. (1997, 1998), and Reddy and Marth (1993a, 1993b) for feta, kefalograviera, and chedder cheeses, respectively. They also met with the results of Ayyash et al. (2011a, 2011b) on halloumi and nabulsi cheeses, and Ayyash et al. (2012) of low moisture mozzarella cheese (LMMC).

Table 4. Averages of the sensory evaluation values of low sodium pasteurized white cheese and Labaneh samples

Analysis	Pasteurized white cheese			Labaneh			Average
	C	50% P, 50% S	75% P, 25% S	C	50% P, 50% S	75% P, 25% S	75% P, 25% S
Appearance	8.2^{ab}	8.0^{a}	8.7^{b}	8.5^{a}	8.3^{ab}	8.0^{b}	8.0
Smell	8.3^{a}	8.0^{a}	8.0^{a}	8.1^{a}	8.3^{a}	8.3^{a}	8.3
Taste	8.0^{a}	7.9^{a}	4.0^{b}	8.2^{a}	8.5^{a}	7.5^{b}	7.5
Consistency	8.0^{a}	7.6^{a}	7.7^{a}	8.2^{a}	8.1^{a}	7.3^{b}	7.3
Overall acceptability	7.8^{a}	8.0^{a}	3.5^{b}	8.2^{a}	8.1^{a}	6.1^{b}	6.1
Average	8.0	7.9	6.4	8.2	8.3	7.4	7.4

Note. C: Control (0% KCl, 100% NaCl), P: KCL, S: NaCl. Data are presented as the mean ± SD. For each parameter, values with the same letter are not significantly different as determined by $LSD_{0.05}$ test.

4. Conclusion

It was concluded that substitution with KCl was acceptable specifically for taste and overall acceptability till 50% KCl salt replacement in Jordanian pasteurized white cheese and labaneh. This treatment did not affect the microbial growth, acidity or the proximate analysis of these products and they were remained within the Jordanian standards of white cheese and labaneh. Hence KCl could be used as an alternative substitute to NaCl to develop the processing of Jordanian pasteurized white cheese and labaneh.

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