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RESEARCH ARTICLE

Optimization of gluten-free bread using RSM (Design Expert) to study its textural and sensory properties

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Abstract

The urgent need for gluten-free bread by celiac disease patients and gluten-sensitive populations has spawned a new and emerging food industry to provide a substitute bread that is gluten-free. This study aims to provide an effective substitute bread using locally available indigenous crops like jackfruit seed and flour (*Artocarpus heterophyllus Lam*) and Mapillai samba rice flour (*Bridegroom oryza sativa* L) as the key ingredients. Central composite rotatable design of response surface methodology was applied to study the overall comparative acceptability of the gluten-free bread. By adjusting the ratios of the three main ingredients, 20 different composite flour formulations without gluten were used to make gluten-free bread. Textural qualities (hardness and springiness), loaf volume, color value, and sensory quality were studied to find the best combination of the three key components for the creation of gluten-free bread. Such a viable and desirable product will have commercial implications.

Keywords: Celiac disease, Gluten-free, Indigenous crops, Jackfruit seed flour, Jackfruit flour, Mapillai samba rice flour.

Introduction

Bread, also called 'the staff of life' since its inception, has become a globally used household vital commodity in the daily diet. It is artificially made from wheat flour with the main ingredient of gluten. Gluten has been called the 'miraculous ingredient' imparting bread with its unique taste and texture and assumes a vital role in bread making. However, it is not tolerated by an emerging and growing population, including celiac patients, for whom it can be dangerously toxic. Hence, the new global need for gluten-free bread has encouraged the use of gluten-free substitutes. The value of this is enhanced when it is made with locally available ingredients. A rising number of individuals with sensitivities to ingredients such as wheat gluten have led to the development of clever, marketable gluten-free grains and millets. This has allowed gluten-free products to establish a presence on supermarket shelves, suggesting that the decline in the use of millet may have been a short-lived deviation Manohar, S., & Vijayakumar, P. (2020). The overall acceptability and nutritional composition will determine the adequacy of the substitute. The desirability of wheat bread lies in the amino acids present in protein that become elongated and organized into a webbing to possess extensibility, the capacity to maintain its shape and elasticity, and the capacity to stretch, in order to avoid becoming flat, more crumbly and less chewy. Experiments with non-gluten flours have often yielded watery batters, resulting in bread with poor loaf volume, texture, hardness, chewiness and a lack of the desired visco-elasticity, acceptable colour and taste. Hence, the challenge lies in finding a gluten replacement that would match the functions of gluten. Masure *et al.* 2019 affirm that bread made without gluten is characterized by smaller size, dryness in the loaf and above all poor sensory qualities. Neither millets nor main staples like rice seem to show the cohesiveness and visco-elasticity shown by wheat with its gluten (Masure H.G. *et al.* 2016). To meet the lacuna that the absence of gluten creates, it becomes necessary to find another substitute or additive that will take its place and make the dough perform like a gluten dough. The primary ingredients used were jackfruit flour (JFF), jackfruit seed flour (JSF) and Mapillai samba rice flour (MSRF). The

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jackfruit seed flour (27.3%), Mapillai samba rice flour (13.6%) and jackfruit flour (9.1%) were selected because they were gluten-free and were locally available.

This study's goal was to create a gluten-free bread with these selected ingredients that would provide nutritional value and contribute acceptable rheological, textural and sensory properties that would make the final product comparable to gluten wheat bread.

The technological gap created by the absence of gluten, such as visco-elasticity and gas-retaining abilities, was replaced with a hydrocolloid. Sabanis and Tzia (2011) found that adding hydrocolloids effectively acted as the polymeric substances that enable the gluten-free (GF) dough to adopt visco-elasticity properties and enhance the dough's capacity to hold gas. What are hydrocolloids? Hydrocolloids comprise of different chemical structures of polysaccharides which are soluble in water and offer a variety of functional qualities that make them widely used in the food sector. (Rosell C.M *et al.* 2007). The ability of hydrocolloids to improve water-binding capacity, viscosity, hydration rate, and temperature effect on hydration are the factors that determine their use in GF applications. This was crucial since, for the most part, the viscosity of hydrocolloids decreases with temperature whereas, at the correct temperatures, they increase gas production and retention during fermentation. ([] Padalino L *et al.* 2016) & (Culetu A *et al.* 2021). In striving to meet the lack of these attributes, adding an extraneous hydrocolloid was deemed essential and proved effective. After a detailed literature search, the hydrocolloid selected for this purpose was xanthan gum (XG). This bread was developed using xanthan gum at a low concentration of 0.1 grams.

