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Application of Response Surface Methodology for Nutritional Properties of Cookies Fortified with Niger

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ABSTRACT: The present research aimed to examine the feasibility of using extremely nutritious Niger seed in baked goods and evaluate the nutritional properties made using whole Niger flour and sugar replacements to develop niger fortified cookies. In this research work, the independent parameter, i.e., WNF (whole niger flour): RWF (refined wheat flour) (90:10–70:30), sugar (20-60g), shortening agent (15-35g), baking powder(2.5-4.5g) for the development of niger fortified cookies with high protein, and nutrient-dense and to maximize the acceptability by the application of mathematical approach based on CCRD RSM was successfully used to optimize the niger flour fortified cookies beneficially. The optimal combination of different ingredients required to produce cookies was a moisture content of 22.388%, protein 14.945%, fat 29.307%, carbohydrate 50.135%, crude fiber 2.394%, calcium 93.534%, phosphorus 235.948 %, Zinc 2.640%, Iron 11.354% at WNF: RWF 22.388g, sugar 41.617g, shortening 24.143g, baking powder 3.5g respectively. The final consumer perceives the nutritional properties of cookies as criteria of quality.

Keywords: Nutritional, Niger, Fortified, Cookies, RSM.

INTRODUCTION

The bakery's goods In both rural and urban homes, bread, cookies, and biscuits are everyday food treats. Cookies are significant in the backed snack food category due to their scent, flavour, and crispness. All age groups, but notably children, enjoy cookies. The Dutch term "koekje" or "koekie," which means tiny cake, is where the name "cookie" originates. In various tastes and styles, cookies are produced using sugars, spices, cocoa powder, butter, groundnuts, and dried fruits (Waheed *et al.*, 2010). Cookies are used worldwide because of their superior taste, longer shelf life, and simplicity of handling. Cookies are often made with three low-nutrition ingredients: refined wheat flour, fat, sugar, and another leavening agent.

Niger (*Guizotia abyssinica)*, a yellow flowering kharif oilseed crop, belongs to the Asteraceae family, also known as Ramtil and Jagni in Hindi. It has been developed in Ethiopia and India for about 5000 years. In tribal parts of Madhya Pradesh, where other crops fail to thrive. Niger seed contains 483 calories, oil (30–40%), protein (10–25%), solvent sugars (12–18%), crude fiber (10–20%), moisture (10–11%), and ashes (4%). It also contains a wealth of vitamins and minerals. Each 100 g of niger seed contains 3.66 mg of niacin, 0.43 mg of thiamine, 0.22 to 0.55 mg of riboflavin, 50 to 587 mg of calcium, and 180 to 800 mg of phosphorus. Unsaturated lipid content of 75–80% linoleic acid, 7-8% palmitic and stearic acids, and 5-8% oleic acid make up the oil, which accounts for around 40% of the weight of the seed (Getinet and Teklewold 1995). The Indian varieties have 25% oleic acid and 55% linoleic acid, respectively (Nasirallah *et al*., 1982). Niger is often called "Black Gold" or "thistle gold" devoid of hazardous elements.

Niger seeds are a substantial source of protein and energy and the richest source of iron, with 56.7 mg of iron per 100 g (Gopalan *et al.*, 2012). The Niger seed should be made cost-effective with improved nutritional quality to utilize its nutritious qualities. The Niger seed should be made more affordable and with improved nutritional value to utilize its nutritious qualities. Niger flour used in place of refined wheat flour in cookies, they can combine the nutritional benefits of the various ingredients in the above blend while also reaping the

benefits of baking, which increases the final product's nutritional value, delectability, and acceptability. Therefore, replacing the flour in cookies with Niger seed flour is a superior alternative to combat protein and calorie deficiencies and anemia caused by iron deficiency. So far, scanty research has been done to utilize Niger flour in bakery products. Therefore, the present study was to determine the nutritional quality of niger-fortified cookies by applying RSM.

MATERIALS AND METHODS

The present research work was carried out at the Department of Food Science and Technology, Department of crop Physiology College of Agriculture and Department of post harvest and process engineering, college of Agriculture engineering Jawaharlal Nehru Krishi Vishwa Vidyalaya Jabalpur during year 2021-2022.

