

Sensory properties of white bread enriched with lemon juice, corn flour and baking soda

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ABSTRACT Bread is one of the most common food staples highly consumed by Maldivians. Food additives such as anticaking agents (baking soda), thickener (corn flour) and chelator (lemon juice) were used to enrich bread and introduced to the Maldivian market in order to determine how these anti-caking agents changed the overall acceptability including taste, aroma, appearance, texture and colour by consumers as a healthier and tastier alternative for normal white bread. The aim of the study was to determine how the addition of corn flour, lemon juice and baking soda to bread changed the overall acceptability including taste, aroma, appearance, texture and colour by consumers. Enriched bread and white bread (control) samples were sliced into equally sized pieces and served separately for each participant. The sensory evaluation of the bread samples was studied using a 9-point Hedonic scale with 30 random participants to determine the overall acceptability and the mean score for taste, appearance, texture and color. Using Microsoft Excel and SPSS software, the data was analyzed and graphs were generated. The enriched bread had overall acceptability of 6.97 ± 0.89 and the mean values of taste (6.2 ± 1.19), appearance (7.13 ± 0.70), texture (7.07 ± 0.98) and colour (7.2 ± 0.85). The aroma of the lemon soda bread was found less favorable (5.47 ± 1.17) compared to the enriched bread. The overall acceptability of enriched bread was rated 'like moderately' by 43.3% participants although 70% of the participants rated 'like very much' for normal white bread. The new formulation could be improved to increase the consumer likeness to the taste, particularly varying the formulation of lemon and corn flour.

Keywords: anticaking agents, corn flour, lemon soda bread, sensory evaluation, Maldives

Bread, in its many varieties, has been a staple food in many parts of the world including Maldives. Consumer trends within the bread-making industry at present are desire for healthier, authentic and natural products (Sajdakowska et al., 2021). To fulfil these demands, the bakery industry invests in clean-label versions of its products. Clean label products do not contain any synthetic substances or additives and are designed to meet the requirement for a simpler and more consumer-friendly ingredient list (Scarton et al., 2021). Yet no scientific evidence has documented the use of food additives and preservatives in the formulation of the bread manufactured in the Maldives.

Apart from wheat flour, salt, yeast, shortening and other optional ingredients such as eggs, sugar, dehydrated fruits, and nuts, additives are commonly used in bread products. Additives are natural or artificial substances that are added to food products for the purpose of preserving or modifying the chemical or sensory properties (Gioia et al., 2017).

Preservatives are used in bread to extend shelf-life since bread usually has a high-water activity level of 0.90 in comparison to other bakery products such as flavourless flat biscuits which has a water activity of 0.129 ± 0.003 at 25°C (Cervenka et al., 2006). A bread with a pH between 5.0–6.2 is susceptible to molds mainly such as *Aspergillus* and *Penicillium* strains which in turn, spoils the bread.

Food additives such as anticaking agents, thickeners and chelators are commonly used in bread to enhance taste and prolong the shelf-life of the food products (Saha & Bhattacharya, 2010). Anticaking agents are anhydrous compounds that are added in small amounts to dry food ingredients to prevent the particles from caking together and improve the flowability of food powders (Larsson, 2016). When baking soda is used as an anticaking agent, it should be consumed in small quantities. A regular intake of baking soda has shown to support general body functions by regulating the blood's natural pH levels and also can be used to treat and relieve some diseases (Fakhri et al., 2016).

Thickeners are mainly used to increase the viscosity of the food, for example, corn flour is a very commonly used thickening agent which contains high amounts of vitamins and iron (Saha & Bhattacharya, 2010). Corn flour is a better source of phenolic compounds, rich in fibre (2.30mg/kg) and total fat (Table 1) and has a significant higher antioxidant activity when compared to wheat flour (1.14 mg/kg) (Khan et al., 2016; Nikolic et al., 2019). Chelators are chemical compounds that prevent oxidation and increase the shelf-life of baked goods, for example, lemon juice is used as a chelating agent (Saha & Bhattacharya, 2010).