Materials and Methods

Materials

All the ingredients and raw materials were purchased from local markets and a platform for online E-commerce purchases.

Experimental Design for Optimizing Bread Formulation

The response surface methodology's optimal mixture design (Ibidapo O.P *et al.* 2020) was employed to investigate the impact of the three independent variables, that is, JFF (X1), JSF (X2), and MSRF (X3), on the dependent variables of bread volume (Y1), hardness (Y2), springiness (Y3), L* value of crust (Y4), L* value of crumb (Y5), and OAA (Y6).

Table 1 shows the real and configured values of the independent variables. Table 2 shows the twenty experimental runs (triplicates) used with the three independent variables. The results were used to prepare the bread per the independent variable composition. The average values of these responses were analyzed using the quadratic polynomial regression equation as shown:

Below, the Central Composite Rotatable Design (CCRD) results were used to create second-degree polynomial equations. Fitting adequate models represented by a second-degree polynomial equation was used to do the regression analysis of the answers.

$$Y = ß_0 \pm ß_1X_1 \pm ß_2X_2 \pm ß_3X_3 \pm ß_{11}X_1^{2} \pm ß_{22}X_2^{2} \pm ß_{33}X_3^{2} \pm ß_{12}X_1X_2 \pm ß_{13}X_1X_3 \pm B_{23}X_2X_3$$

Bread Preparation

Twenty different combinations formulated by Design Experts Software were used (Table 2). Jackfruit flour, jackfruit seed flour and Mapillai samba rice flour added up to 50% while the remaining 50% was made up of the composite flours of arrowroot flour and tapioca starch flour. During the bread-making process, these additional ingredients were added in the following amounts (Sugar 10%, yeast 3%, salt 1%, oil 5%, and xanthan gum 0.1%). Arrowroot and tapioca composite flours contributed 50% of the total, while the three flours of JFF, JSF, and MSRF were developed and scaled up using Design Experts software. RSM provided 20 different JFF, JSF and Mapillai samba rice flour combinations. All the dry ingredients were scaled up to 100 g of flour and weighed into the mixing bowl as shown in Table 2. The amount of water added was 90 to 100 mL - enough to make it into a smooth consistency batter. This batter was immediately transferred into a pre-weighed, pre-greased (greased with sunflower oil) loaf pan bread mold. It was then kept for proofing in the proofing chamber at a constant temperature of 35°C under a relative humidity of 85 to 90% for 20 to 30 minutes. This ensured that the bread loaf rose to approximately double the size of the batter. Then, the raised batter was transferred into a rotary oven that was maintained at a temperature of 180°C for baking for a period of around 30 minutes or until it was done. The change in color was an added sign.

This final bread loaf was transferred into a wire pan cooling rack for around 3 hours (Ibidapo O.P *et al.* 2020). Then it was packed in polyethylene packaging materials. It was kept at room temperature for 24 hours.

The characteristics of this optimized gluten-free bread were then compared with the predicted values and its desirability.

Table 1: Actual and coded values of the independent variables

Component	*Factor*	*Name*	*Units*	*Minimum*	*Maximum*	*Coded low*	*Coded high*	*Mean*
X_1	A	JFF	G	0	30	-1 ↔ 10.00	± 1 ↔ 30.00	20.00 ± 9.18
X_2	B	JSF	G	0	30	-1 ↔ 10.00	± 1 ↔ 30.00	20.00 ± 9.18
X_3	C	MSRF	G	0	15	-1 ↔ 5.00	± 1 ↔ 15.00	10.00 ± 4.59

Evaluation of bread loaf volume

The bread volume was determined using the AACC 2001 rapeseed displacement technique (AACC International). By subtracting the volume of the bread mold pan from the volume of the pan containing the bread loaf, the bread volume (cm^3) was computed.