A. Raw materials

Crude materials such as refined wheat flour and other materials such as sugar, vanaspati ghee, sodium bicarbonate and ammonium bicarbonate were procured from the nearby market. The Niger seed were procured from Chandangaon, Chhindwara (MP). Niger flour were prepared from Niger seed by utilizing brabender flour mill and sieved through 40 mesh sieve.

Experimental design Based on review of literature and preliminary trials, the plan of experimental work was prepared and experimental parameters were identified. The detailed work plan, sample variables and experimental designs are given below. Cookies were prepared by blending appropriate proportion of refined wheat flour, Niger seed flour. Standardize cookies were prepared using following proportion as shown in Table 1.

Table 1: Standard Cookies ingredient.

Ingredients	Quantity
Flour (g)	100.00
Sugar (g)	50.00
Shortening (g)	40.00
Sodium bicarbonate (g)	0.75
Ammonium bicarbonate (g)	1.00
Water (ml)	20.00

Variables their coded and decoded (actual) values for Niger fortified cookies presented in Table 1 and the cookies were prepared by using refined wheat flour, Niger flour at different levels using AACC micro method (AACC, 1995) as shown in Table 2.

Table 2: Variables their coded and decoded (actual) values for niger fortified cookies

Sr. No.	Variables	Units	Code	Coded levels				
				-2	-1	0	+1	+2
1.	RWF: WNF	G	X1	10	15	20	25	30
2.	Sugar	G	X2	20	30	40	50	60
3.	Shortening	G	X3	15	20	25	30	35
4.	Baking powder	G	X4	2.5	3.0	3.5	4.0	4.5

WNF: Whole Niger flour, RWF: Refined Wheat Flour

Table 3: Experimental design matrix for preparation of niger fortified cookies.

Treatments	A:RWF:WNF(g)	B:Sugar(g)	C:Shortening(g)	D:Baking Powder(g)
T1	15	30	20	3
T2	25	30	20	3
T3	15	50	20	3
T4	25	50	20	3
T5	15	30	30	3
T6	25	30	30	3
T7	15	50	30	3
T8	25	50	30	3
T9	15	30	20	4
T10	25	30	20	4
T11	15	50	20	4
T12	25	50	20	4
T13	15	30	30	4
T14	25	30	30	4
T15	15	50	30	4
T16	25	50	30	4
T17	10	40	25	3.5
T18	30	40	25	3.5
T19	20	20	25	3.5
T20	20	60	25	3.5
T21	20	40	15	3.5
T22	20	40	35	3.5
T23	20	40	25	2.5

T24	20	40	25	4.5
T25	20	40	25	3.5
T26	20	40	25	3.5
T27	20	40	25	3.5
T28	20	40	25	3.5
T29	20	40	25	3.5
T30	20	40	25	3.5

B. Preparation of cookies

Cookies were made by substituting varying amounts of Niger seed flour for refined wheat flour in accordance with Table 1. By adding the necessary amount of water broken up with sugar, sodium bicarbonate, and ammonium bicarbonate, the batter was completely altered. The dough was prepared, rolled in the cookie dropper machine, and divided into pieces using a cookie cutter. The pieces were placed on a heating plate that had been greased, and they were baked for 18 minutes at 180–200°C. The cookies were stored in cool packaging.

C. Methodology

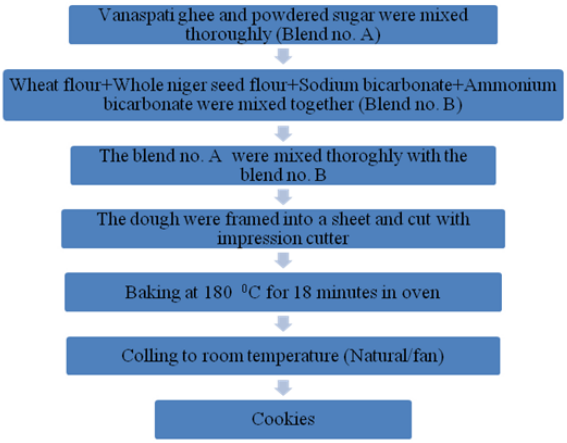

Fig. 1. Preparation of Niger flour fortified cookies.

