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Optimization of Texture in Sorghum Ice Cream Cone Production Using Sensory Analysis

J. Kigozi[1,*], N. Banadda[1], Y. Byaruhanga[2], A. Kaaya[2] and L. Musoke[2]

[1]*Department of Agricultural and Bio-Systems Engineering, Makerere University, P.O. 7062 Kampala, Uganda*

[2]*Department of Food Technology and Nutrition, Makerere University, P.O. Box 7062 Kampala, Uganda*

Abstract: As consumers we are all acutely aware of the texture when we eat or drink solids or liquids and there can no doubt that texture is an important determinant of food quality. Results from the development of the process for sorghum based cones suggested the importance of optimizing the appearance and texture in future studies in the cone development for better consumer acceptance. In this study sensory analysis was used to determine differences in the product texture due to changes in the formulation for fifteen different formulations for the sorghum cones; in view of optimizing the sorghum cone texture. The sensory panel was used to determine the texture rated according to hardness, crispness and overall acceptability. Panelists used a 6-point scale for sensory evaluation (6 = "extremely hard" to 1 = "soft") to rate hardness and 6 = "extremely crispy" to 1= "Not crispy" to rate crispness and a 9-point hedonic scale (9 = "like extremely"; 1 = "dislike extremely") to rate the overall acceptability. Cones formulations which ranked higher; 8.25 and 8.06 respectively than the control 7.5 in consumer acceptance where F14 (where the sorghum was decreased by 25 %) and F9 (where water was decreased by 14%). Formulation F14 which resulted in the best texture was thus be selected and adopted as the formulation for the sorghum ice cream cones.

Keywords: Ice cream cones, optimization, sorghum, texture.

1. INTRODUCTION

Today's consumers are discerning, demanding and more knowledgeable about food and expect products which are safe, of good value and of high sensory quality [1]. Therefore knowing consumers preferences and perceptions of the sensory characteristics for texture is very important for a food production process. Texture can be measured by sensory or instrumental methods. Results from the development of the sorghum cones showed that for the sorghum cone, appearance (r = 0.856) and texture (r = 0.806) were most strongly (P < 0.05) correlated to overall acceptability. These results suggested the importance of optimizing the appearance and texture in future studies in the cone development. The texture of an ice cream cone is most importantly described by consumers as its crispness [2]. However its meaning is imprecise and varies, nevertheless it is agreeable to that crispy products are mechanically brittle, producing a typical sound at fracturing [3-5]. In this study sensory analysis was used to determine differences in the product texture (hardness, crispness and overall acceptability) due to changes in the formulation for the sorghum cones; in view of optimizing the sorghum cone texture. A trained panel was used for the analysis.

*Address correspondence to this author at the Department of Agricultural and Bio-Systems Engineering, Makerere University, P.O. 7062 Kampala, Uganda; Tel: ?????????????; Fax: ????????????????; Email:jbulyakigozi@yahoo.com

2. MATERIALS AND METHODS

2.1. Material Selection

Dry *Epuripur* sorghum was obtained from Victoria seeds, Uganda. The grain was cleaned and sorted to remove any spoilt grain and any other foreign particles. It was milled using a Wonder mill at the highest level of fineness producing whole sorghum flour mean of particle size 120 µm. Commercial wheat flour (Bakhresa Grain Milling (U) LTD, Uganda) randomly sampled from the open market was purchased and used for the control. Other ingredients such as sugar (Kakira Sugar Works, Uganda), corn starch (American Garden Products, U.S.A), oil (Bidco Uganda Ltd, Uganda), sodium metabisulphite (NORBRIGHT IND, CO.LTD, China), sodium bicarbonate (BIDCO oil Refineries, Kenya), ammonium bicarbonate DESBRO (U) LTD, Uganda) were also randomly purchased from the local supermarkets. The ingredients were used to prepare sorghum ice cream cones of varying formulations.

2.2. Recipe Formulation

The recipe used was according to Kigozi *et al.*, (2011) and the ingredients were varied to comprise 13 different formulations (F1: F14) as shown in Table **1**. Formulation 1 (F1) comprised the recipe according to Kigozi *et al.*, 2011 [6]; 200 g sorghum, 60 g maize starch as a binder, 40 g sugar, 3g leavener (sodium bicarbonate), 3.64 g lecithin, 8 ml oil, 350 ml water, 2 g salt and 1g sodium metabisulphite. The other twelve formulations (F2: F14) comprised a 12.5%

Table 1. Cone formulations.

