“DEVELOPMENT OF LOW SODIUM CONTENT BREAD BY PARTIAL SUBSTITUTION OF TABLE SALT WITH SALT SUBSTITUTES AND ANALYSIS OF ITS CONSUMER ACCEPTANCE”

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Submitted to the Department of Nutrition and Food Engineering in the partial fulfillment of B.Sc. in Nutrition and Food Engineering

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APPROVAL

This Project titled "**development of low sodium content bread by partial substitution of table salt with salt substitutes and analysis of its consumer acceptance**, submitted by Anish Kumar Das Joy to the Department of Nutrition and Food Engineering, Daffodil International University, has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. In Nutrition and Food Engineering and approved as to its style and contents. The presentation has been held on

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I hereby declare that,” development of low sodium content bread by partial substitution of table salt with salt substitutes and analysis of its consumer acceptance” this project has been done under the supervision of **Mr. Md. Shamsur Rahman, Lecturer, Department of NFE,** Daffodil International University. I also declare that neither this project nor any part of this project has been submitted elsewhere for award of any degree or diploma.

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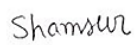

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ABSTRACT

Bread is a versatile and widely consumed food item that finds its place in various dishes and cuisines worldwide. These breads are typically small and round in shape, offering a soft and slightly sweet texture. The ingredients used to make bread can vary, but commonly include wheat flour, yeast, sugar, and butter. This allows for a range of bread variations, such as hamburger buns, hot dog buns, and sweet breads like cinnamon rolls.

The versatility and ease of making bread contribute to its popularity. Bread can be enjoyed on its own as a simple snack, or it can serve as a base for creating delicious sandwiches, burgers, and other culinary creations. Due to its widespread use and significance, a study was undertaken with the aim of developing and analyzing the proximate composition and sensory perception of bread.

The study successfully developed the bread product under investigation. According to the United States Department of Agriculture (USDA), a 100g serving of bread contains approximately 256 kcal, 4% fat, 26g carbohydrates, and 9.3g protein. To evaluate the sensory aspects of the bread, 30 untrained participants took part in a sensory analysis. These participants were students from Daffodil International University.

During the sensory analysis, the participants used a 9-point hedonic scale to assess the bread based on its color, flavor, texture, and overall acceptability. This evaluation process aimed to gauge the sensory perception and overall quality of the bread product. By involving a diverse group of participants, the study sought to obtain a comprehensive understanding of how the bread was perceived and received by individuals with varied backgrounds and preferences.

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CHAPTER 1: INTRODUCTION

1. Introduction

Lately, there has been considerable attention given to the impact of sodium chloride, commonly known as table salt, on the human diet. Extensive reports indicate that consuming excessive amounts of salt on a daily basis lead to hypertension, various cardiovascular disorders, and additional health issues. (Elliott et al., 1996; du Cailar et al., 2002). This leads to a significant burden on healthcare systems and has adverse effects on society. The significance of reducing sodium chloride in the diet has been emphasized through recent legislation introduced by the European Union (European Parliament and the Council of the EU, 2006), Canada (Canadian Food Inspection Agency, 2008), and the United States of America (FDA, 2005). These regulations permit the use of nutrition and health claims for food products with reduced sodium content. Recent research has highlighted that the majority of processed foods contain substantial amounts of sodium added during the manufacturing process, resulting in excessive sodium consumption. (He et al., 2001). Bread is classed as a staple food worldwide and has been found to be a major source of dietary sodium (Greenfield et al., 1984; James et al., 1987), being responsible for an average of 30% of the daily salt intake (Girgis et al., 2003). Nevertheless, decreasing the salt content in food products affects several essential quality aspects that greatly impact consumer satisfaction and industrial feasibility. These factors encompass the distinctive salty taste present in foods and the ability of salt to enhance the overall flavor profile by complementing other taste components. Additionally, salt acts as a preservative, inhibiting microbial growth through the reduction of water activity. It is crucial not to overlook the influence of salt on the handling and processing characteristics of food as well. (Hutton, 2002). Salt plays a significant role throughout the process of bread manufacturing, exerting a substantial impact on both the production stages and the ultimate attributes of the final product. (Kilcast and Angus, 2007).

