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Effect of Different Emulsifiers on Sensory Qualities of High Cassava Flour Composite Bread

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Abstract: **This study investigated the effect of different emulsifiers on sensory qualities of wheat and cassava composite bread at up to 40% substitution level. Composite bread was produced using the straight dough mixing method. 70/30% and 40/60% composite blends of wheat and cassava bread with emulsifiers and control (100% wheat flour) were produced in other to determine the effect of the emulsifiers on sensory qualities. CMC (Carboxyl-methyl cellulose) emulsifier performed best among the three emulsifiers and was further varied in quantity to determine its overall effect on variation. The bread samples were served to an untrained panelists to evaluate the sensory qualities based on the effect of the emulsifiers over the control sample. Parameters set for the evaluation included appearance, taste, texture and general acceptability. The effect of the emulsifiers, especially CMC, had positive and acceptable performance better than AHC (Amylase-hemicellulase) and Lecithin when compared with the control at p<0.05. Both 30% and 40% substitution samples had significant difference in all the parameters at p<0.05. Further increase in quantity of the best performing emulsifier (CMC) for both 30% and 40% substitution levels, had negative impact on sensory quality. Off taste and off odour were developed and perceived with higher increase of the emulsifier which greatly affected the overall acceptability. The study therefore concludes that the feasibility of producing cassava bread with about 40% substitution level with the desirable organoleptic qualities with the aid of emulsifiers.**

Keywords: **Cassava, Composite bread, Emulsifiers, Sensory, Wheat.**

I. INTRODUCTION

Bread is a fermented confectionary product produced mainly from wheat flour, water, yeast and salt by a series of processes involving mixing, kneading, shaping, proofing and baking with variations in recipe, mixing processes, methods of dough development, shape, processing equipment and degree of baking, particularly in terms of automation and in the range of bread products available to the consumer [1], [2]. Bread is not one of Nigeria's indigenous technologies. Till date, most Nigerian's have not been introduced to other types of bread apart from that made from 100% wheat flour [3]. Nigeria grows starchy tubers such as cassava, taro, sweet potato etc in abundance which can be substituted for bread. This can minimize or even eliminate the importation of wheat by utilizing our locally produced staples for bread [4]. Efforts are being made to partially replace wheat flour with non-wheat flours as a possibility for increasing the utilization of indigenous crops cultivated in Nigeria, as well as contribute to lowering cost of bakery products [5].

The concept of composite flour was initiated by the FAO in collaboration with some research institutes in 1971, the objective of which was to identify a new replacement for wheat in bread making, baked goods and pasta products and to find flour formulation with composition combining optimal nutritive value with appropriate processing characteristics [6]. Various research trials were made and among the tuberous crops, cassava (*Manihot esculanta crantz*), was found to be the best choice for wheat substitution in bread making and other pastry products [7-11]. However, the trials made have shown that there are eminent technical problems encountered at the bakeries with cassava substitution such as, decreased water absorption and dough strength, increased mixing time, decrease in specific loaf volume and poor dough formation in mixing and kneading processes [12-14]. On the basis of the prevailing technical problems, flour improvers were introduced with the aim of improving the quality of the compositing flour bread. Successful trials were made up to 20% substitution level [15-18]. Hence, this study was aimed at determining the level of wheat flour substitution to 40% using different emulsifying agents to assess the sensory attributes of bread produced from the blend.

II. MATERIALS AND METHODS

A. Raw Materials Procurement:

The raw materials were procured with Kaduna and Makurdi metropolis in Nigeria. Items purchased include: Cassava Tubers (TMS 30572): Benue State Agricultural and Rural Development Authority (BNARDA), Makurdi, Wheat / Millet grains: Abubakar Gumi Central Market, Kaduna Emulsifiers: Abubakar Gumi Central Market, Kaduna, Baking fat, Active yeast, sugar, salt, (super market, Kaduna).

