Biointerface Research in Applied Chemistry
Platinum Open Access Journal (ISSN: 2069-5837)

Article

Volume 10, Issue 5, 2020, 6112 - 6118

https://doi.org/10.33263/BRIAC105.61126118

Development of Low Sodium Table Butter via Partial Replacement of Sodium Chloride with Potassium Chloride

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Received: 10.04.2020; Revised: 1.05.2020; Accepted: 1.05.2020; Published: 3.05.2020

Abstract: Butter is a dairy product that is trendy among consumers because of its uncommon taste and aroma. Table butter involves the addition of common salt (NaCl) during its processing. Thus, its daily consumption leads to a high intake of sodium which is not good for health. Excessive sodium level in daily diet is associated with an increase in blood pressure of consumers which leads to certain heart disease including heart-stroke, cardiac-collapse and kidney disease. Hence, in the present study was designed to reduce the sodium content in the table butter via replacement of sodium chloride with potassium chloride. Potassium chloride not only replaces sodium but also provides the lowering of blood pressure (B.P.) in high B.P. patients. The present study reveals that low sodium butter made with potassium chloride is acceptable to consumer's w.r.t. important sensory attributes. KCl in table butter can replace up to 30% of sodium chloride (NaCl) with acceptable sensory characteristics.

Keywords: Butter; table salt; low-sodium; dairy product; sensory acceptability.

1. Introduction

Milk is considered a very necessary and fundamental source of nutrients [1]. Liquid milk and products prepared from milk are very much liked by consumers of all ages [2-3]. Many of the fat-rich dairy products (including butter) are used as fundamental ingredients in various dishes or products [4-8]. Recent trends in dairy and food research suggest that scientists are more targeted to develop dairy and food products with some value addition and functional application [9-21]. Butter is one of the main products of dairy industry which contribute good share in dairy products market because of its appealing taste and aroma. Butter is prepared from ripened and chilled cream via churning process. Butter grains are separated from buttermilk during churning process and are subjected to washing and working operations to get the finished butter. Depending on the addition of table salt in butter making; butter can be categorized into two types: white butter & table butter. White butter is the type of butter that is prepared from the cream without the addition of table salt (NaCl) whereas table butter involves addition of table salt (NaCl) at the rate of 2-3% in its production process. Sodium chloride (NaCl) is an important and crucial ingredient of table butter which is mainly responsible for its characteristic flavor and it also controls microbial growth in butter. It gets solubilized in the water content present in the table butter and distributed throughout the butter body for uniform taste via working of butter. It can cause problems if the working of butter is not proper as it can cause precipitation of curd present in butter. Table salt can also decrease the water-holding ability of table butter as it aids in the formation of big water droplets which leads to leaky body of table butter. Hence, proper working of table butter is required to prevent the leakage or syneresis of water from table butter.

In human body, sodium perform crucial role in controlling the osmotic balance. It also helps in maintaining optimum functions of nerves. If a person increases the levels of sodium in his/her daily diet it will lead to an increase in blood pressure which further may enormously enhance the danger of heart-stroke, cardiac-collapse and certain diseases related to kidneys. Reduction in the sodium content of diet is considered to have potential influence on reduction of blood pressure of selected human population. That is why the requirements or market demand for low-sodium dairy and food products are rising day-by-day to decrease the levels of sodium intake in daily diet [22-23]. Addition of up to 3% sodium chloride is allowed in table butter making. Generally 2.5% NaCl is added in table butter by butter manufacturers. A high intake of sodium could lead to an increase in blood pressure. There are several ways for reducing sodium chloride content in food products. One of the methods is a replacement of sodium chloride in food products with other chemicals that exhibit identical saltiness on consumption of these food products. Partial substitution of sodium chloride with potassium chloride (KCl) is an easy and preferable method for reducing sodium levels in dairy products [24]. It has been tried in various types of cheeses. Potassium chloride cannot completely replace NaCl in dairy products because it is associated with some defects in end products such as bitterness, metallic flavor and some textural variations [25]. Hence, only 30 % of sodium chloride replacement with potassium chloride has been recommended. Above this level, it produces prominent undesirable flavor in the product which is not accepted by consumers. Hence it is recommended to partially substitute NaCl with KCl and added to the products in blended form [22]. No research study has been reported in the literature related to the development of low sodium butter by replacement of NaCl with KCl till date. Hence, the present research study was taken up to develop low sodium butter by partial replacement of common salt and to characterize physicochemical properties of low-sodium butter.