Sodium chloride (NaCl), also referred to as salt or table salt, is extensively utilized in the production of food. (Man, 2007). Salt is formed through the ionic bonding of sodium and chlorine, resulting in an compound. When consuming 2.54 grams of salt, approximately 1 gram of sodium is obtained. Pure salt is a transparent, colorless, hygroscopic, and crystalline substance, possessing a specific gravity of 2.165. (Man, 2007). For countless millennia, salt served as a widely employed method for preserving various types of food. However, with the advent of freezers and refrigerators in the past century, the significance of salt as a preservative diminished, leading to a decline in its usage. In more recent times, there has been a notable increase in daily salt intake, primarily due to the growing consumption of processed foods, meals from canteens, and fast food. The excessive consumption of salt has been linked to hypertension, a condition that significantly raises the likelihood of developing cardiovascular diseases such as heart attacks and strokes. (Gibson et al., 2000; AIB International, 2008).

Following the realization that roughly half of the deaths attributed to chronic diseases could be linked to cardiovascular diseases, the World Health Organization (WHO) and the Food and Agriculture Organization (FAO) emphasized the importance of reducing daily sodium intake in 2003. Numerous studies have extensively reported the association between salt and hypertension, as well as high blood pressure. These studies encompass various epidemiological investigations and research. (Elliott et al., 1996), migratory (Poulter et al., 1990), intervention (Forte et al., 1989), treatment (He and MacGregor, 2002), animal (Denton et al., 1995), and genetic studies (Lifton, 1996). Increased consumption of salt has also been associated with other diseases such as albuminuria. a (du Cailar et al., 2002; Verhave et al., 2004), stomach cancer (Beevers et al., 2004; Tsugane et al., 2004), asthma (Carey et al., 1993; Mickleborough et al., 2005), and kidney diseases (Matkovic et al., 1995). Hence, the obvious need of salt reduction is urgent and undisputable from a health point of view. Recent reports indicate that a mere 13% of the population in the UK is aware of the significant contribution made by bread and other cereal products to their daily salt intake (Food Standard Agency and Food & Drink Innovation Network, 2009; Angus, 2007). Lowering the salt content in cereal products alone would already result in a noteworthy reduction in daily salt intake, consequently having a substantial impact on reducing the occurrences of strokes, heart attacks, and heart failure. (He et al., 2007). Hence, collaborations between responsible organizations such as food industries, governments, and research institutions prove to be advantageous.

1.2 Bread Nutrition fact

Bread is a different type of dessert and healthy food for children and adults of all kinds. This phrase conveys the hope that many children will bear to the family.

Table 1 Chemical composition of Bread

Ingredients	gm Daily Value
Protein	1.98 ± 0.11%
Fat	8.03 ± 0.40%
Ash	1.45 ± 0.03%
Fiber	0.81 ± 0.13%
Carbohydrate	66.27 ± 0.20%
Moisture	21.46 ± 0.11%

(Hiral Patel, July 18, 2022)

1.3 Objective of this study

1. Develop low sodium content bread by partial substitution with sodium salt
2. Evaluate sensory acceptance of reformulated bread

CHAPTER 2: MATERIALS AND METHODS

2.1 Preparation of Bread

2.1.1 Raw Materials

Commercially available wheat flour (Maida), Sugar, Butter, sugar, powdered milk , Yeast collect from the local market of Ashulia and specially $MgCl_2$ and NaCl Salt form the laboratory of Dept. of NFE , Daffodil International University.

2.1.2 Manufacturing of dough for Bread

All the ingredients taken in a bowl and mixed well. After mixing the all ingredients the dough was prepared.

Table 2 Formulations od Bread

Ingredient Name	T1	T2	T3	T4
Flour	250 gm	250 gm	250 gm	250 gm
Sugar	20 gm	20 gm	20 gm	20 gm
Water	180 ml	180 ml	180 ml	180 ml
Oil	10 ml	10 ml	10 ml	10 ml
Powder Milk	20 gm	20 gm	20 gm	20 gm
Yeast	7 gm	7 gm	7 gm	7 gm
Salt	3gm (100% NaCl)	2.7gm (NaCl), 0.3 ($MgCl_2$)	2.4gm (NaCl), (0.6gm $MgCl_2$)	2.1gm (NaCl), 0.9gm ($MgCl_2$)
Butter	50gm	50gm	50gm	50gm

T1= Bread (100 % NaCl), T2= Bread (90% NaCl+10% $MgCl_2$), T3= Bread (80% NaCl+20% $MgCl_2$), T4= Bread (70% NaCl+30 % $MgCl_2$)

2.1.3 Procedure for manufacturing of Bread

The ingredients for each Bread were weighed accurately. At first flour, butter (liquid form by heating), sugar, powdered milk. Instant yeast, salt is mixed together. Next 180 ml water added into the mixture. After making the dough it was putted into the oven at 35° C for 1 hour for resting. After then taken out the dough and knead it. The putted again for 2nd phase of resting approx. 30 min. Before putting into the oven, given the shape and did butter brush. Finally putted it into the oven at 220°C for cooling for 15-20 min to do bake. When the baking is done, put it out and let it cool

