Response surface optimization of baking parameters for improved quality loaf with local content in a developing economy

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This study borders on the optimum combination of imported wheat flour and local cassava flour for bread making at optimal baking time and temperature. The aim is to increase local content in bread production in a developing economy –Nigeria, while attaining acceptable quality bread loaf using response surface methodology. The three factors under consideration are Baking time, X_1 *(in minutes), Baking temperature,* X_2 *(in degree Celsius) and Wheat/Cassava mix concentration,* X_3 *(in percentage). Three important qualities of baked loaf to be monitored are moisture content,* Y_1 *(in percentage), volume of loaf,* Y_2 *(in cm^3) and plastic limit,* Y_3 *(in cm). Different variations of central composite design (CCD) involving the different axial distances and partial replications of the cube and star portions were evaluated using fraction of design space graphs. This is to identify, among the numerous design options, the design that gives the best spread of minimum variance of prediction of responses throughout the design region. CCD with cuboidal axial distance and with the star portion replicated twice was selected and laboratory results, analyzed using Design Expert 12, gave optimal values of the baking factors and responses.*

Keywords: baking temperature, baking time, cassava/wheat flour, central composite design, design replication

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1 Introduction

Bread is a staple food known across colour and culture throughout the globe. Wheat flour is the most common type of flour used in baking bread and according to Pillsbury and Ekebald (2019), flour made from wheat grains is the most satisfactory type of flour for baked products. The heavy presence of gluten in wheat has led to efforts for other grains and food materials to complement wheat flour in bakery (Lamacchina et al., 2014). Efforts have been made to sustain bread production and availability through the use of other sources of flour such as rye, barley, oats, sorghum, millet, rice corn and tubers such as cassava, often in combination with wheat flour: see Cauvain (2015).

Nigeria, for instance, depends a lot on imported wheat flour to sustain her baking industry and meet the demands for wheat-based consumer foods. According to Nzeka (2019), Nigeria's wheat importation stands at 5.6 million metric tonnes for the 2019/2020 market year which is about a four percent increase from that of the 2018/2019 market year. On the other hand, local wheat production stands at paltry sixty thousand metric tonnes for the 2019/2020 market year. Moreover, according to Nzeka (2019), local wheat contains qualities which are not suited for bread production such as high protein content, less moisture and gluten (see, also, Lyddon, 2018). Therefore, there is heavy dependence on imported wheat flour. According to Olukoya (2019), Nigeria's cost of imported wheat is estimated to worth 362 billion Nigerian Naira in 2018, accounting for 42.5 percent of total amount spent on

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importation of agricultural products in 2018.This has put a lot of strain on the prices of wheat-based foods such as bread with the increasing population of the country (Lyddon, 2019).

There is need for the use of flour from locally available farm products to complement the use of wheat flour in Nigeria's baking industry to reduce the high cost of wheat-based bakery products. Supplementing wheat flour or finding a composite complement such as maize, cowpea, rye, millet, etc. has been the subject of some studies: see, for example, Olaoye et al. (2006), Ade-Omowaye et al. (2008), Alozie et al (2009), Chavan et al. (2009), Ahmed and Campbell (2012), Igbabul et al. (2013), Olapade and Oluwole (2013), Olaoye et al. (2015), Olaoye et al. (2016), Azeez et al. (2018) and Olaoye and Obidegwe (2018). Among the many local composite wheat complements mentioned earlier, cassava flour is the most abundant in Nigeria as Nigeria is ranked world's largest producer of cassava: see, for example, Akinkpelu et al. (2011) and Worldatlas (2017).

The use of cassava flour in Nigeria as composite wheat flour has been adopted by many Nigerian baking industries as the Federal Government enacted a law empowering bakers to include 10 percent of cassava flour in all bakery products. This is aimed at curtailing the huge amount spent by the government annually in importing wheat flour to meet local demand for baked food. However, independent observations have shown that many local bakeries use arbitrary quantity of cassava flour in bread production, resulting in very low quality loaf with very low shelf-life, high moisture content, etc. Moreover, government's choice of 10 percent cassava flour is also arbitrary and there is no guarantee that it will lead to acceptable quality loaf. In this study, we employed response surface methods to obtain a central composite design (CCD) variation with minimum variance of prediction for optimum combination of local cassava and imported wheat flours in bread production. Some of the successful applications of response surface methodology in optimizing food production include Charkraborty et al. (2011), Sakiyan (2014), Nahemiah et al. (2016), Osman et al. (2017) and Panghal et al. (2018).