Evaluation of bread hardness and springiness

Texture profile analysis (TPA) of bread crumbs was assessed on uniform 10 mm thick slices. Three slices of bread were sliced from the centre of the loaf and utilized for texture analysis (Armero K and Collar C.1997). TPA was performed 24 hours after baking using a texture analyzer (Stable Microsystems, Surrey, UK) with an 80 mm diameter cylindrical aluminum probe, using a double compression test that penetrated to a depth of 50% at a test speed of 2 mm/s, with a 30 second interval between the first and second compressions. (Gómez M *et al.*, 2013). Exponent Connect Lite software (version 8.0.3.0) was used to compute hardness and springiness from profile data.

Evaluation of color L value of crust, crumb, and OAA of bread*

L* values for the crust and crumb were obtained through Hunter Lab, color flex EZ, fifteen trained panelists, including Research Scholars, Scientists, and Technical Assistants from CFTRI were selected to perform sensory analysis and evaluation of product samples for OAA on a 7-Point hedonic rating scale which ranged from 1 = Dislike extremely to 7 = like extremely (Winger M, *et al.*, 2014).

Proximate composition of the optimized bread

"The proximate composition of optimized bread samples, comprising moisture, ash, protein, fat, and fiber, was assessed following the standard AACC 2000 procedures. The total carbohydrate content was calculated using the formula carbohydrates (%) = 100 - (Moisture ± Ash ± Fat ± Protein) (Rani S, *et al.,* 2018).

Statistical Data Analysis

The DesignExpert version's optimal mixture design.10.0.2.0 (State Ease) was used for experimental design and optimization. The response surface methodology (RSM) is an effective statistical approach for improving processes or formulations (Baş D and Boyacı I.H. 2003). RSM was chosen since many studies (Marco C and Rosell C.M. 2008, McCarthy D.F *et al.* 2005, Sabanis D *et al.,* 2009, Sanchez H.D *et al.* 2004, Toufeili I. M. A. D *et al.* 1994, Ylimaki G, *et al.* 1998, Poongodi Vijayakumar, T., & Deepa, M. 2010, Vijayakumar, T. P., & Boopathy, P. (2014) reported on the effective use of RSM in the creation and optimization of various gluten-free bread variants.

Results and Discussion

A comparison of the different characteristics (Bread Loaf Volume, Hardness, (Springiness, Crust, Crumb L Value and Overall Acceptability (OAA)) was studied so as to optimize the best combination of the ingredients. As per Table 2, the obtained value of loaf volume ranged from 272 ± 2.89 to 390 ± 5, hardness 130.617 ± 4137 to 384.573 ± 4.49, and springiness 0.338 ± 0.03 to 0.523 ± 0.04. The L* value of crust and crumb ranged from 24.2 ± 0.05 to 40.32 ± 0.35 and 37.42 ± 0.032 to 44.89 ± 0.04, respectively.

The values presented in Table 2 above were the result of three trial runs for each characteristic of loaf volume, hardness, springiness, crust L*, crumb L* and OAA.

The experimental results were fitted with quadratic models. ANOVA Table 3 showed that there was a significance in the fitted models and it was found that the lack of fit was not significant ($P < 0.05$). The R^2 value of the responses was higher and reflected the accuracy of the model.

Loaf Volume

The visual and sensory acceptability of bread depends on its bread volume and therefore becomes a vital parameter to measure the quantitative performance of the bread. Figure 1 and Table 2 show that the loaf volume ranged from a minimum value of 272 ± 2.89 cm^3 in run no 20 (where no jackfruit seed flour was added and had 20 gms of jackfruit flour and 10 grams of Mapillai samba rice flour) to a maximum value of 390 ± 5 cm^3 in run no 10. The composition of flours including the inclusion of jackfruit seed flour contributed to obtaining maximum value. According to Carson and Edwards (Carson G. R and Edwards 2009), a high protein content, with its increased water-absorbing capacity, adds to a bigger loaf volume potential and has also been reported to have superior keeping quality, providing all other variables stay constant.