2.2 Proximate analysis of bread

2.2.1 Estimation of protein

The Kjeldhal method consists of 3 steps. They are as follows
1. Digestion
2. Distillation
3. Titration

Digestion of sample

Around 0.4gm of the sample was taken into a digestion flask and 10 ml of H_2SO_4 was added to it. Then 2gm of digestion mixture was taken into the Kjeldahl flask. The flask is then heated in a Kjeldahl digestion chamber at a temperature of 40°C at the beginning. Letter the temperature increases to 65°C and heated for 4-5 hours or until the solution becomes crystal green color. Then the flasks were cooled and transferred to a volumetric flask and made the volume of 100 ml with distilled water.

Figure 1: digestion flask

Distillation

10 ml of solution was taken into a distillation flask. Then added 150 ml of distilled water and 10 ml of 40% NaOH into the flask. Heated the flask at 60-75 degrees C temperatures for 30 minutes. Collect it by trapping flasks with 10 ml of 0.1m HCL solutions and 1-2 drops of methyl red solution. After completing the distillation, the trapping flask was removed and titrated with NaOH.

Figure 2 distillation flask

Titration

Titrate the distillate with 0.1N of NaOH until color changes to light yellow

Figure-3 the End point of titration with light yellow color

Calculation

Calculated the percentage of crude protein by the following formula.

Protein%={(B-S) ×1.4×10×5.95×0.1} ÷sample weight

Where,

Titration value of blank = B

Titration value of sample = S

Value of liquid sample =10ml

2.2.2 Determination of Ash

Ash refers to the inorganic residue remaining after the ignition of organic matter in a food sample. Ash was measured by following the AOAC method.

Apparatus

1. Crucible lid
2. Balance meter
3. Spatula
4. Electric muffle furnace
5. Desiccator
6. Hand gloves.

Procedure

1. Weight the empty crucible with lid by measuring balance.
2. Place around 2-gram samples into the crucible and close by lid.
3. Place the close crucible in the electric muffle furnace at 600°C for 6 hours.
4. After 6 hours of ignition the crucible has taken out and cooled into a desiccator.
5. After cooling the weight of the crucible was measured again.

Figure 4 Electric Muffle Furnace

Calculation

Ash%=Mass of Ash ÷Mass of sample ×100

2.2.3 Determination of moisture content

A moisture analyzer was used to measure the fat.

Apparatus

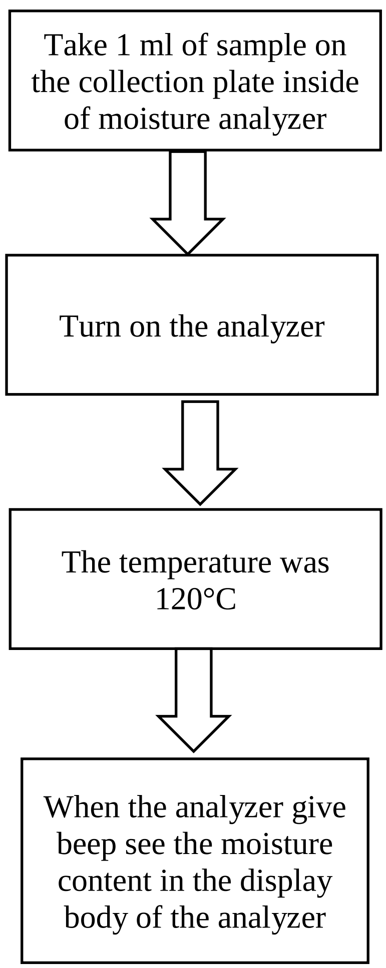
Moisture analyzer.

Reagent

No Reagent

Figure 5 moisture analyzer

Procedure



Flow chart of fat test process

2.3. Sensory analysis of Bread

Sensory evaluation of the Bread experiment was conducted after two hours of preparation by 30 participants according to the method of Lawless Heymann (1998). The two samples were labeled with three-digit numbers 351 and 373 and presented to participants. These samples, one with added $MgCl_2$ and another without $MgCl_2$, were evaluated for color, flavor, texture, and overall acceptance by 30 testers. The participants were selected from the teachers, students of the Department of Nutrition & Food Engineering, Daffodil International University.