B. Equipment / utensils:

The equipment and utensils used in carrying out the baking of the bread were from the workshop in Department of Food Technology, Kaduna Polytechnic, Kaduna. The items used includes: oven dryer, knife, cassava peeler/ grater, manual screw press, milling machine, roller pin, electronic balance, wooden mortar, sieve and tray.

C. Sensory Evaluation of the Various Emulsified Composite Bread:

Sensory Evaluation of the samples were carried out for consumer acceptance and preference using twenty untrained judges, comprising staff and students of Kaduna Polytechnic, rating on a Reference Bread Score Ranges from the highest score of 100 to the lowest score of 0 on a designed questionnaire containing all the parameters of evaluation [19]. Data collected were subjected to Analysis of Variance (ANOVA) and the difference separated using Duncan Multiple Test. The qualities assessed included color (crust and crumb), taste, texture, general appearance and acceptability.

D. Production of Cassava Flour:

The Industrial Profile Method (IPM) approved by FIIRO for the production of high quality cassava flour (HQCF) was used [20].

E. Raw Materials and Emulsifiers Composition:

The method described by Desrosier for the production of white bread was applied [21]. This was based on the percentages of the major ingredients on the total amount of the composite flour: 1% yeast, 1% salt, 2% fat, 13% sugar and 50% water. Table 1 shows the composite bread formulation made from wheat and cassava flours for 30% and 40% substitution levels respectively. The quantities of the emulsifiers were determined based on the instruction of the amount for use per quantity of flour, as provided by the manufacturer on the container's label as shown in Table 2.

F. Composite Bread Production from the Various Blends:

The straight dough mixing method described by Desrosier was applied [21]. Each sample dough was properly mixed, kneaded, weighed, shaped, panned, proved and baked in an oven of a temperature setting of 180^{o}C. Baking time varied from the different blends ranging from 45 minutes to 55 minutes. The variation in baking time increased with increasing substitution.

TABLE 1: INGREDIENTS COMPOSITION

Wheat Flour (%)	Cassava Flour (%)	Yeast (g)	Salt (g)	Fat (g)	Sugar (g)	Water (ml)
100	0	3	3	6	40	180
70	30	3	3	6	40	220
60	40	3	3	6	40	229

TABLE 2: EMULSIFIERS COMPOSITION

Wheat Flour (%)	Cassava Flour (%)	Lecithin (g)	Amylase-hemicellulase (g)	Carboxyl-methyl cellulose (g)
100	0	Nil	Nil	Nil
70	30	1.7	2.0	5.0
60	40	1.7	2.0	5.0

III. RESULTS AND DISCUSSION

A total of nine bread samples were produced: 1 loaf (control) 100% wheat flour bread without emulsifier, 3 loaves (70/30%) emulsified composite W/C bread, 3 loaves (60/40%) emulsified composite W/C bread and 2 loaves (70/30% and 60/40% respectively) unemulsified composite W/C bread.

Sensory Evaluation: Organoleptic evaluation of the bread samples was ascertained by consumer acceptance and preference method using twenty (20) untrained panelists based on the parameters provided. All the data collected were subjected to analysis of variance (ANOVA) and the difference was separated by Duncan multiple test.

Appearance (crust and crumb): Mean sensory scores obtained for 70/30% composition were 6.80, 7.75 and 6.15 for emulsified bread with AHC, CMC and LC respectively, while the control had 8.40 with LSD of 0.33 as shown in Table 3. All the values had significant differences showing individual performance of the emulsifiers. Scores recorded for 60/40% were 6.95, 8.00, 6.00 and 8.80 for AHC, CMC, LC and the control respectively. With LSD 0.40, all samples had significant differences as shown in Table 4. Significant difference resulted with performance of the emulsifiers on caramelization affecting the appearance of the various samples. The scores, however, can serve as a measure of effect of the various emulsifiers on appearance, as it appeals to the eyes. With increased quantity of CMC emulsifier, as the best performing emulsifier, the mean score on appearance appreciated significantly to 8.73 of the composite bread, as against the score of 8.00 of the control with LSD 0.49 at $p<0.05$. This has gone along way to prove that emulsifiers have positive effect on appearance even with the highest substitution, agreeing with the findings of Shittu *et al.*, and Sanderson that CMC improves the texture and crumb structure of baked products [15, 22].