Hardness

Figure 2 and Table 2 indicate that the characteristic of hardness ranged from 130.617 ± 4137 in Run #19 (with low Mapillai samba rice flour) to a value of 384.573 ± 4.49 in run

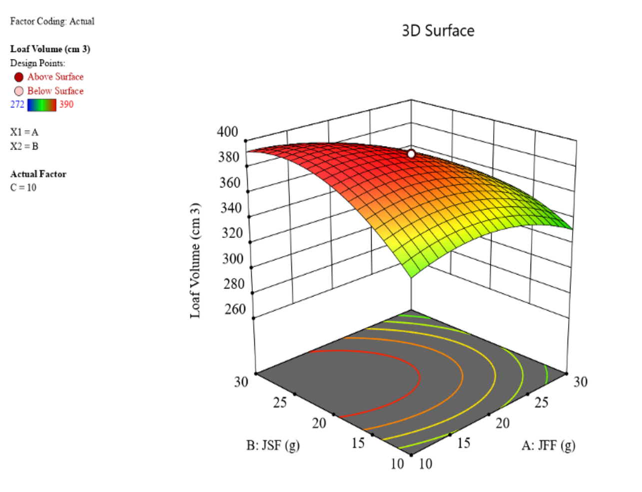

Figure 1: Bread loaf volume

Table 2: The response effect of several independent ingredient factors

Runs	*JFF (g)*	*JSF (g)*	*MSRF (g)*	*Loaf volume (cm^3)*	*Hardness (N)*	*Springiness (mm)*	*Crust L**	*Crumb L**	*OAA*
1	20	20	20	320 ± 5	228.186 ± 7.67	0.43 ± 0.04	35.96 ± 0.05	39.71 ± 0.04	4.53 ± 0.9
2	20	20	10	383.33 ± 2.89	373.503 ± 9.53	0.353 ± 0.01	36.61 ± 0.03	41.01 ± 0.03	5.3 ± 1.3
3	20	40	10	321.67 ± 2.89	231.912 ± 16.21	0.437 ± 0.06	25.52 ± 0.55	41.73 ± 0.04	4.37 ± 1.4
4	30	30	5	300 ± 8.66	325.706 ± 14.86	0.43 ± 0.07	34.75 ± 0.13	43.96 ± 0.02	4.07 ± 1.4
5	20	20	10	385 ± 0	354.82 ± 10.16	0.364 ± 0.02	36.41 ± 0.31	41.1 ± 0.26	5.3 ± 1.2
6	30	30	15	331.67 ± 5.77	312.76 ± 6.34	0.409 ± 0.07	32.1 ± 0.37	41.66 ± 0.05	4.6 ± 1
7	30	10	5	336.67 ± 7.64	245.313 ± 5.62	0.523 ± 0.04	33.42 ± 0.24	44.38 ± 0.04	4.2 ± 1.2
8	0	20	10	358.33 ± 2.89	223.911 ± 1.3	0.515 ± 0.04	26.06 ± 0.06	37.42 ± 0.03	4.67 ± 1.2
9	40	20	10	288.33 ± 2.89	298.057 ± 4.46	0.507 ± 0.16	40.32 ± 0.35	44.89 ± 0.04	4.57 ± 1.1
10	20	20	10	390 ± 5	378.238 ± 4.66	0.364 ± 0.02	36.52 ± 0.26	41.35 ± 0.04	5 ± 1.2
11	20	20	10	386.67 ± 7.64	383.02 ± 2.89	0.363 ± 0.04	36.6 ± 0.05	41.27 ± 0.03	5.23 ± 1,3
12	20	20	10	390 ± 0	384.573 ± 4.49	0.365 ± 0.02	36.59 ± 0.01	41.32 ± 0.05	5.27 ± 0.9
13	20	20	10	390 ± 5	382.98 ± 9.48	0.365 ± 0.26	36.59 ± 0.03	41.57 ± 0.03	5.33 ± 0.7
14	30	10	15	300 ± 0	313.091 ± 17.21	0.347 ± 0.1	38.3 ± 0.09	42.44 ± 0.03	4.6 ± 0.9
15	10	10	15	306.67 ± 2.89	310.42 ± 9.67	0.448 ± 0.03	31.73 ± 0.02	40.04 ± 0.04	4.53 ± 1.2
16	10	30	15	387 ± 3	204.573 ± 5.2	0.484 ± 0.01	28.06 ± 0.04	38.12 ± 0.06	4.93 ± 1.4
17	10	30	5	370 ± 5	218.98 ± 10.51	0.338 ± 0.03	27.2 ± 0.1	39.53 ± 0.05	4.87 ± 1.3
18	10	10	5	355 ± 5	243.891 ± 6.83	0.463 ± 0.05	24.2 ± 0.05	40.39 ± 0.03	4.3 ± 1.2
19	20	20	0	345 ± 5	130.617 ± 4.37	0.458 ± 0.01	25.84 ± 0.01	42.4 ± 0.02	3.93 ± 1.3
20	20	0	10	272 ± 2.89	297.035 ± 7.72	0.489 ± 0.01	26.8 ± 0.04	42.3 ± 0.3	4.27 ± 2.6