Table 1
Nutritional Value of Corn Flour and Wheat Flour

Nutrition facts per serving of 125 g		
	Corn flour	Wheat flour
Protein	8.1 g	13 g
Dietary Fiber	8.5 g	3.4 mg
Total fat	4.2 g	1.2 g

Note. Nutrition facts obtained from the database <https://www.nutritionix.com/>

Lemons and limes, besides having ascorbic acid, also have a high content of citric acid (Penniston et al., 2008), which is a weak organic acid, safe for consumption. It is also widely used as a natural preservative and acidifying agent in foods and beverages. They are rich in bioactive compounds including hesperidin and naringin (Hsieh et al., 2021). The main flavonoids in lemons are ferulic acid. Furthermore, lemons contain polyphenolic compounds such as catechin, which are antioxidant and free radical scavenging. Lemons have also shown to prevent cardiovascular diseases (Hsieh et al., 2021).

The sensory quality of bread, as an important dimension of the total product quality, is registered by the human senses of sight, smell, taste, hearing and touch. Before introducing enriched food products to the market, it is important to check the sensory quality of bread that can be assessed through consumers-acceptance tests, as well as other analytical methods (Callejo, 2011).

The main purpose of this study is to introduce an enriched white bread,

enhanced with lemon juice, corn flour and baking soda to the Maldivian market, and to conduct a sensory evaluation to determine the overall acceptability of the product by the consumers.

Materials and Method

2.1 Materials

Ingredients for the experiment was bought within the capital city. Lemon juice was created using fresh lemon bought from the local fruits and vegetable market. While the rest of the ingredients, plain flour, corn-flour, baking soda, yeast, sugar, baking powder, milk and butter was bought from a local supermarket.

2.2 Method

1. Bread enriched with lemon juice, corn flour and baking soda

The straight dough method (Luiz & Vanin, 2021) was used to produce the bread. This method involves the addition of all ingredients: plain flour (320 g), 192 g corn flour, 7 g baking soda, 28 g salt, 43 g butter, 43 g yeast, 43 g sugar, 2 g baking powder, 43 g lemon juice, 75 ml milk and 375 ml water at the mixing stage and kneading to obtain the dough.



Figure 1. Ingredients used to make enriched bread

2. Normal white bread (control)

To make normal white bread, all the ingredients; (Figure 2) plain flour 512 g, 8 g salt, 43 g butter, 43 g yeast, 43 sugar, 71 g milk and 375 ml water were mixed and kneaded to obtain the dough.



Figure 2. Ingredients used to make bread without treatment (control)

Baking of Bread

Margarine was smeared within all baking pans to prevent the dough from sticking to the pan. The dough samples were then placed within the baking pans and covered with a lid, it was left at room temperature ($37\pm 2^{\circ}\text{C}$) to ferment. After fermentation process was completed the dough was punched, divided and scaled to pieces for both experimental and controlled breads. The oven was preheated to 250°C and the bread was baked for 30 to 40 minutes. Figure 3 shows the final product for the controlled bread and figure 4 shows the final product for the experimental enriched bread.



Figure 3. Showing the final product for the controlled bread



Figure 4. Showing the final product for the experimental enriched bread

Sensory evaluation of bread samples

The normal bread is coded as NB1-30 (control) and the enriched bread is coded as EB1-30 in preparation for the analysis. Second, in preparation for the sensory evaluation phase, 30 untrained participants were selected to assess both control (NB1-30) and enriched bread (EB1-30) samples for acceptance on criteria such as appearance, colour, taste, aroma, texture and overall acceptability using a hedonic scale from 1 (dislike extremely) to 9 (like extremely) (Singh-ackbarali & Maharaj, 2014).

The results obtained were analyzed using Microsoft Excel and SPSS software (IBMS SPSS Statistics 20).

Results

As shown in Table 2 most of the participants rated 6, 7 and 8 on the hedonic scale which represents “like slightly”, “like moderately” and “like very much”, respectively, for all of the attributes of the enriched bread. Out of the 30 participants, 6 (20%) of the participants rated the appearance of the bread a “Like slightly”, 14 (46.7%) participants rated it “Like moderately” and 10 (33.3%) participants rated it as “Like very much”.