TABLE 3: EFFECT OF EMULSIFIERS ON SENSORY QUALITY OF W/C COMPOSITE FLOUR BREAD FOR 30% SUBSTITUTION LEVEL

Composition (%)	Emulsifier	Appearance	Taste	Texture	Overall Acceptability
100 (Control)	Nil	8.40^{a}	8.70^{a}	8.45^{a}	8.55^{a}
70/30	AHC	6.80^{c}	6.75^{c}	7.60^{b}	7.00^{c}
70/30	CMC	7.75^{b}	7.75^{b}	7.95^{b}	7.90^{b}
70/30	LC	6.15^{d}	6.50^{c}	7.05^{c}	6.30^{d}
LSD	-	0.33	0.34	0.35	0.33

Key: AHC-Amylase-hemicellulase; CMC-Carboxyl methyl cellulose; LC-Lecithin; LSD-least significant value

TABLE 4: EFFECT OF EMULSIFIERS ON SENSORY QUALITY OF W/C COMPOSITE FLOUR BREAD FOR 40% SUBSTITUTION LEVEL

Composition (%)	Emulsifier	Appearance	Taste	Texture	Overall Acceptability
100 (Control)	Nil	8.80^{a}	8.80^{a}	8.00^{a}	8.45^{a}
60/40	AHC	6.95^{c}	7.05^{c}	6.95^{b}	6.95^{c}
60/40	CMC	8.00^{b}	7.95^{b}	7.95^{b}	8.00^{b}
60/40	LC	6.00^{d}	6.95^{c}	6.00^{c}	5.95^{d}
LSD	-	0.40	0.35	0.38	0.36

Means within the different superscripts across the column vary significantly ($p<0.05$)

Taste: Table 3 shows the results obtained for 70/30% composition. The values obtained were 6.75, 7.75, 6.50 and 8.70 for AHC, CMC, LC and control respectively. With LSD of 0.34, all the samples had significant differences except for composite bread emulsified with AHC and LC (Table 3). Values recorded for 60/40% composite bread ranged from 7.05, 7.95, 6.95 and 8.80 for AHC, CMC, LC and control respectively as shown in Table 4. Equally, significant differences existed between all the samples except for AHC and LC with LSD of 0.35. The difference in taste was not because the samples were rejected when compared with the control but based on preference. However, there seemed to appear a sharp decline in scores with increasing quantity of CMC, as the best performing emulsifier with significant difference with the control at LSD of 0.52. The increase in CMC resulted to an unpalatable taste. This had a negative effect on the sensory quality reflecting on its overall acceptability, though the effect on other aesthetic qualities remained positive especially on the color, texture, appearance, weight and specific loaf volume. This is an indication to the fact that there is an acceptable limit of increasing the quantity of the emulsifier for acceptability even though the more the quantity dosed, the better the physical properties. Both 30% and 40% composite bread samples emulsified with CMC performed better in taste than bread samples emulsified with AHC and LC. And in general, emulsifiers impart positive effect in taste in substitute flour based products because the intensity of the aroma of the emulsified bread samples influenced the taste remarkably showing that the emulsifiers have such characteristics to influence those aesthetic qualities of taste and aroma. This is in line with the work of Ayo, that emulsifiers added in baked goods had high correlation coefficient on odor and taste [5].