2 Procedure

The parameters of interest are Baking time, X_1 (in minutes), Baking temperature, X_2 (in degree Celsius) and Wheat/Cassava mix concentration, X_3 (in percentage) while the bread quality characteristics considered are moisture content, Y_1 (in percentage), volume of loaf, Y_2 (in cm^3) and plastic limit, Y_3 (in cm). The central composite design (CCD) was developed by Box and Wilson (1951) and has become the most useful second-order design for response surface exploration. To construct the CCD, X_1 was set at low level of 10 minutes and high level of 20minutes, X_2 was set at low level of 195 degrees Celsius and high level of 245 degrees Celsius while X_3 was set at low level of 10 percent cassava concentration and high level of 40 percent cassava concentration. With this, the initial design matrix of the CCD was constructed to reflect the actual values for the experiment. The initial design matrix with cuboidal alpha and with one centre point is given in Figure 1 while the coded values are presented in Figure 2.

$$X' = \begin{array}{c} X_1 \\ X_2 \\ X_3 \end{array} = \begin{array}{ccccccccccccccc} 10 & 20 & 10 & 20 & 10 & 20 & 10 & 20 & 10 & 20 & 15 & 15 & 15 & 15 & 15 \\ 195 & 195 & 245 & 245 & 195 & 195 & 245 & 245 & 220 & 220 & 195 & 245 & 220 & 220 & 220 \\ 10 & 10 & 10 & 10 & 40 & 40 & 40 & 40 & 25 & 25 & 25 & 25 & 10 & 40 & 25 \end{array}$$

Figure 1: Initial Design Matrix for Cuboidal Axial Distance with One Centre Point for the Illustrative Example

$$X' = \begin{array}{ccccccccccccccc} -1 & 1 & -1 & 1 & -1 & 1 & -1 & 1 & -1 & 1 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & 1 & 1 & -1 & -1 & 1 & 1 & 0 & 0 & -1 & 1 & 0 & 0 & 0 \\ -1 & -1 & -1 & -1 & 1 & 1 & 1 & 1 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \end{array}$$

Figure 2: Coded Levels for the Design in Figure 1

For the purpose of selecting the best design, the cube and star portions of the CCD were partially replicated and evaluated graphically at different axial distances. The replicated variations of the CCD considered include two cubes plus one star (C_2S_1), one cube plus two stars (C_1S_2), three cubes plus one star (C_3S_1), one cube plus three stars (C_1S_3), four cubes plus one star (C_4S_1) and one cube plus four stars (C_1S_4). These variations were evaluated with the traditional CCD, C_1S_1. Dykstra (1960) and Chigbu and Ukaegbu (2017) discussed some of the advantages of partial replications of the CCD. The total number of runs, N, for the experiment is given by $N = n_c f + 2n_s k + n_0$, where $k = 3$ is the number of factors, n_c is the number of replication of the factorial runs, f, while n_s is the number of replication of the axial runs, $2k$ and n_0 is the number of runs at the centre. The design that displays the smallest variance of prediction is considered the most suitable for optimum combination of composite wheat flour in bread production. The prediction variance is given by