2. Materials and Methods

2.1. Materials.

Cream, skim milk, table salt and annatto color samples were made available by Dudhsagar Dairy, Mehsana, and rest of the chemical used in the analysis were of analytical grade and were procured from Sigma Chemicals (India).

2.2 Preparation of control table butter.

The control butter sample was prepared using cream standardized for 40% fat content. This standardized cream was then subjected to pasteurization at 80°C for 25 seconds. This pasteurized cream was then cooled and stored at 5 °C for 12 h, and churning of cream was then carried out at 8 °C in planetary stand mixer. After phase inversion and formation of butter grains, buttermilk was separated, and the grains were washed with pasteurized chilled water (8 °C). After removal of wash water, 2.5 % refined table salt (sodium chloride) was added, followed by kneading for about 8 min for joining butter grains and eliminating the remaining water. The required quantity of water and color was added to butter and the final moisture content of 16% was achieved. This was referred to as ‘control butter’ (T_1) in this study.

2.3. Preparation of low sodium table butter.

For the preparation of low sodium butter samples, the sodium chloride was replaced with potassium chloride at the rate of 10%, 20%, 30% and 40% levels on weight basis and was designated as T_2, T_3, T_4 & T_5 butter samples, respectively. The quantity of annatto color added to butter samples was similar to control butter. The butter samples were placed in plastic containers and stored under refrigeration (10 °C) for further analysis.

2.4. Analysis of control and low sodium butter.

Control butter sample and low sodium butter samples were analyzed for moisture content, salt content, curd/SNF content and fat content using AOAC standard methods of analysis (1995). Color of the samples was measured using colorimeter (Konica Minolta).

2.5. Sensory Evaluation.

Control table butter and low-sodium table butter samples were also evaluated for their sensory characteristics using 9-points hedonic scale. Sensory evaluation was conducted by twenty five sensory judges who were selected on the basis of knowledge and previous experiences of sensory evaluation of butter samples. The sensory attributes selected for scoring were color and appearance of butter, flavor of butter, body and texture of butter and overall acceptability of butter samples. Refrigerated butter samples having approximately 10°C temperature were given to sensory judges in irregular order. Containers used for serving butter samples to sensory panelists were also coded for unbiased sensory scores. Necessary things such as mouth-rinse water and spitting pan were also provided to sensory judges during the evaluation sessions.

3. Results and Discussion

3.1. Physico-chemical Analysis.

Results obtained from the analysis of control and low sodium butter reveals that there were no significant differences between the values obtained for moisture content, salt content, curd/SNF content, fat content and color values of control and low sodium butter (Table 1).

Table 1. Analysis of control and low-sodium butter.

Butter Samples	**T_1**	**T_2**	**T_3**	**T_4**	**T_5**
Moisture %	15.91	16.32	16.35	16.31	16.16
Salt %	2.25	2.27	2.30	2.31	2.29
Curd %	1.46	1.47	1.51	1.51	1.51
Fat %	80.13	79.90	79.80	79.95	80.05
Color (Yellowness	48.00	48.35	48.30	48.35	48.45

Note: Results are average values of determinations made in triplicate
T_1- control butter; **T_2**- butter with 10% NaCl replacement;
T_3- butter with 20% NaCl replacement;
T_4- butter with 30% NaCl replacement;
T_5 - butter with 40% NaCl replacement