D. Nutritional analysis of flour and cookies

Moisture content. The moisture content in the samples was estimated according to the method described in AOAC (2012).

$$\text{Moisture}\,(\%) = \frac{W_1 - W_2}{W_1 - W} \times 100$$

W1=Weight (g) of the dish with the material be for drying

W2=Weight (g) of the dish with the material after drying

W=Weight (g) of the empty dish

Crude fat. The crude fat content was determined by the ether extraction using Soxhlets apparatus using standard method (AOAC, 2012):

Protein content. The protein content in sample was determined by using conventional micro-Kjeldahl digestion and distillation procedure as given in AOAC (2012).

$$N_2(\%) = \frac{\text{No. of } H_2SO_2 \times \text{Volume of } 0.1\,NH_2SO_4 \times 0.14}{\text{Weight of Sample}}$$

Crude Protein (%) = N2% × 6.25

(i) Crude fibre content. The crude fibre was determined by the method as described in AOAC (2012)

$$\text{Crude Fiber}\,(\%) = \frac{W_1 - W_2}{\text{Weight of Sample}\,(g)} \times 100$$

Where,

W1=Weight of material before ashing (g)

W2=Weight of material after ashing (g)

(ii) Ash content. The ash content in the samples was estimated according to the method described in AOAC (2012).

$$\text{Ash}(\%) = \frac{\text{Weight of crucible with ash} - \text{Weight of empty crucible}}{\text{Weight of sample}\,(g)} \times 100$$

(iii) Carbohydrate content. Carbohydrates were calculated by different method as follows

Carbohydrate (%) = 100 – % (Moisture + Crude fat + Crude protein + Ash + Crude + fiber)

(iv) Mineral content. Atomic absorption spectrophotometer analysis of calcium, phosphorus, iron, and zinc was performed. Di-acid digestion was used to prepare the sample for the measurement of minerals. Double distilled water was utilised for mineral measurement across the entire glass. In a digestion tube built by Pelican, 0.05 grimes of powdered material were placed, and 15 milliliters of a di-acid solution made of conc. In 5:2 ratio, nitric acid and perchloric acid were added. A clear aliquot was achieved by heating the mixture on a heater at 250°C. The digested material was formed into a volume of 100 ml and filtered through Whattman No. 1 filter paper. The estimation was performed using a Varian Techtron model AA-120 atomic absorption double beam spectrophotometer.

E. Statistical analysis

The data were analyzed with use of 13 processor computer using design expert 16 software. Response surface graphs of selected responses were developed to study the effect of the data obtained from each experiment design in dependent variables and to optimize the levels of ingredients. The findings of each experiment were presented in result.

RESULTS

The present study was undertaken with an objective to optimize and standardized the process for niger flour fortified cookies. The investigation entitled "Application of Response Surface Methodology for Nutritional Properties of Cookies Fortified with Niger" was carried out to understand the effect of sugar, fat and Niger flour on cookies characteristics. The

nutritional properties of cookies developed by using Niger seeds (*Guizotia abyssinica*) was investigated. Cookies were blended with 10 to 30% Niger seed flour, 3.0, 3.5 and 4% baking powder 20, 30, 40, 50 and 60 % Sugar and 15, 20 to 30 % shortenings. The result was analyzed using response surface methodology (RSM) software 2FI model 13 which proved the good efficacy of findings. Summarized data of results enlisted below.

A. Development and optimization of process for the preparation of niger seed flour fortified cookies

The aim of present study was to developed and optimize the extent of refined wheat flour for the assembly of niger seed flour fortified cookies and to check there result of partial replacement of refined wheat flour with niger seed on developed cookies quality. Thirty treatments of cookies dough were ready victimization totally different quantitative variation of sugar, shortening and varied baking powder within corporation of niger flour. Refined wheat flour was partly replaced using niger flour at 5 levels (10, 15, 20, 25 and 30g/100g), Shortening (fat) at 5 levels (15, 20, 25, 30and 35g/100g) and sugar were used at five levels i.e. (20, 30, 40, 50 and 60g/100g) while the baking powder varied at 5 levels (2.5, 3, 3.5, 4 and 4.5g/100g).

B. Chemical analysis of developed cookies

(i) Nutritional Analysis. The results of nutrient composition of raw niger seed and developed Niger seed cookies presented in Table 4. The nutritional composition of cookies developed by incorporation of niger seed is recorded and depicted in the Table 4.