Table 3: Analysis of the significance of the regression model selected for different responses

	Loaf volume	*Hardness*	*Springiness*	*crumb L*	*Crust L*	*OAA*
A-JFF	-18.13***	22.96***	-0.0025	1.83***	3.49***	-0.0869**
B-JSF	11.87***	-11.31***	-0.014***	-0.3200***	-0.5063**	0.0669
C-MSRF	-5.38***	18.88***	-0.0076**	-0.7113***	1.93***	0.1494***
AB	-12.5***	26.35***	0.0073	0.1975	-0.5250	-0.1337**
AC	3.25***	0.3387	-0.041***	-0.3100**	-0.7700**	0.0763
BC	16.75***	-20.21***	0.0395**	-0.1775	-1.77***	-0.0087
A^2	-16.03***	-28.66***	0.0358***	-0.0341	-0.8845***	-0.1658***
B^2	-22.53***	-27.79***	0.0238***	0.1809***	-2.64***	-0.2370***
C^2	-13.66***	-49.05***	0.0191***	-0.0591	-1.46***	-0.2595***
ANOVA						
Model (F value)	419.23	60.25	72.47	89.17	71.84	20.52
Lack of fit (F Value)	0.6838	1.91	9.23	3.20	252.97	1.54
R^2	0.9974	0.9819	0.9849	0.9877	0.9848	0.9486

Jackfruit Flour, B- Jackfruit Seed Flour. C- MapillaiSampa Rice flour, Abbreviation OAA- Over All Acceptability *$p \leq 0.05$*** *$p \leq 0.01$****.

#12 (as the amount of samba rice was increased). Roman *et al. 2020*. found that the content of amylose and its length were crucial attributes of the bread's firming, starch retrogradation and hardness. The amylose content of Mapillai samba rice flour was observed to be (24.53%). According to Tulyathan *et al.* 2022, the amylose concentration of jackfruit seed starch was 32% and was higher than the mean value found in tapioca starch (17%) and corn starch (26%). Zobel H.F (1984) states that this could probably be due to the differences in amylose molecular weight and its ability to leach out of the starch granules.