The moisture of the butter samples ranged from 15.91 to 16.35%. Control butter sample exhibited the lowest moisture content i.e. 15.91%. All the butter samples having NaCl replaced with KCl exhibited slightly more moisture content as compared to control butter sample. Salt content was determined using titration with $AgNo_3$ solution which only reacts with chloride and reveals the salt content of butter samples. Salt content of butter samples ranged from 2.25%

to 2.31%. T_4 butter sample was having the highest salt content. Curd content of all the butter samples was almost similar and were ranged from 1.46% to 1.51%. Curd content of butter represents the SNF content in the butter. Fat content of butter samples ranged from 79.80% to 80.13%. Replacement of NaCl with KCl did not affect the color of the butter samples however butter samples containing KCl showed more yellowness with respect to control butter sample (Figure 1).

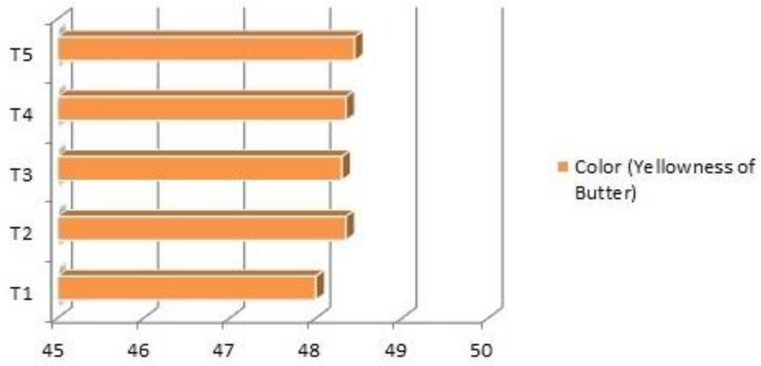

Figure 1. Effect of NaCl replacement with KCl on the color (yellowness) of butter samples.

3.2. Sensory Evaluation.

Sensory properties are very significant from consumer view point [26-27].In contrast to the physicochemical analysis of control and low sodium butter, sensory evaluation results showed significant differences among sensory attributes. It reveals that the replacement of sodium chloride with potassium chloride in table butter influences sensory parameters (Table 2).

Table 2. Sensory evaluation of control and low sodium butter.

Butter Samples	T_1	T_2	T_3	T_4	T_5
Color & Appearance	7.16	7.16	7.12	7.10	7.03
Body and Texture	6.83	6.83	6.83	6.67	6.64
Flavor	6.56	6.42	6.39	6.27	5.67
Overall Acceptability	6.79	6.78	6.73	6.72	6.32

Note: Results are average values of scores obtained from 25 sensory panelists
T_1- control butter; **T_2**- butter with 10% NaCl replacement;
T_3- butter with 20% NaCl replacement;
T_4- butter with 30% NaCl replacement;
T_5 - butter with 40% NaCl replacement

Scores for color and appearance of butter samples were ranged from 7.03 to 7.16. Butter samples with 10% replacement showed similar scores for color and appearance as compared to control (Figure 2). The lowest score for color and appearance was observed for T_5 sample. However, the change was very slight. Sensory scores for body and texture was the same for control, T_1 and T_2 butter samples. However, T_4 and T_5 butter samples showed somewhat lower scores as compared to control (Figure 2). The main difference in sensory score was observed for flavor attribute of butter sample which mainly describes the acceptability of the low-sodium table butter. The sensory scores for flavor of butter sample decreased with an increase in the replacement level of NaCl with KCl (Figure 3).