$$V[\hat{y}(x)] = \mathbf{x}'(X'X)^{-1}\mathbf{x}, \tag{1}$$

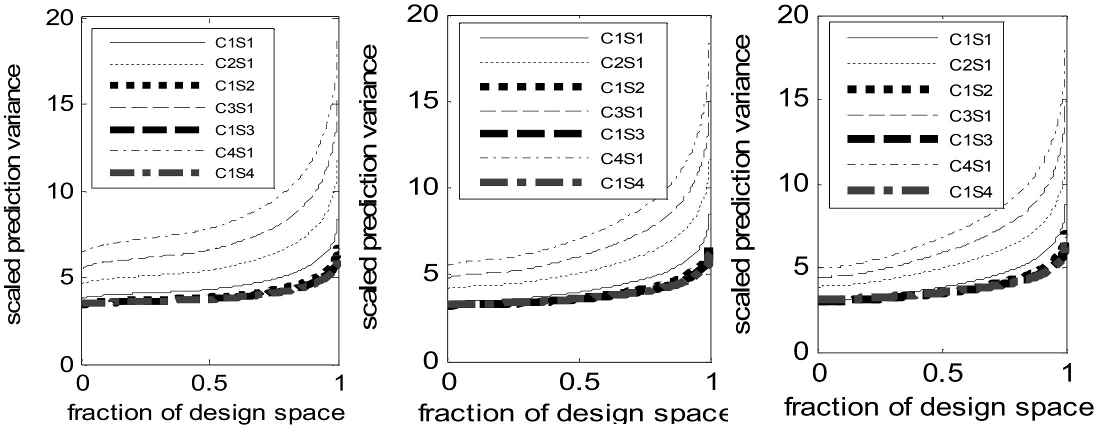
where $\hat{y}(x)$ is the predicted response at point, $\mathbf{x}$, in the design space, where $\mathbf{x}' = [1; x_1, x_2, x_3; x_1^2, x_2^2, x_3^2; x_1x_2, x_1x_3, x_2x_3]$ and $(X'X)^{-1}$ is the inverse of the information matrix, $X'X$. The prediction variance is scaled by multiplying by N, the number of design runs to obtain the scaled prediction variance (see, for example, Ukaegbu and Chigbu, 2015),

$$NV[\hat{y}(x)] = N\mathbf{x}'(X'X)^{-1}\mathbf{x}, \tag{2}$$

which is the appropriate metric for comparing the designs graphically. Ideally, the smaller the scaled prediction variance of the design across the entire design space, the better the prediction capability of the design.

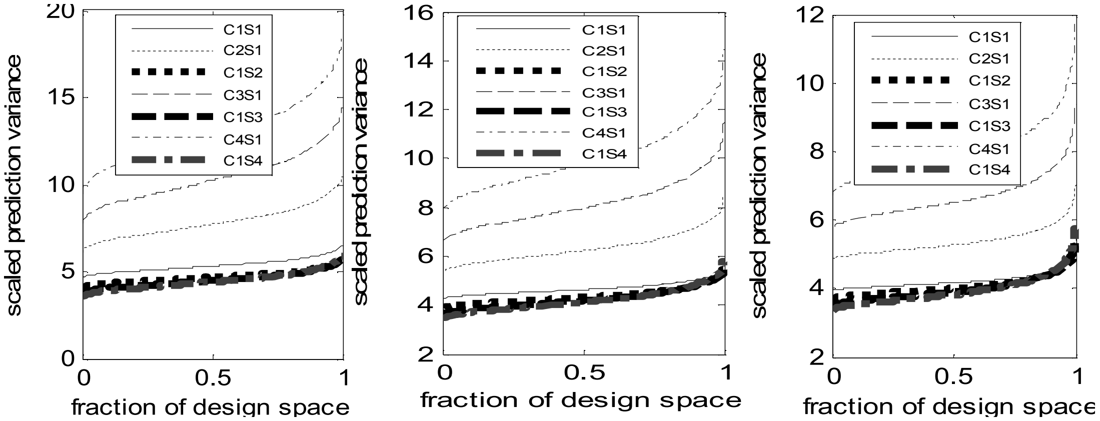
3 Graphical Evaluation

The fraction of design space graph (FDSG) was developed by Zahran et al. (2003) as a graphical method for assessing the prediction variance characteristics of a response surface design. The graphs are presented in Figures 3 to 6 for the scaled prediction variances of the variations of the CCD and for $n_0 = 1$, 2 and 3 centre points.