Springiness

According to Marco and Rosell, springiness is related to the aeration and elasticity of bread, and high values are preferable. Conversely, if the springiness value is low, the bread can become brittle and can crumble easily. Figure 3 and Table 2 show that the characteristic of springiness was 0.338 ± 0.03 in run #17 (with a low content of Mapillai samba rice flour, and high jackfruit seed flour) and in run #7, it was 0.523 ± 0.04 (where there was a high content of high jackfruit seed flour and high jackfruit flour but there was no Mapillai samba rice flour). This study found that when the higher value of amylose in Mapillai samba rice flour was lowered, the springiness values became higher. This has been corroborated by Biduski*et al. (2018)* whose study showed similar results that as the amount of Mapillai Samba was decreased, it was noted that the springiness value became higher, along with a decrease in starch retrogradation.

Colour Value of Crust and Crumb

Crust L value

Figure 4 and Table 2 pointing out the Crust L* Value, in run #18, the value was 24.2 ± 0.05 (in which there was an equal proportion of jackfruit flour and jackfruit seed flour and the color was dark as exhibited by the low L* Value). But in run #9, the L* value was 40.32 ± 0.35 in other words. The hue darkened as the amount of jackfruit seed flour rose, whereas the color lightened as the amount of jackfruit flour grew.

Crumb L value

Figure 5 and Table 2 show that the values of the crumb L*, run #16 showed a lower value of 38 ± 0.06 (where there was a higher proportion of jackfruit seed flour and Mapillai samba rice flour) but the sample of bread turned lighter in run #9 (44.89 ± 0.04) when there was a higher proportion of jackfruit flour and a lower level of the remaining two flours.