As most of the participants do not like the bitter taste of bread, 40% of them rated the taste of the enriched bread as “Like slightly” while 53.33% of participants rated “Like very much” for the control (normal white bread) (Table 2). The appearance of the enriched bread was rated ‘Like moderately’ by 46.7% of the participants while 46.7% of the participants rated ‘Like very much’ for normal white bread. The overall acceptability of enriched bread was rated ‘Like moderately’ by 43.3% participants although 70% of the participants rated ‘Like very much’ for normal white bread. Generally, when the food is more nutritious its overall acceptability by consumers is low and a way to promote its marketability is by promoting its health benefits.

Table 2
The Sensory Evaluation of Control Bread and Enriched Bread as Rated by Study Participants (percentage of participants rated)

Attributes	5 (neither like or dislike)	6 (like slightly)	7 (like moderately)	8 (like very much)	9 (like extremely)
Appearance	Control Bread 0	0	3 (10%)	13 (43.33%)	14 (46.67%)
	Enriched Bread 0	6 (20%)	14 (46.7%)	10 (33.3%)	0
Taste	Control Bread 0	5 (16.67%)	4 (13.33%)	16 (53.33%)	8 (26.67%)
	Enriched Bread 0	12 (40%)	6 (20%)	5 (16.7%)	0
Odour	Control Bread 0	2 (3.33%)	2 (6.67%)	10 (33.33%)	17 (56.67%)
	Enriched Bread 0	8 (26.7%)	7 (23.3%)	0	0
Texture	Control Bread 1 (3.33%)	1 (3.33%)	9 (30%)	9 (30%)	10 (33.33%)
	Enriched Bread 0	4 (13.3%)	11 (36.7%)	12 (40%)	0
Color	Control Bread 0	0	1 (3.33%)	14 (46.67%)	15 (50%)
	Enriched Bread 0	5 (16.7%)	11 (36.7%)	13 (43.3%)	0
Overall acceptability	Control Bread 0	0	2 (6.67%)	21 (70%)	7 (23.33%)
	Enriched Bread 0	6 (20%)	13 (43.3%)	9 (30%)	0

Table 2 describes the normal white bread (control) results which shows that most of the participants prefer normal white bread over the enriched bread in terms of all the sensory attributes; appearance (46.67%), taste (26.7%), odour (56.7%), texture (33.3%), color (50%), and overall acceptability (70%).

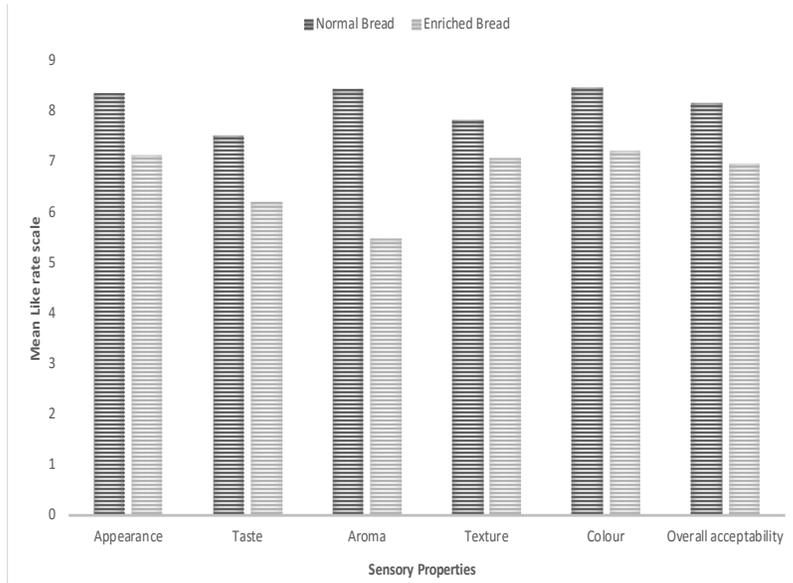


Figure 5. Showing the mean value obtained from the 30 participants for specific sensory attributes for both experimental and control bread

As shown in Figure 4, the mean value for taste of the enriched bread was 6.2 ± 1.19 , 'like slightly', appearance was rated 'like moderately' 7.13 ± 0.70 , texture was 7.07 ± 0.98 , 'like moderately') and the colour of the bread was rated 'like moderately' 7.2 ± 0.85 . The aroma of the experimental enriched bread instead was rated as 'neither like/dislike' 5.47 ± 1.17 . The overall acceptability was 'like slightly' for the lemon soda bread (6.97 ± 0.89) and like very much' for the control bread (8.17 ± 0.53). The appearance, colour of the crust and crumb, texture and taste scored the highest value while the odour had the lowest mean value for the enriched bread.