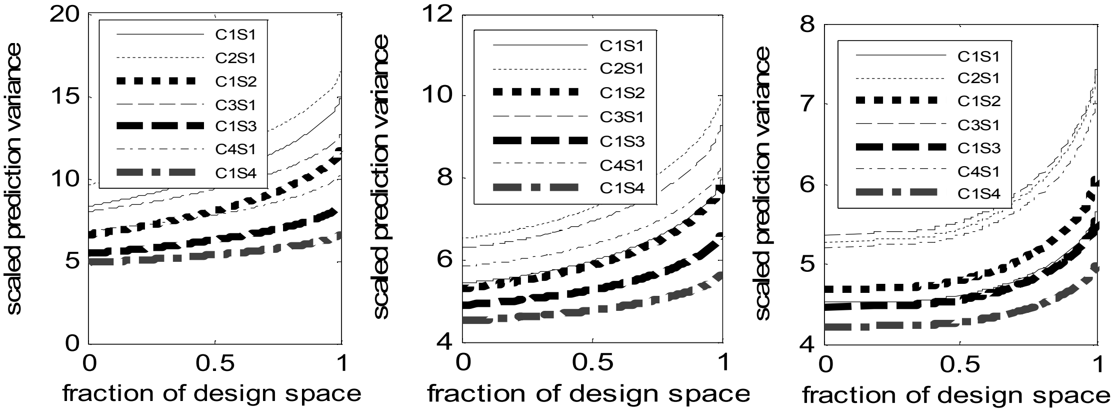
(a) (b) (c)

Figure 3: FDSG for Scaled Prediction Variances for (a) $n_0 = 1$ (b) $n_0 = 2$ (c) $n_0 = 3$ for the Cuboidal CCD



(a) (b) (c)

Figure 4: FDSG for Scaled Prediction Variances for (a) $n_0 = 1$ (b) $n_0 = 2$ (c) $n_0 = 3$ for the Orthogonal CCD



(a) (b) (c)

Figure 5: FDSG for Scaled Prediction Variances for (a) $n_0 = 1$ (b) $n_0 = 2$ (c) $n_0 = 3$ for the Rotatable CCD

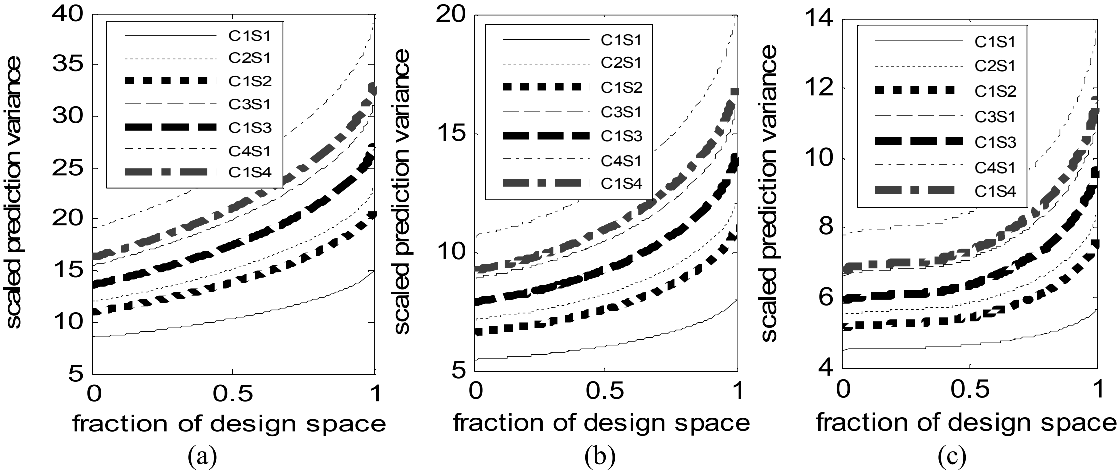


Figure 6: FDSG for Scaled Prediction Variances for (a) $n_0 = 1$ (b) $n_0 = 2$ (c) $n_0 = 3$ for the Spherical CCD

The next step is to select the best design from each group for a given axial distance, α, based on their prediction variance performance. The selected designs are further compared in order to select the one with the lowest and most stable prediction variance. The graphs in Figure 3 show that among variations of the cuboidal CCD with axial distance, α = 1 , the replicated-star CCD has the best spread of small prediction variances across the entire design space which seems not to improve much with additional centre points. The scaled prediction variance graphs show that additional replication of the star portion does not improve the prediction capability of the replicated-star CCD options. The CCD, C_1S_1, tend to compete with the replicated-star options for about 40 percent of the design space beyond which the scaled prediction variance deteriorates. The replicated-cube CCD options display very poor prediction capabilities with high scaled prediction variance. Based on these, the replicated-star CCD option, C_1S_2, with $n_0 = 1$ centre point is recommended since it has the same prediction variance characteristics with the other replicated-star CCD options but with the smallest number of experimental runs, $N = 21$.