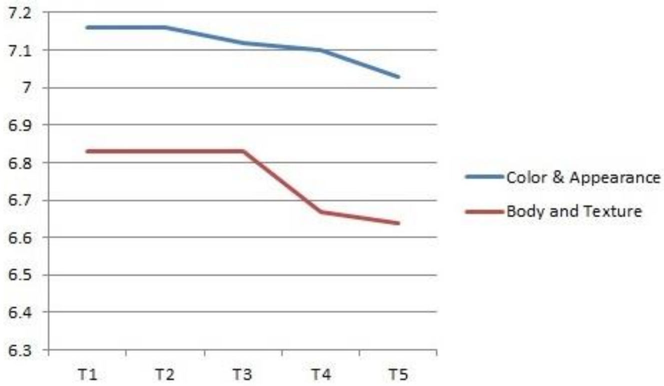

Figure 2. Effect of NaCl replacement with KCl on the color & appearance and body & texture of butter samples.

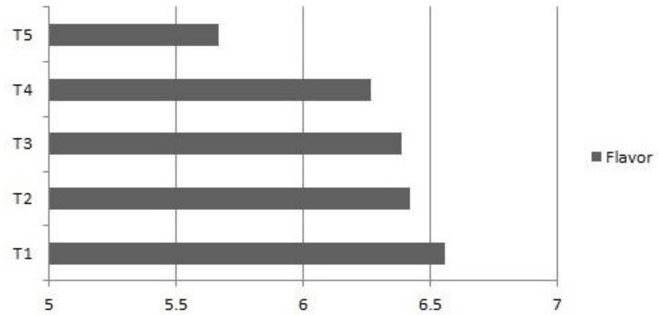

Figure 3. Effect of NaCl replacement with KCl on the flavor of butter samples.

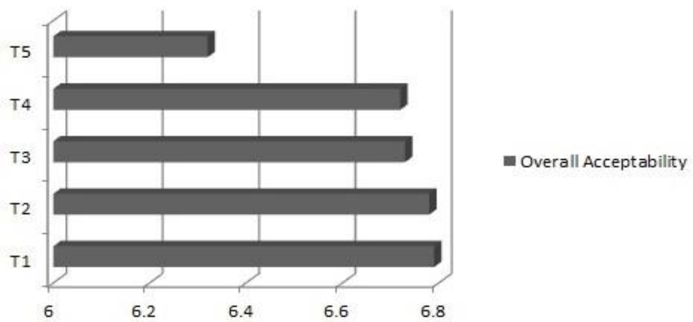

Figure 4. Effect of NaCl replacement with KCl on the overall acceptability of butter samples.

Control butter sample showed the highest flavor score whereas T_5 butter samples exhibited the lowest score for flavor. Results reveal that NaCl replacement up to 30% (T_4 Sample) was accepted by sensory panelists and beyond that level bitter metallic flavor was reported by the sensory panelists. Overall acceptability of the butter samples ranged from 6.79 to 6.32. Control butter sample was the most accepted sample whereas T_5 butter sample was the least accepted butter sample. Overall acceptability results also suggest that T_4 Sample was acceptable by consumer with a little lower score as compared to control butter sample with no replacement of NaCl with KCl (Figure 4).

4. Conclusions

It is concluded from the research that the sodium chloride in table butter can be replaced with potassium chloride at 20-30% level. However, some panelists observe slight bitter and pronounced salty flavor in the butter samples containing potassium chloride higher than 30% concentration. Beyond this concentration the butter samples show poor acceptability. It is recommended that some flavoring compounds may be added to low-sodium butter containing potassium chloride to mask this bitter and pronounced salty flavor at a higher levels of KCl. Hence, it is concluded that low-sodium table butter can be produced with partial replacement of sodium chloride with potassium chloride without sacrificing the organoleptic properties of the table butter.

Funding

This research received no external funding.

Acknowledgments

Authors acknowledge Executive Director of Mansinhbhai Institute of Dairy & Food Technology, Mehsana for providing facilities for this research work & Managing Director of Dudhsagar Dairy, Mehsana for providing samples for this study.

Conflicts of Interest

The authors declare no conflict of interest.

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