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Supplementary Materials

Optimization of a gas-fired *gurasa* (local bread) baking oven using response surface methodology (RSM)

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ABSTRACT

Gurasa (local bread) is an important diet in many households in Northern parts of Nigeria for time immemorial, especially in Kano State, Nigeria. This study is to develop a *gurasa* baking oven, carry out the performance evaluation of the oven and also to optimize the baking parameters of the oven using the response surface methodology (RSM). The oven is composed of three baking compartments; these include a heat source, a control panel and the main frame. The baking compartments consist of heating rods and the *gurasa* baking trays. The heat source is a gas burner that generates the required heat to bake the products. There is a control panel that is used to set the temperature at which the gas cylinder goes off (after the preheating of the oven) and the heat in the oven is maintained for some time with the aid of the insulator in between the walls. Using the response surface method, the oven was evaluated to know its baking efficiency, baking damage, and capacity. The oven has a baking efficiency of 87.5 %, baking damage of 11.5 % and a capacity of 23.4 kg/hr with 27 loaves per batch. The RSM showed values of the responses ranged from 16 – 95 g, 5.24 – 13.6 %, 845.8 – 3684.2 N/m^2 and 0.7–8.06 cm^3/g for weight loss, moisture content, tensile strength and specific volume respectively. Quadratic models to predict weight loss, moisture content, tensile strength and specific volume of *gurasa* in terms of baking temperature, baking period and mass of dough were developed. The optimum baking process was achieved at a baking temperature of 200^oC, a baking period of 9 minutes and a dough mass of 130 g. These values show that the oven can be adopted for domestic and commercial baking.

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Appendix 1: ANOVA for response surface quadratic model of the performance evaluation of the oven

Source	Df	Weight loss (g)		Moisture content (%)		Tensile strength (N/m^2)		Specific volume (cm^3/g)	
		Sum of squares	p-value	Sum of squares	p-value	Sum of squares	p-value	Sum of squares	p-value
Model	9	13966.56	< 0.0001	80.72	< 0.0001	1.50E+07	< 0.0001	99.93	< 0.0001
A-A: Temperature	1	0.5	0.7718	12.45	< 0.0001	13390.66	0.367	0.546	0.1789
B-B: Period	1	0.5	0.7718	2.18	0.0036	41702.72	0.1326	0.019	0.7885
C-C: Mass of Dough	1	32	0.0466	15.29	< 0.0001	1.21E+07	< 0.0001	70.92	< 0.0001
AB	1	156.25	0.0011	1.77	0.0063	69247.92	0.0644	1.56	0.0394
AC	1	0.25	0.8372	0.2916	0.1615	9900.25	0.4344	0.0306	0.7339
BC	1	12.25	0.1792	0.4096	0.1060	62525	0.0757	0.9506	0.0894
A^2	1	4481.64	< 0.0001	14.10	< 0.0001	1996.42	0.7207	5.4	0.0022
B^2	1	5960.59	< 0.0001	6.22	0.0002	21948.8	0.2568	10.74	0.0003
C^2	1	3633.22	< 0.0001	28.03	< 0.0001	2.62E+06	< 0.0001	7.11	0.001
Residual	7	38.5		0.8334		1.01E+05		1.71	
Lack of Fit	3	38.5		0.8334		1.01E+05		1.71	< 0.0001
Pure Error	4	0		0.0000		0		0.0003	
R^2		0.9973		0.9898		0.9933		0.9831	
Adjusted R^2		0.9937		0.9766		0.9848		0.9615	
Predicted R^2		0.9560		0.8365		0.8934		0.7304	
C.V. %		6.66		3.20		6.78		13.55	
Adequate precision		42.5309		30.8732		29.5497		18.9971	

Appendix 2: Plot of predicted against the experimental values for various responses