For statistical analysis of sensory data, a 1-9 point hedonic rating test was used to assess the degree of acceptability of Bread containing $MgCl_2$ and without $MgCl_2$ to measure the different levels. The hedonic scale was in the following sequence like extremely-9, like very much-8, like moderately-7, like slightly-6, neither like nor dislike-5, dislike slightly-4, dislike moderately-3, dislike very much-2, dislike extremely-1 were evaluated.

Duo-trio test also performed with different variant of bread with 30 panelist to find out whether any different of taste exist among different formulated bread.

CHAPTER 3: RESULT AND DISCUSSION

3. Result and Discussion

3.1 Proximate composition Bread

Table 3 Composition of bread in terms of its constituents

Parameters	T1	T2	T3	T4
Moisture%	5.6 ±0.15[a]	5.46 ±0.15[a]	5.35 ±0.14[a]	5.51 ±0.16[a]
Fat%	8.03 ±0.40[a]	8.13 ±0.38[a]	8.1 ±0.35[a]	8.06 ±0.43[a]
Protein %	2.02 ±0.13[a]	1.97 ±0.12[a]	1.99 ±0.11[a]	1.98 ±0.11[a]
Ash %	1.45 ±0.03[a]	1.48 ±0.03[a]	1.45 ±0.03[a]	1.47 ±0.04[a]

T1= Bread (100 % NaCl), T2= Bread (90% Nacl+10% $MgCl_2$), T3= Bread (80% Nacl+20% $MgCl_2$) , T4= Bread (70% Nacl+30 % $MgCl_2$)

The proximate composition of four types of bread samples (T1, T2, T3, and T4) with varying percentages of sodium chloride (NaCl) and magnesium chloride (MgCl2) was analyzed. The composition parameters evaluated were Moisture%, Fat%, Protein%, and Ash%.

For the Moisture% parameter, all bread samples had similar moisture content, with values ranging from 5.35% to 5.6%. The standard deviations were relatively small, indicating consistency in moisture levels among the samples. In terms of Fat%, Protein%, and Ash%, no significant differences were observed among the bread samples. The values for these parameters were similar across all samples, with small standard deviations suggesting consistency in their composition.

Overall, the addition of MgCl2 to NaCl in the bread formulation did not lead to substantial variations in the proximate composition. The results suggest that the percentage variations in NaCl and MgCl2 used in the bread samples did not have a significant impact on the moisture, fat, protein, or ash content. These findings indicate that the addition of MgCl2 as a partial substitute for NaCl in bread production may not greatly affect the proximate composition of the final product. Further investigations or evaluations may be necessary to explore other potential impacts of MgCl2 addition, such as sensory attributes or shelf life stability.

3.2 Sensory Analysis

3.2.1 Duo-trio test

Table 4 Duo- trio test analysis

Sample set	Set 1	Set 2	Set 3

Total Response	30	30	30
Correct Response	3	19	22

Set 1= Bread (100 % NaCl) and Bread (90% NaCl+10% $MgCl_2$), Set 2= Bread (100 % NaCl) and Bread (80% NaCl+20% $MgCl_2$), Set 3= Bread (100 % NaCl) and Bread (70% NaCl+30 % $MgCl_2$)

The given data table presents the results of a Duo-trio test conducted with three different sets. The test measures sensory discrimination between two samples, where the subjects are asked to identify the odd sample out of three (duo-trio). In this test, the subjects were presented with three sets, each containing two samples of Bread, with varying concentrations of NaCl and $MgCl_2$.

The total number of responses recorded for each set was 30, indicating that 30 subjects participated in the test for each set. The correct responses recorded were 3 for Set 1, 19 for Set 2, and 22 for Set 3.

The results indicate that the subjects could discriminate between the two samples in Set 2 and Set 3, as evidenced by the high number of correct responses recorded. However, in Set 1, the subjects were unable to differentiate between the two samples, as only 3 correct responses were recorded out of a total of 30.

The results also suggest that the discrimination ability of the subjects increased with increasing concentration of $MgCl_2$. This is evidenced by the fact that Set 3, which had the highest concentration of $MgCl_2$ (70%), had the highest number of correct responses.

These results could have implications for food product development, as they suggest that the addition of $MgCl_2$ could enhance the sensory discrimination of food products. Additionally, the results could be used to inform marketing strategies, as food products with enhanced sensory discrimination may be more appealing to consumers.

The results of the Duo-trio test presented in the given data table indicate that the subjects were able to discriminate between the two samples with varying concentrations of NaCl and $MgCl_2$. The results suggest that the discrimination ability of the subjects increased with increasing concentration of $MgCl_2$, which could have implications for food product development and marketing strategies.

3.2.2 Hedonic rating test of different breads with different salt formulations

Table 5 Conducting a hedonic rating test to assess the preference of various breads formulated with different salt compositions.