Discussion

The addition of corn flour nutritionally enhances the bread as corn flour contains high amounts of fibre, starch, vitamins and minerals. Corn flour is gluten-free which makes it healthier than all-purpose flour or bread flour which is more commonly used in bread making (Skendi et al., 2021). Corn flour also contains phytochemicals such as vitamins, minerals, phenolic acids and carotenoids and flavonoids that come from the corn. The regular consumption of corn flour has shown to reduce the risk of many diseases like type 2 diabetes, cardiovascular diseases, obesity and some types of cancer (Siyuan et al., 2018). Even though it is highly nutritious, corn flour is not a commonly used ingredient in making bread.

The addition of lemon juice enriches the bread with natural preservative as it is

an acidifying agent due to its acid content including ascorbic as well as citric acids. These acids are weak organic acids and hence, safe for consumption. Moreover, the addition of lemon juice in the enriched bread formulation is considered healthy due to the phytochemicals and antioxidant capacities of the lemon (Chang et al., 2015). Lemon juice can be a great substitute for artificial antioxidants as it contains 46 antioxidants including vitamin C, proanthocyanidins, flavonoids, hesperidin and eriocitrin (Quita, 2016).

Doughs with lemon juice required a longer mixing time, produced bread with lower volume, firmer crumb, lighter crust and lower mold occurrence, when compared to the market standard (Scarton et al., 2021). These changes are due to lower pH before and after proofing (range from 3.6 to 4.2), which may have reduced product formation from the Maillard reaction (Scarton et al., 2021). The lemon juice carries pH regulators as it contains ascorbic and citric acids which helps maintain the quality of the bread by inhibiting bacterial or fungal growth in the bread (Teixeira et al., 2019). Moreover, drinking lemon juice significantly lowered the mean blood glucose concentration by a peak of 30% (Freitas et al., 2020). Therefore, the addition of lemon juice to bread can be a simple and effective method to lower glycemic impact (Freitas et al., 2020).

The golden and dark colour of bread comes from both the caramelization reaction between sugars formed during the fermentation process in the initial stages of baking. The Maillard reaction between amino acids and reducing sugars also plays an essential role in the development of the aroma of bread (Scarton et al., 2021). The results from the sensory evaluation for the aroma of the lemon soda bread is 5.47 ± 1.17 , which is the least mean value out of all the attributes tested.

The taste is the most important factor which affects the acceptability of an edible product (Taghdir et al., 2017). When lemon juice is added to the enriched bread, the consumer acceptance of its taste is lower (6.2) as compared to the normal white bread (8.0). This can be improved by adjusting the amount of lemon juice and sugar which are the main ingredients that give flavour to the bread. Hence it is recommended to do further research to identify the quantity of lemon juice and sugar need to improve the acceptability of the product.

Conclusion and Recommendation

The experimental bread enriched with corn flour starch, lemon juice and baking soda was produced and sensory perceptions evaluated by 30 untrained panelists. The results revealed that the taste of the enriched bread had a 'Like Slightly', 'Moderately Like' for appearance and colour, and 'Neither Like nor Dislike' to odour with the overall acceptability of 'Like Slightly'. Therefore, with little changes in the formulation such as the amount of food additives used, the taste and aroma of the enriched bread can be improved. The adequate formulation change that would improve the acceptability of the product can only be found through further research. The addition of corn flour gives the bread a richer nutrition value with consumers incorporating more fibre in their diets through the consumption of the enriched bread. With the reformulation, the enriched bread could be a potential healthier option to normal bread available in the Maldivian market.

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