Formulation/Description	Sorghum Flour (g)	Sugar(g)	Maize Starch(g)	Water (ml)	Oil (ml)	Leavener (g)	Lecithin (g)
F 1 (original)	400	80	120	700	16	6	7.28
F 2 (Low oil)	400	80	120	700	14	6	7.28
F 3(High oil)	400	80	120	700	18	6	7.28
F 4 (Low maize)	400	80	100	700	16	6	7.28
F5 (High maize)	400	80	140	700	16	6	7.28
F 6 (low sugar)	400	60	120	700	16	6	7.28
F 7(High sugar)	400	100	120	700	16	6	7.28
F 8 (Low water)	400	80	120	600	16	6	7.28
F 9 (High water)	400	80	120	800	16	6	7.28
F10 (Low leavener)	400	80	120	700	16	5	7.28
F11(High leavener)	400	80	120	700	16	7	7.28
F 12(Low lecithin)	400	80	120	700	16	6	3.64
F 13(High lecithin)	400	80	120	700	16	6	10.92
F14(Low sorghum)	300	80	120	700	16	6	7.28
F15(High sorghum)	500	80	120	700	16	6	7.28

increase or decrease in oil, a 12.5% increase and decrease in lecithin, a 14% water increase or decrease in water, a 25% increase or decrease in sugar, a 16.7% increase or decrease in leavener, a 16.7% increase or decrease in maize starch and 25% decrease in sorghum, while keeping the amounts of other ingredients constant. The resulting batters were baked using a cone making machine at 125^{o}C for the lower mould and 175^{o}C for the upper mould which temperatures were determined experimentally and yielded the best end product. Dry ingredients were all first measured into a bowl and oil, lecithin, water added and mixing done using a hand mixer (Make: Philips Model HR1456) at low speed until all ingredients were well mixed to form a batter.

2.3. Determination of the Baking Time

Preliminary experiments were done at constant baking time but it was realized that some cones did not attain readiness indicative that the variation in ingredients had an effect on the baking time. The baking time in minutes for each of the cone formulations was measured in three replicates using a stop clock. The clock was set to zero and started as soon as the batter was poured into the ice cream cone baking machine. End of baking was determined when the cones started browning and the clock stopped.

2.4. Determination of Ice Cream Permeability

The ice cream permeability for cones baked from each of the fourteen cone formulations was determined. Ice cream permeability was measured as the time taken for ice cream to permeate through a given cone. Ten ice cream cones were set on test tube racks and loaded with soft serve ice cream. The time taken for the ice cream to permeate to the outside of the cone was measured in minutes and recorded as the ice cream permeability of the cone.

2.5. Sensory Analysis

A trained consumer test panel (n =8) was recruited from the school of Food Technology, Nutrition and Bio-Engineering, Makerere University by polite solicitation. Panelists were selected based solely on interest, time availability, and lack of allergies to food products used in the study from a pool of 30 people and trained to identify differences in texture in the ice cream cones. The sensory panel was used to determine the texture rated according to hardness, crispness and overall acceptability. Panelists used a 6-point scale for sensory evaluation (6 = “extremely hard” to 1 = “soft”) to rate hardness and 6 = “extremely crispy” to 1= “Not crispy” to rate crispness. Panelists used a 9-point hedonic scale (9 = “like extremely”; 8 = “like very much”; 7 = “like moderately”; 6 = “like slightly”; 5 = “neither like nor dislike”; 4 = “dislike slightly”; 3 = “dislike moderately”; 2 = “dislike very much”; 1 = “dislike extremely”) to rate the overall acceptability [7].

2.6. Data Analysis

Means and standard deviations were calculated for each of the sensory attributes Consumer panel results were also analyzed using LSD for significance of mean differences compared to the control (F1) using SPSS 15.0. All analysis tests were performed at a significance level of 0.05.