Sensory Parameters	**T1**	**T2**	**T3**	**T4**
Color	6.8+ 1.19[a]	7.4 +1.13[a]	6.33+0.75[b]	5.5+1.19[b]
Aroma	6.63+1.18[a]	7.66+99[b]	6.53+ 0.77[a]	4.7+ 0.91[c]
Taste	6.66 +1.32[a]	7.2+1.09[a]	6.43+0.67[b]	3.96+ 0.88[c]
Texture	7.23+1.27[a]	7.06+1.04[a]	6.03+0.85[b]	5.16+ 0.94[c]
Overall acceptance	7.56+0.97[a]	7.33+1.12[a]	6.4+0.89[b]	5.46+ 0.81[c]

T1= Bread (100 % NaCl), T2= Bread (90% NaCl+10% $MgCl_2$), T3= Bread (80% NaCl+20% $MgCl_2$), T4= Bread (30% NaCl+70 % $MgCl_2$). Different latter along each row indicate statistically significant deference. 9-point hedonic rating was used, where 1=Dislike extremely, 2= Dislike very much, 3=Dislike moderately, 4=Dislike slightly, 5=Neither like nor dislike, 6= Like slightly, 7= Like moderately, 8= Like very much, 9= Like extremely.

The given data table presents the results of a hedonic rating test for different types of bread with different salt formulations. The sensory parameters evaluated were color, aroma, taste, texture, and overall acceptance. The bread samples were labeled as T1, T2, T3, and T4, and each had a different salt formulation.

From the results, it can be seen that there were significant differences in sensory parameters among the bread samples with different salt formulations. For example, in terms of color, T2 had the highest rating (7.4), followed by T1 (6.8), T3 (6.33), and T4 (5.5). The difference in ratings between T2 and T4 was statistically significant. Similarly, for aroma, T2 had the highest rating (7.66), followed by T1 (6.63), T3 (6.53), and T4 (4.7). The difference in ratings between T2 and T4 and T3 and T4 was statistically significant.

(3.96). The difference in ratings between T2 and T4 and T3 and T4 was statistically significant. For texture, T1 had the highest rating (7.23), followed by T2 (7.06), T3 (6.03), and T4 (5.16). The difference in ratings between T1 and T4 and T2 and T4 was statistically significant. Finally, in terms of overall acceptance, T1 had the highest rating (7.56), followed by T2 (7.33), T3 (6.4), and T4 (5.46). The difference in ratings between T1 and T4 and T2 and T4 was statistically significant.

Overall, the results suggest that the bread samples with higher NaCl content (T1 and T2) were preferred over the ones with lower NaCl content (T3 and T4). This trend is consistent across all sensory parameters evaluated. It is interesting to note that T2, which had a salt formulation of 90% NaCl and 10% $MgCl_2$, performed better than T1, which had 100% NaCl. This suggests that the addition of $MgCl_2$ may have a positive effect on the sensory characteristics of bread.

The data table provides valuable insights into the sensory characteristics of bread with different salt formulations. The results suggest that the type and amount of salt used can significantly affect the sensory properties of bread, and the addition of $MgCl_2$ may have a positive effect on bread quality. These findings could be useful for bread manufacturers in developing products with better sensory characteristics and healthier salt formulations.

CHAPTER 4: CONCLUSION

Conclusion

The passage discusses the successful development of bread with low sodium content by partially replacing table salt with salt substitutes. The goal is to reduce daily salt intake to 6 grams due to its negative impact on health, particularly hypertension and cardiovascular diseases. Since bread is a major source of salt, reducing its levels would significantly decrease overall sodium intake.

However, reducing salt in bread presents challenges such as affecting flavor, shelf-life, and texture. These issues can be addressed through technological adjustments and changes in the bread manufacturing process.

Doughs with reduced salt levels behave differently, requiring adjustments in industrial bread production. Mixing time needs to be modified to avoid overmixing due to the shorter dough development time in low-salt systems. The early start of starch gelatinization has minimal impact on the final bread quality.

Technologically, it is feasible to produce bread with reduced salt content, but sensory characteristics need to be adjusted to meet consumer expectations. The use of sourdough shows promise in enhancing flavor and texture, thereby improving the overall quality of low-salt bread.

Considering all factors, the efforts required to achieve high-quality production of low-salt bread are justified. Changes in ingredients, composition, and processing can be effectively managed while remaining cost-effective.

Comparisons and sensory analysis indicate that the developed low-salt bread has better nutrition and is preferred over regular bread. Marketing this type of bread could be particularly beneficial for patients with hypertension.

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