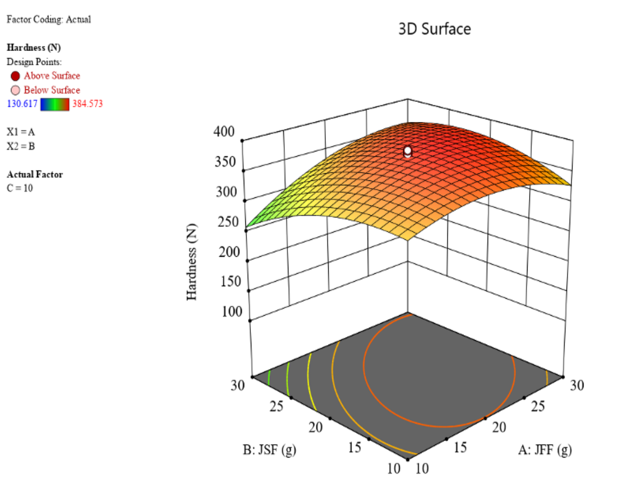

Figure 2: Hardness

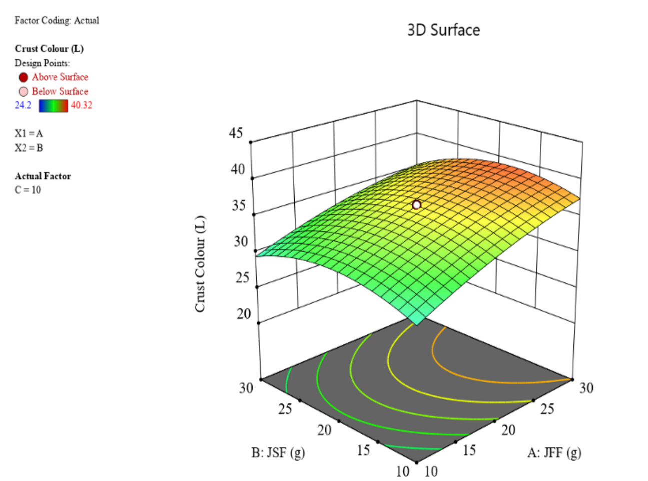

Figure 4: Crust color (L) value

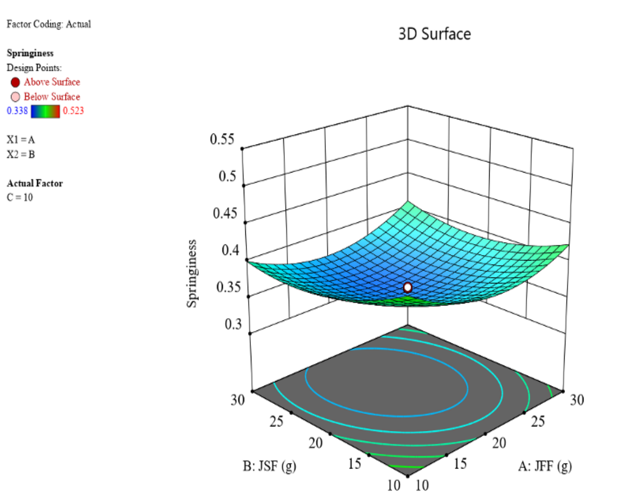

Figure 3: Springiness

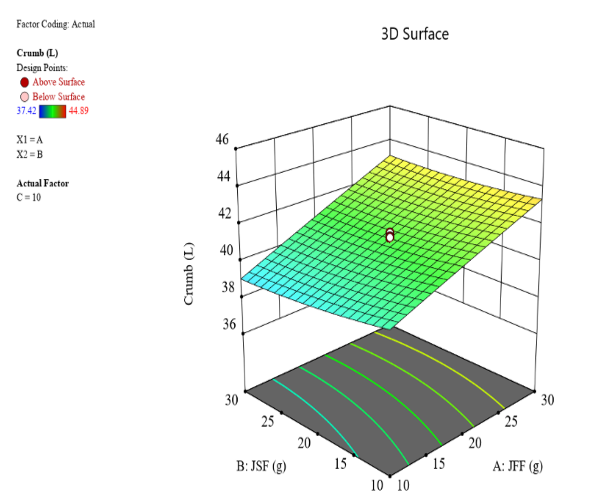

Figure 5: Crumb color (L) value

OAA

In run #19, the OAA was lowest at 3.93 ± 1.3 (in which no Mapillai samba rice flour was added) but in run #13 the OAA was highest at 5.33 ± 1.3. Figure 6 shows that the equal amounts of JFF and JSF brought the hedonic scale value to a higher range. JFF flour contributed to the sweetness and color acceptability. Hence, JSF, JFF and MSRF proportions were adopted from the compositions used in run #13. As per the OAA, the final bread product was baked with 20 g of JSF, 20 g of JFF and 10 g of MSRF.

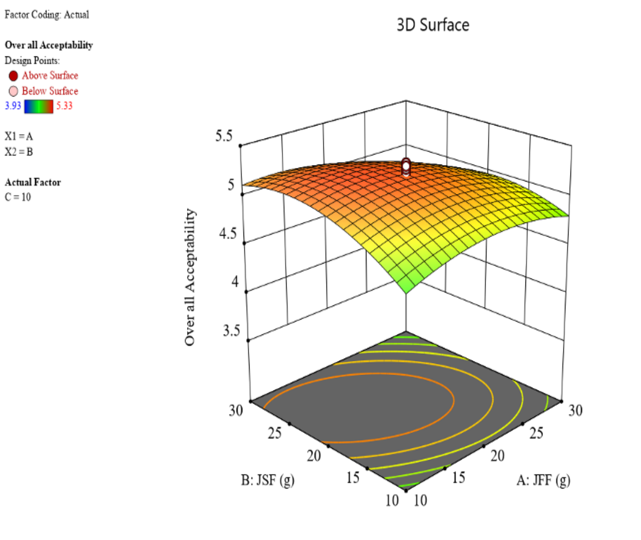

Figure 6: Overall acceptability

Table 4: The constraints fixed for numerical optimization

Name	*Goal*	*Low value*	*High value*
A:JFF	is in range	10	30
B:JSF	is in range	10	30
C:MSRF	is in range	5	15
Loaf volume	Maximize	272	390
Hardness	Minimize	130.617	384.573
Springiness	Maximize	0.338	0.523
Crust color (L)	Minimize	24.2	40.32
Crumb (L)	is in range	37.42	44.89
Overall acceptability	Maximize	3.93	5.33

Key to Table: JFF: Jackfruit Flour; JSF: Jackfruit Seed Flour; MSRF: Mapillai Samba Rice Flour