Table 4: Chemical composition of niger seed flour and refined wheat flour.

Parameter	Unit	Niger seed Flour	Refined Wheat Flour
Moisture Content	%	8.03	10.89
Protein Content	%	15.3	12.21
Fat Content	%	30.2	2.04
Carbohydrate	%	42.6	72.0
Ash Content	%	3.04	0.79

Table 5: The experimental design and data for response surface analysis.

Treatment	Moisture%	Protein%	Fat%	Carbohydrate%	Crude fibre%	Calcium (mg/100g)	Phosphorus (mg/100g)	Zinc (mg/100g)	Iron (mg/100g)
Control	4.23	9.85	21.45	49	0.3	55.34	68.27	0.98	4.75
T1	4.27	14.15	29.01	49.3	2.1	93.78	236.65	2.97	11.78
T2	4.32	15.67	30.16	51.88	2.67	93.6	236.23	2.62	11.36
T3	4.32	14.09	29.24	50.56	2.15	93.76	236.6	2.79	11.76
T4	4.34	14.18	29.06	50.83	2.19	93.19	235.03	2.53	11.09
T5	4.49	14.12	28.53	48.31	2.06	93.33	235.63	2.56	11.11
T6	4.92	15.76	30.12	50.75	2.65	93.89	237.57	2.85	11.56
T7	4.21	14.19	28.53	48.22	2.09	93.58	235.97	2.57	11.3
T8	4.26	15.65	30.22	51.55	2.66	93.66	236.49	2.84	11.32
T9	4.44	14.11	29.53	49.2	2.11	93.25	235.46	2.49	11.04
T10	4.43	14.12	29.17	49.45	2.55	93.52	235.88	2.64	11.45
T11	4.61	14.05	28.67	48.21	2.1	93.61	236.36	2.56	11.42
T12	4.11	15.55	30.32	49.64	2.69	93.21	235.01	2.33	11.06
T13	4.61	14.16	28.53	48.34	2.07	93.01	234.98	2.17	11.02
T14	4.64	15.53	30.34	50.67	2.84	93.45	235.01	2.56	11.08
T15	4.64	14.03	28.08	49.33	2.05	93.65	236.51	2.59	11.49
T16	4.58	15.69	30.12	51.55	2.32	93.59	236.1	2.59	11.41
T17	4.55	13.89	28.31	48.38	2.33	93.79	236.76	2.89	11.55
T18	4.23	14.14	28.04	49.26	2.04	93.54	235.89	2.62	11.38
T19	4.01	15.05	29.07	49.89	2.52	93.2	235.06	2.49	11.07
T20	4.67	15.03	29.05	50.79	2.34	93.59	236.3	2.68	11.39
T21	4.31	15.08	29.03	48.91	2.38	93.69	236.52	2.68	11.69
T22	4.22	15.02	29.09	51.78	2.43	93.55	235.9	2.66	11.34
T23	4.19	15.07	29.03	48.85	2.34	93.55	235.85	2.61	11.33
T24	4.63	15.01	29.07	50.92	2.41	94	237.05	3.00	11.89
T25	4.52	15.07	29.06	47.78	2.36	93.61	236.37	2.58	11.48
T26	4.56	15.08	29.04	50.87	2.39	93.67	235	2.49	11.06
T27	4.31	15.06	29.05	49.85	2.41	93.75	236.57	2.87	11.61
T28	4.45	15.02	29.03	50.96	2.42	93.52	235.87	2.65	11.41
T29	4.16	15.04	29.08	48.84	2.31	93.86	237.23	2.96	11.69

Table 6: Analysis of the variance (ANOVA) for response surface 2FI model for nutritional characteristics of Niger fortified cookies.