3. RESULTS AND DISCUSSION

Table **2** shows the results from the sensory analysis as well as the baking time of the cones. A decrease of 16.7% in maize starch and 14% increase in water resulted in a significant reduction in the mechanical hardness while 25% increase in sugar and a 14% decrease in water resulted in significant increase in the hardness of the cone. 12.5% decrease in oil , and 25% decrease in sorghum resulted in significant increase, in the crispness and overall acceptability while a 16.7% increase in maize starch, 25% increase in sugar resulted in significant decrease in the crispness and overall acceptability. These changes can be explained by the fact that a decrease in the ratio of starch to water results in a structure that is more densely packed due to incomplete gelatinization , with some of the starch remaining in the native form, and is harder and less crispy at the end of baking, the reverse also being true. This agrees with Hadiyanto *et al.*, (2006) that crispness is dependent on gelatinization which in turn is dependent on availability of water. The decrease in crispness due to increase in sugar is because sugar competes with the water for gelatinization [9, 10] Also according to Hadiayanto *et al*., (2006) [8] that lipids are hardly affected during baking but they affect softness, crispness and staling. As a result, 16.7% increase in maize starch, 25% increase in sugar, 16.7% decrease in leavener, 14% decrease in water and 12.5% increase in lecithin resulted in a decrease in the overall acceptability of the cone.

Cones formulations which ranked higher than the control (7.5) in consumer acceptance were those where the sorghum was decreased by 25% (8.25) and water decreased by 14% (8.06) this being because more water was availed thus increasing the extent of gelatinization. Decrease in oil also resulted in an increase in the consumer liking because high levels of oil soften the cone structure. Baking time was also decreased by increase in sugar, lecithin, water, maize starch and decrease in the water and the oil implying that these formulations can save on energy as compared to the control. Increase in sugar concentration results in quicker browning due to the milliard reaction and thus a reduction decrease in baking time [10-12]. Although formulation 14 and 9 gave cones that were accessed better for texture than the control, formulation 14 could not hold ice cream for long enough for ice cream (10 minutes) (Table **6-2**) to be eaten which is about 18 minutes (Kigozi, 2011). Formulation 9 yielded was able to hold ice cream for long enough for ice cream

CONCLUSION

In this study sensory analysis was used to determine differences in the product texture (hardness, crispness and overall acceptability) due to changes in the formulation for the sorghum cones; in view of optimizing the sorghum cone texture. A trained panel was used for the analysis. Cones formulations which ranked higher than the control (7.5) in consumer acceptance were those where F14 where the sorghum was decreased by 25 % (8.25) and F9 where water was decreased by 14% (8.06). Cones from formulation F14 which had the best texture compared to the control when checked for ice cream permeability were found to be too weak. They crumbled within 10 minutes. Cones from

Table 2. Sensory attributes and overall acceptability of Ice cream cones as rated by 8 trained panelists.

Formulation	Hardness[a] μ (SD)	Crispness[b] μ(SD)	Overall acceptability[c] μ(SD)	Ice cream permeability (min)	Baking time (min)
F 1 (original)	3.75(0.46)	4.38(0.74)	7.50(0.92)	22.0	6.5
F 2 (Low oil)	4.00(0.53)	4.13(0.83)	7.11(0.92)	28.6	5.5
F 3 (High oil)	3.22(0.67)	3.00(0.00)	6.00(0.00)	35.54	6.15
F 4 (Low maize)	2.75(0.70)*	4.38(0.74)	7.25(1.28)	20.0	6.25
F5 (High maize)	4.75(0.75)	2.75(0.89)*	5.00(0.00)*	49.3	5.0
F 6 (low sugar)	3.06(0.56)	4.50(0.93)	7.60(0.74)	21.0	6.25
F 7(High sugar)	4.75(0.71)*	2.75(0.71)*	5.00(0.00)*	60.03	5.5
F 8 (Low water)	4.88(0.64)*	2.63(1.19)*	4.50(2.61)*	60.05	5.5
F 9 (High water)	2.75(0.88)*	4.88(0.83)	8.06(0.78)	19.2	5.0
F10 (Low leavener)	3.67(0.87)	3.44(0.88)*	5.94(1.18)*	44.7	6.5
F 11(High leavener)	3.38(1.18)	4.50(0.00)	7.28 (0.0)	25.0	5.0
F 12(Low lecithin)	4.22(0.99)	4.00(1.10)	6.63(0.52)	57.0	5.67
F 13(High lecithin)	3.25(1.28)	3.63(1.10)	6.25(0.88)	35.2	4.5
F14 (low sorghum)	3.00(0.75)	5.13(0.83)	8.25(0.71)	10.10	5.0

[a]Scale for Hardness: Range 6= "extremely hard" to 1 = "soft"
[b]Scale for Crispness: Range 6 = "extremely crispy" to 1 = "not crispy"
[c]Scale for overall acceptability 9 = "like extremely" to 1 = "dislike extremely"
*Significantly different from the control at a 0.05 level of significance

formulation F9 with an ice cream permeability of 19.2 minutes were therefore selected as the best cones overall and were thus recommended for piloting in the food industry.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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