Table 5: Scores of predicted value and experimental value

Solution 1 of 63 response	*Predicted values*	*Experimental value*
Loaf volume (cm^3)	386.08	385 ± 4.18
Hardness (N)	208.7	209.65 ± 1.35
Springiness	0.49	0.49 ± 0.01
Crust color (L)	28.93	28.83 ± 0.73
Crumb (L)	38.42	38.51 ± 0.36
Overall acceptability	5	5.7 ± 0.46

Statistical Data Analysis

Optimisation of variables and verification

The numerical optimization of the dependent variables was applied to the Design-Expert software (Version 12) to extract the independent variable. Table 4 shows that constraints were fixed to independent and response variables to maximize characteristics such as bread volume, springiness and OAA, while minimizing the less favorable characteristics such as hardness, keeping the L* value of crust and crumb within range. To achieve optimization, the independent variables were controlled with the response variables, namely maximization of loaf volume, springiness and overall acceptability with the achieved minimization of hardness to bring the L* value in range as shown in Table 4.

Table 5 shows that at the optimum level, the predicted values for responses were bread volume 386.08 cm^3, hardness = 208.70 N, springiness = 0.49, L* =28.93 and L* crumb= 38.42, OAA = 5. The conforming model was achieved by performing the experiment at 3 optimized levels of independent factors (JFF = 10%, SF = 30%, MSRF-15%). Table 5 shows that the experimental values were in close alignment with the predicted values and were within ± 5 % of each other.

In Table 6, an approximate comparison of the proximate nutritional composition of the optimized experimental bread with regular gluten bread shows that the amount of carbohydrate, crude fibre and moisture is higher in the experimental gluten-free bread while the ash value, protein content and fat values are lower for 100 g of bread. So, a slice of gluten bread has 3 g of protein, 16 g of carbohydrates and 1.24 g of fat, while a slice of this gluten-free bread has 2 g of protein, 18 g of carbohydrates and .07 g of fat (Ronie M. E *et al.* 2023).

This study has shown that gluten-free bread can not only be acceptable in physical characteristics such as loaf volume, texture and sensory acceptability when compared to regular gluten wheat bread but is also nutritionally comparable. This will be a bonus for the emerging gluten-sensitive populations that have been deprived of this vital commodity.

Table 6: Proximate composition of optimized gluten-free bread and regular wheat bread (100 grams-approximately 3 slices)

	Moisture	*Total ash*	*Protein*	*Fat*	*Crude fibre*	*Carbohydrate*
Gluten-free bread	37.92 ± 1.22	0.67 ± 0.02	6.15 ± 0.03	0.21 ± 0.01	0.84 ± 0.03	54.41 ± 0.11
Regular wheat bread	34.90 ± 0.92	1.16 ± 0.20	11.43 ± 0.08	3.72 ± 0.37	0.40 ± 0.06	48.38 ± 1.23

Conclusion

Gluten-free breads are becoming increasingly popular and the ingredients used to make such breads vary widely. There have been issues as a result of the lack of gluten in gluten-free bread, and mixture design has become an important tool for optimizing the right combination of the different ingredients. JF flour contributed to the texture and body of the bread while JSF impacted the sweetness and L* color and crumb and, consequently, the sensory attributes. The amylose content of MSRF contributed to the loaf volume. The JSF added to the protein content while the unprocessed whole grain nature of MSRF added to the total nutritional value. In striving to meet the lack of these attributes, adding an extraneous hydrocolloid was deemed essential and proved effective. This study showed that the use of locally available ingredients can be optimized to make a successful bread with texture and sensory acceptability to compare well with regular gluten bread. Just because celiac patients and gluten-sensitive populations have to adjust to food products without adding gluten, it becomes necessary to provide adequate and comparable substitutes that are gluten-free yet provide texture and sensory acceptability in a commonly used product like bread. Hence, this bread adequately meets the challenges of providing gluten-free bread for gluten-sensitive populations and holds great promise for commercial and industrial use.

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