TABLE 5: EFFECT OF VARYING QUANTITY OF THE BEST PERFORMING EMULSIFIER (CMC) OF WHEAT AND CASSAVA COMPOSITE FLOUR BREAD (60/40 %) ON SENSORY QUALITY

Attributes	C1	C2	C3	C4	C5	C6	LSD
Appearance	8.00^{b}	8.00^{b}	8.20^{ab}	8.47^{ab}	8.67^{a}	8.73^{a}	0.49
Taste	8.00^{a}	5.40^{b}	4.80^{c}	4.00^{d}	3.67^{d}	3.47^{d}	0.52
Texture	8.07^{a}	8.00^{a}	8.00^{a}	7.73^{ab}	7.20^{b}	7.13^{b}	0.57
Overall Acceptability	8.33^{a}	7.60^{b}	6.93^{c}	6.47^{c}	5.87^{d}	5.67^{d}	0.60

Means with different superscripts across the rows vary significantly ($p < 0.05$) C1 = Composite Bread Containing 5.0 g CMC, C2 contains 5.2 g, C3 contains 5.4 g, C4=5.6g, C5=5.8g, C6=6.0g

Texture: The values obtained for 70/30% samples were 7.60, 7.95, 7.05 and 8.45 for AHC, CMC, LC and control respectively with LSD 0.35. The control distinguished itself significantly from all the emulsified samples. AHC and CMC had no significant difference but significantly different from LC. For 60/40% composite samples, scores obtained were 6.95, 7.95, 6.00 and 8.00 for AHC, CMC, LC and control respectively. With LSD of 0.38, the control and CMC emulsified had no significant difference but significantly differed from AHC and LC emulsified samples. For samples of varying quantity of CMC, values obtained showed that C1, C2, C3 and C4 had no significant difference but significantly differed from samples C5 and C6 as shown in Table 5. Equally, sample C4 had no significant difference with samples C5 and C6 with LSD of 0.57. In both 30 and 40% substitutions, CMC had more stabilizing effect on texture over AHC and LC. This is an indication of the ability of the emulsifier to enhance the formation of gel in solution when heated thus bringing about good textural product [5]. For samples of varying quantity of CMC, scores started depreciating with increase in the level of CMC. Texture was grossly affected giving a negative effect on increase. With decreased textural score, this suggests that the quality of bread that can be produced from wheat-cassava flour mixture depends on the level of substitution which also agrees with the work of Eddy *et al* that the lower the substitution level the better the outcome of the loaves and vice versa [23].

Overall acceptability: Values for 70/30% emulsified substitution were 7.00, 7.90, 6.30 and 8.45 for AHC, CMC, LC and control respectively. With LSD of 0.33, all the samples had significant differences. The values obtained for 60/40% emulsified composition were 6.95, 8.00, 5.95 and 8.45 for AHC, CMC, LC and control respectively. Equally, all the samples had significant differences with LSD 0.36. With 30 and 40% emulsified composite bread samples, this, therefore, explains that effect of the emulsifiers on general acceptability maintained a stable response even with the change in composition. This is in agreement with the findings of Oluwamukomi *et al* that emulsifiers improve the quality of baked products [23]. For samples of increasing quantity of CMC emulsifier, overall acceptability values had significant difference with all the remaining samples. This was also reflected on the gradual decrease in general acceptability with further increasing variation of CMC virtually affecting all other attributes of the sensory quality with the exception of the appearance. In general, effect of the emulsifiers on 30 and 40% compositional variation had positive effect on general acceptability of the bread samples.

IV. CONCLUSION

Though the sensory scores for both 30 and 40 % substitution levels were slightly different from some of the sensory attributes of 100% wheat flour bread, it has, however, been found that the effect of the emulsifiers on such high cassava flour substitution imparted positively to the acceptability and willingness to go on its production and consumption. There is the possibility of the government to achieve its drive towards reducing importation of wheat flour into the country and encouraging the utilization of our local produce, thereby conserving our foreign exchange. Looking at the results obtained, there is hope in the feasibility of a high cassava composite bread with the help of emulsifiers to be a very viable alternative to achieving the so much desired national economic growth, food security and healthy living in the country.

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