The performances of variations of the orthogonal CCD in Figure 4 are similar to those of the cuboidal CCD discussed above where the replicated-star CCD variations are the best. However, an additional centre point improves the prediction variance performances slightly. The C_1S_1 option has low prediction variances but not as close as the case of cuboidal CCD while the cube-replicated variations are very poor. Considering the slight improvement with an additional centre point, the replicated-star CCD option, C_1S_2, with $n_0 = 2$ centre points and with smaller sample size compared to $C_1S_3$and C_1S_4 which display similar prediction variance properties but with higher sample sizes, is selected from the group of orthogonal CCD variations. Furthermore, variations of CCD with practical alpha, $\alpha = \sqrt[4]{k}$, behave exactly like their orthogonal counterparts and therefore, not presented to avoid unnecessary duplications.

The rotatable CCD variations in Figure 5 also have the replicated-star options as the best with minimum scaled prediction variances. There are improvements in the prediction variance performances of the designs as the number of centre points increases from $n_0 = 1$ to $n_0 = 2$. An additional centre point does not have significant effect in reducing the scaled prediction variances. Considering the obvious differences in the spread of scaled prediction variances of the replicated-star options, the design, C_1S_3, is selected from the group of rotatable CCD variations.

For the variations of spherical CCD with $\alpha = \sqrt{k}$, the graphs in Figure 6 show that C_1S_1 has the lowest and most stable scaled prediction variances throughout the entire design region which improves with additional centre points and was, therefore, selected with $n_0 = 3$ centre points. The other replicated variations, as shown in the graphs, deteriorate as the replication increases by displaying high prediction variances across the entire design space.

Furthermore, the four selected designs were subjected to further evaluation using the FDSG but now on a common scale to determine the best out of the four. The FDSGs are displayed in Figure 7. The graphs show that the star-replicated cuboidal CCD option, C_1S_2, displayed the most stable and smallest prediction variances throughout the entire design space. Based on this, the replicated-star CCD in cuboidal region, where $\alpha = 1$, is recommended for the experiment to predict responses with minimum precision. The design is displayed in Figure 8.

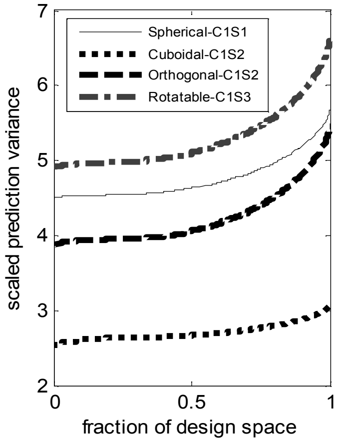


Figure 7: FDS plots of Selected Optimal Designs, Spherical-C_1S_1, Cuboidal-C_1S_2, Orthogonal-C_1S_2, and Rotatable-C_1S_3

$$\begin{array}{rccccccccccccccccccccc}
X_1 & 10 & 20 & 10 & 20 & 10 & 20 & 10 & 20 & 10 & 10 & 20 & 20 & 15 & 15 & 15 & 15 & 15 & 15 & 15 & 15 & 15 \\
X' = X_2 = & 195 & 195 & 245 & 245 & 195 & 195 & 245 & 245 & 220 & 220 & 220 & 220 & 195 & 195 & 245 & 245 & 220 & 220 & 220 & 220 & 220 \\
X_3 & 10 & 10 & 10 & 10 & 40 & 40 & 40 & 40 & 25 & 25 & 25 & 25 & 25 & 25 & 25 & 25 & 10 & 10 & 40 & 40 & 25
\end{array}$$

Figure 8: Design Matrix of the Actual Values of C_1S_2 with One Centre Point and Cuboidal Alpha for the Example

Each column of Figure 8 represents an experiment to be conducted by setting the variables to the corresponding actual values.

4 Determination of Optimal Solution

Some numerical data were obtained from the laboratory of Home Science, Nutrition and Dietetics Department, University of Nigeria, Nsukka, Nigeria. This was achieved by performing twenty-one baking experiments (corresponding to the twenty-one runs of the CCD) with each experiment set to the actual values of the three experimental factors in each column of Figure 8. The values of the moisture content, volume of loaf and elastic limit were measured after each experiment. The data from the experiments are displayed in Table 1.