	Moisture(%)	Protein(%)	Fat (%)	Carbohydrates(%)	Crude fiber(%)	Calcium(mg/100gm)	Phosphorus(mg/100gm)	Zinc(mg/100gm)	Iron(mg/100gm)
Std. Dev.	0.0484	0.5358	0.5908	1.10	0.2053	0.2093	0.6847	0.1939	0.2470
Mean	2.10	14.79	29.15	49.85	2.35	93.55	236.03	2.65	11.37
C.V.%	2.31	3.62	2.03	2.21	8.75	0.2238	0.2901	7.31	2.17
R^2	0.3846	0.5026	0.4279	0.4604	0.4288	0.4763	0.4094	0.3268	0.3664
Adjusted R^2	0.0608	0.2408	0.1268	0.1764	0.1282	0.2007	0.0986	-0.0275	0.0329
Predicted R^2	-0.7782	-0.5965	-0.9331	-0.2388	-0.9198	-0.2407	-0.4398	-0.8024	-0.6913
Adeq Precision	4. 1917	5.4039	4.5101	5.4644	4.5953	5.9427	5.3984	4.8405	4.5936

Moisture: The ANOVA Table 6 indicates that the F-ratio 2.38 is more as compared to Table value of 2.96 The R2 0.3846 of perdition model is 5% per cent. Regression coefficient of full 2nd order modal as shown by Table no. 5 that at linear term the effect of level of RWF:NWF was found to be significant at 5% level of confidence where the level of interaction of RWF:NWF and shorting for spared ratio was significant Table 5 in that implies the model is significant.

Moisture = + 2.10 - 0.0064 × A + 0.0028 × B + 0.0130 × C + 0.0180 × D - 0.0145 × AB + 0.0131 × AC - 0.0161 × AD - 0.0130 × BC + 0.0100 × BD + 0.0039 × CD

The protein contain of niger fortified cookies varied from 13.89% to 15.76%. It was revealed that the minimum and maximum protein contain of niger fortified cookies was 15.76% for 25 percent incorporated treatment and 13.89% for 10 per cent niger seed flour incorporated treatment respectively. The model F-value of 3.02 is more than the table value i. e. 2. 38 that implies the model is significant; also the R 2value of model is 0.5026percent.

Protein = + 14.79 + 0.4062 × A - 0.0096 × B + 0.1287 × C -0.0288 × D + 0.0106 × AB + 0.1881 × AC - 0.0106 × AD + 0.0106 × BC + 0.1869 × BD - 0.0031 × CD

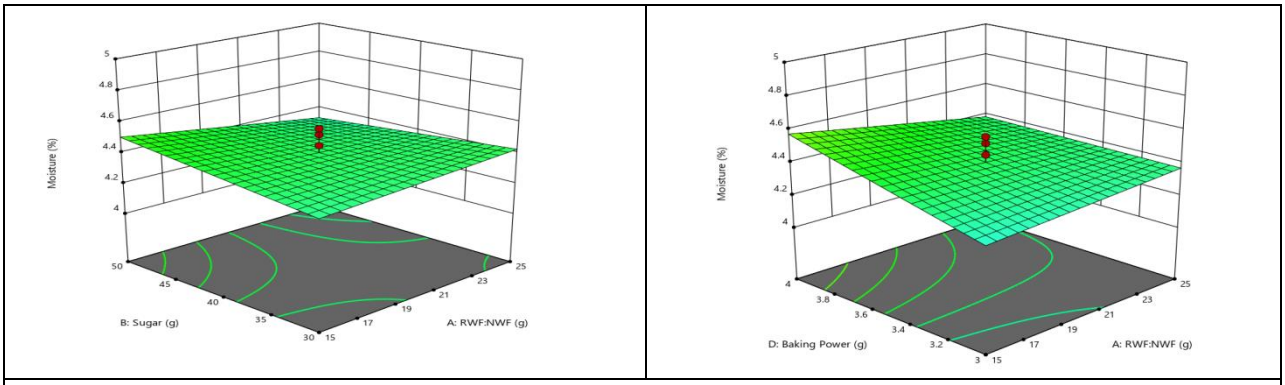

Fig. 2. Impact of RWF: NWF, Sugar and Baking powder on Moisture content.