Table 1: Actual Design Values and Corresponding Response Values from Laboratory Experiments

S/N	Time (mins)	Temperature (^0C)	Wheat/Cassava (%)	Y_1, Moisture (%)	Volume (cm^3)	Plastic Limit (cm)
1	10	195	10	9.50	716.74	0.31
2	20	195	10	8.0	676.92	0.21
3	10	245	10	8.70	703.47	0.20
4	20	245	10	5.10	570.74	0.146
5	10	195	40	7.20	544.19	0.09
6	20	195	40	5.20	504.37	0.11
7	10	245	40	7.10	584.01	0.05
8	20	245	40	5.59	584.01	0.11
9	10	220	25	7.00	584.01	0.154
10	10	220	25	7.70	676.92	0.20
11	20	220	25	7.00	584.01	0.154
12	20	220	25	6.90	597.29	0.18
13	15	195	25	8.30	610.56	0.19
14	15	195	25	6.90	597.29	0.18
15	15	245	25	5.30	570.74	0.16
16	15	245	25	5.59	663.65	0.16
17	15	220	10	8.30	690.19	0.26
18	15	220	10	9.30	703.47	0.20
19	15	220	40	6.20	570.74	0.17
20	15	220	40	6.55	601.22	0.14
21	15	220	25	7.61	590.52	0.173

Table 2: Confirmation of Predicted Response Values

Solution 3 of 100 Response	Predicted Mean	Predicted Median	Std. Dev.	SE Mean	95% CI low for Mean	95% CI high for Mean
Moisture	6.31298	6.31298	0.824744	0.298453	5.6833	6.94266
Volume	591.146	591.146	38.4931	13.9296	561.757	620.535
Plastic Limit	0.161071	0.161071	0.0271933	0.00984053	0.139966	0.182177

Design Expert version 12 software by Stat-Ease (2019) was used in analyzing the experimental data to obtain the optimal baking solution for a combination of wheat and cassava flours in bread making. The variance inflation factor(VIF) of the components of the second-order model of the CCD ranges from 1.0 to 1.08791 (see Appendix A), which shows that there is no multicollinearity existing among the factors and the parameters are not poorly estimated. Out of more than one hundred solutions (see Appendix B) considered by the software, the solution selected by the Design Expert software has the following optimal characteristics: Time is 20 minutes, Temperature is 220 Degree Celsius, Wheat/Cassava concentration is 25 % of cassava, Moisture is 6.31298 %, Volume of loaf is 591.146 cm^3 and Plastic limit is 0.16107 cm. This optimal solution was subjected to confirmatory test using the Design Expert 12 facility at 95 percent confidence interval. The confirmatory results corresponded with the optimal solutions and further revealed that the predicted mean and predicted median values of moisture content, volume of loaf and plastic limit are the same with their optimal values (see Table 2).

5 Implications and Conclusion

We now highlight some of the implications of these results. The federal Government of Nigeria, in 2002, adopted a policy which compels the bakery industry in Nigeria to include 10 % of cassava flour to their bakery products. This was as a result of improved varieties of cassava from the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. This was a way of ensuring inclusion of local content to bakery products consumed in the country. However, through this study, we are recommending 25 % cassava flour for bread production in Nigeria, which is a 150 % increment to the Federal Government's recommendation. And at temperature of 220 degrees Celsius and 20 minutes of baking time, quality bread loaf with optimal moisture (6.31298%) content, volume (591.146cm^3) and plastic limit (0.16107cm) is achievable in developing country, like Nigeria.

The addition of 25 % cassava flour to bread production in Nigeria will drastically reduce the high cost of importing wheat flour, increase the local production of cassava flour across the country and provide viable employment opportunities to the Nigerian teeming unemployed population. The Association of Master Bakers and Caterers of Nigeria, in a report in Vanguard (a Nigerian newspaper) in 2017 reveals that utilizing 10 % of refined cassava flour in bread production will inject about 255 billion Nigeria Naira into the Nigerian economy. The findings of this research indicate that the amount may increase by 150 %.

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Appendix A: Variance Inflation Factors of Design Variables

Term	Standard Error*	VIF	R_i^2	Power
A	0.2887	1	0.0000	88.3 %
B	0.2887	1	0.0000	88.3 %
C	0.2887	1	0.0000	88.3 %
AB	0.3536	1	0.0000	73.1 %
AC	0.3536	1	0.0000	73.1 %
BC	0.3536	1	0.0000	73.1 %
A^2	0.4599	1.08791	0.0808	97.6 %
B^2	0.4599	1.08791	0.0808	97.6 %
C^2	0.4599	1.08791	0.0808	97.6 %

Note: A, B and C represent factors X_1, X_2 and X_3, respectively.

Appendix B: Results of Different Solutions for the Baking Parameters

Number	Time	Temperature	Wheat/Cassava Concentration	Moisture	Volume	Plastic Limit	Desirability	
1	11.030	229.156	39.885	6.569	579.956	0.093	1.000	
2	15.000	220.000	10.000	8.019	671.562	0.224	1.000	
3	**20.000**	**220.000**	**25.000**	**6.313**	**591.146**	**0.161**	**1.000**	Selected
4	19.000	240.000	37.000	5.218	552.916	0.138	1.000	
5	20.000	195.000	40.000	6.035	532.851	0.130	1.000	
6	15.000	245.000	25.000	6.454	617.692	0.147	1.000	
7	15.000	195.000	25.000	7.740	613.267	0.191	1.000	
8	15.000	220.000	40.000	6.175	559.397	0.114	1.000	
9	10.000	220.000	25.000	7.881	639.812	0.177	1.000	
10	10.000	245.000	10.000	8.160	698.107	0.211	1.000	
11	10.000	195.000	40.000	7.603	581.517	0.109	1.000	
12	20.000	195.000	10.000	7.878	645.016	0.214	1.000	
13	10.667	198.333	12.000	9.133	683.255	0.285	1.000	
14	15.000	220.000	25.000	7.097	615.479	0.169	1.000	
15	20.000	245.000	10.000	6.591	649.441	0.158	1.000	
16	11.995	204.067	29.162	7.723	613.132	0.169	1.000	
17	15.865	244.722	35.593	5.674	573.852	0.124	1.000	
18	17.532	229.443	31.463	6.060	579.831	0.144	1.000	
19	16.990	217.387	16.981	7.345	635.544	0.192	1.000	
20	10.767	232.618	31.886	7.013	611.450	0.127	1.000	
21	15.356	203.515	22.592	7.614	621.290	0.193	1.000	
22	17.503	198.496	24.600	7.283	602.891	0.181	1.000	
23	13.380	213.418	10.149	8.433	678.308	0.246	1.000	
24	14.879	217.923	35.521	6.523	576.545	0.131	1.000	
25	11.020	243.817	37.923	6.314	588.641	0.093	1.000	
26	15.621	212.924	24.172	7.233	614.928	0.177	1.000	
27	12.954	222.308	30.072	7.047	606.679	0.148	1.000	
28	18.095	228.449	32.029	5.962	574.883	0.144	1.000	

29	10.303	236.162	15.617	7.994	674.851	0.200	1.000	
30	16.772	228.474	37.007	5.863	562.714	0.129	1.000	
31	11.453	200.223	14.300	8.820	670.999	0.261	1.000	
32	14.157	208.356	16.151	8.073	651.636	0.221	1.000	
33	10.688	238.302	21.050	7.545	652.851	0.171	1.000	
34	16.901	237.135	17.641	6.810	635.259	0.169	1.000	
35	15.651	209.258	23.752	7.348	616.023	0.182	1.000	
36	14.709	207.841	20.356	7.741	633.181	0.200	1.000	
37	16.346	208.674	16.571	7.695	639.440	0.206	1.000	
38	13.125	231.620	35.556	6.444	586.163	0.119	1.000	
39	19.352	220.001	35.565	5.765	554.798	0.142	1.000	
40	11.768	231.862	25.427	7.272	630.660	0.158	1.000	
41	16.736	197.652	27.920	7.221	594.136	0.171	1.000	
42	11.585	243.061	18.689	7.427	657.736	0.172	1.000	
43	12.566	213.206	24.176	7.704	629.805	0.184	1.000	
44	18.493	232.307	13.048	6.967	644.254	0.177	1.000	
45	12.197	232.347	17.526	7.678	658.155	0.191	1.000	
46	11.538	203.207	20.937	8.322	646.034	0.217	1.000	
47	13.155	241.295	26.561	6.743	620.509	0.144	1.000	
48	11.200	231.598	20.682	7.660	651.142	0.181	1.000	
49	16.188	222.074	11.415	7.692	660.673	0.207	1.000	
50	12.997	196.073	37.785	7.241	575.306	0.127	1.000	
51	17.746	212.712	38.187	6.044	552.166	0.131	1.000	
52	19.740	244.814	32.329	5.265	567.204	0.145	1.000	
53	15.928	203.553	19.220	7.730	631.119	0.204	1.000	
54	12.782	232.691	31.589	6.714	602.764	0.133	1.000	
55	12.344	228.665	13.030	8.026	673.926	0.215	1.000	
56	11.084	201.237	18.319	8.605	657.853	0.238	1.000	
57	17.273	233.507	20.311	6.681	623.145	0.166	1.000	
58	19.939	227.430	20.793	6.390	607.827	0.164	1.000	
59	18.437	214.895	25.424	6.663	596.717	0.165	1.000	
60	19.805	229.179	33.663	5.575	560.516	0.145	1.000	
61	15.991	230.726	23.206	6.776	618.313	0.164	1.000	
62	11.773	230.316	27.792	7.166	621.658	0.150	1.000	
63	18.545	206.980	12.935	7.618	642.184	0.205	1.000	
64	11.419	201.993	25.805	8.073	628.305	0.191	1.000	
65	15.345	227.864	12.876	7.586	659.825	0.200	1.000	
66	17.966	196.969	29.599	6.942	581.812	0.162	1.000	
67	16.693	221.161	18.545	7.198	631.478	0.184	1.000	
68	16.263	210.162	27.895	6.974	597.637	0.164	1.000	
69	10.021	234.440	10.105	8.422	696.675	0.231	1.000	
70	10.608	226.746	21.288	7.840	651.327	0.186	1.000	
71	15.979	201.805	29.318	7.146	592.957	0.164	1.000	
72	19.969	205.777	24.754	6.699	590.958	0.168	1.000	
73	18.761	199.205	39.057	6.179	542.778	0.131	1.000	
74	18.680	234.012	29.946	5.856	580.320	0.147	1.000	

75	16.923	242.007	26.413	6.142	602.787	0.147	1.000	
76	12.460	196.756	33.686	7.560	593.311	0.149	1.000	
77	19.185	231.934	36.094	5.452	554.688	0.140	1.000	
78	16.006	221.375	24.172	6.955	613.802	0.169	1.000	
79	13.218	237.226	28.728	6.704	611.737	0.141	1.000	
80	19.113	221.073	39.431	5.538	541.601	0.133	1.000	
81	15.355	200.827	18.891	7.910	634.897	0.211	1.000	
82	13.923	203.929	35.845	7.013	578.751	0.134	1.000	
83	18.224	242.785	32.335	5.554	574.378	0.140	1.000	
84	10.014	222.542	33.278	7.305	609.020	0.128	1.000	
85	19.454	239.670	28.127	5.700	583.855	0.149	1.000	
86	18.024	227.296	36.486	5.729	558.462	0.135	1.000	
87	12.206	200.153	23.022	8.168	634.715	0.207	1.000	
88	10.295	205.580	12.073	9.000	685.435	0.274	1.000	
89	17.248	242.514	28.109	5.974	594.908	0.144	1.000	
90	12.815	225.790	31.573	6.887	602.051	0.138	1.000	
91	14.353	234.254	34.188	6.267	585.536	0.127	1.000	
92	14.650	232.236	20.245	7.129	636.041	0.174	1.000	
93	17.868	229.636	37.149	5.653	556.948	0.133	1.000	
94	18.007	223.765	10.715	7.406	654.587	0.195	1.000	
95	11.250	226.602	25.333	7.495	633.070	0.165	1.000	
96	14.487	229.921	39.777	6.014	563.604	0.110	1.000	
97	13.217	213.586	35.535	6.894	584.199	0.130	1.000	
98	10.837	214.571	18.287	8.302	660.358	0.219	1.000	
99	19.589	223.444	11.041	7.147	645.644	0.184	1.000	
100	12.093	234.649	20.040	7.481	649.470	0.177	1.000	