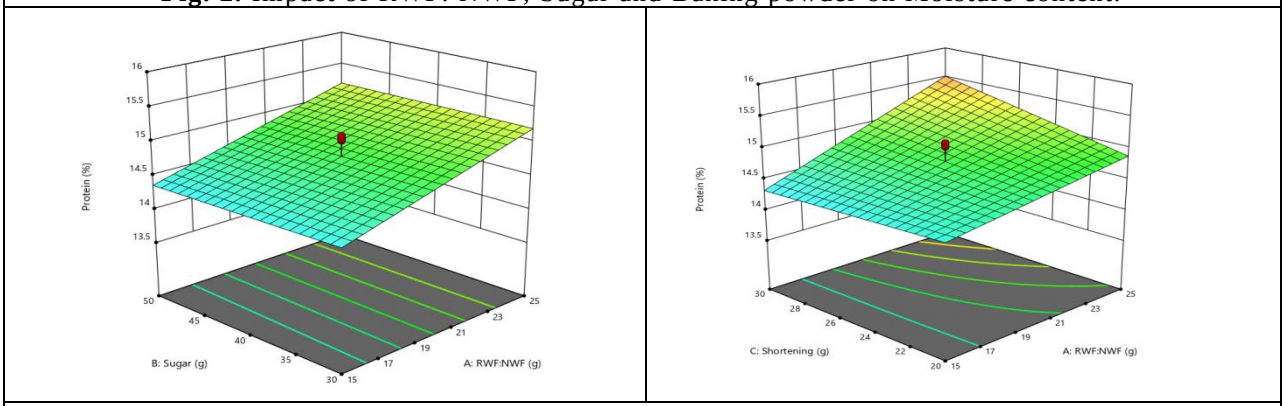

Fig. 3. Impact of RWF: NWF, sugar and shortening on Protein.

Table 5 shows that the different combination of ingredient and there effect on fat ratio that it fat contain of niger fortified cookies varied from 28.04% to 30.34%. The minimum and maximum protein contain of Niger fortified cookies was 30.34% for 25 percent in corporate treatment and 28.04% for 30 per cent niger seed flour incorporated treatment respectively. The Model F-value of 2.79 is more than the table value is 2.38 that implies the model is significant, also the R2 value of model is 0.4279 percent. The finding dictates that model is significant effect at 5% level of significance.

Fat = + 29.15 + 0.3687 × A - 0.0496 × B - 0.0238 × C 0.0013 × D + 0.0631 × AB + 0.3044 × AC + 0.0556 × AD + 0.0006 × BC + 0.0244 × BD - 0.0344 × CD

Table 5 discovered that the carbohydrate content of cookies varied from 48.211 to 51.88 per content. The lowest and highest Fat content in niger fortified cookies was at Treatment 11and 2 respectively The Model F-value of 2.46 is more than the table value 2. 38 that implies the model is significant; also the R2 value of model is 0.4604percent.

Carbohydrate = + 49.85 + 0.6921 A + 0.1579 B + 0.2246 C - 0.0363D - 0.219 AB + 0.3619 AC - 0.1494 AD + 0.1981 BC + 0.0094 BD + 0.4456 CD

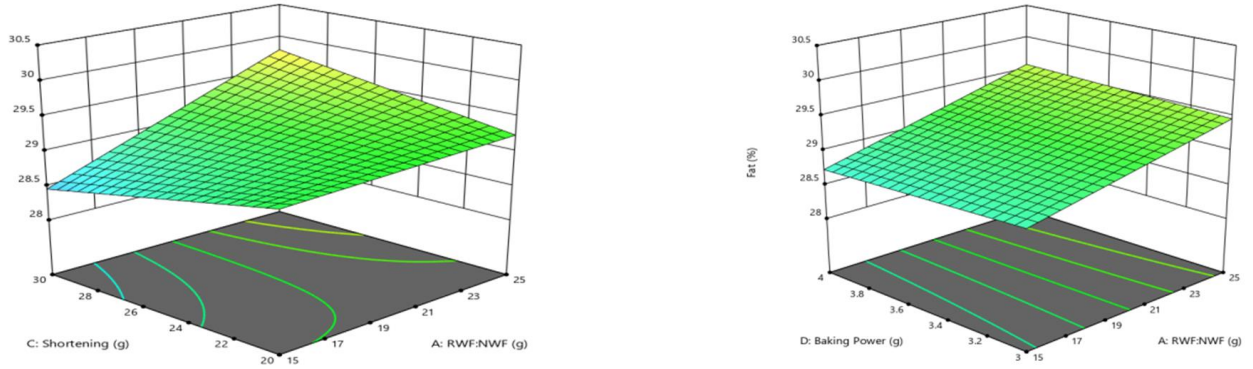

Fig. 4. Impact of shortening and baking powder on Fat content.

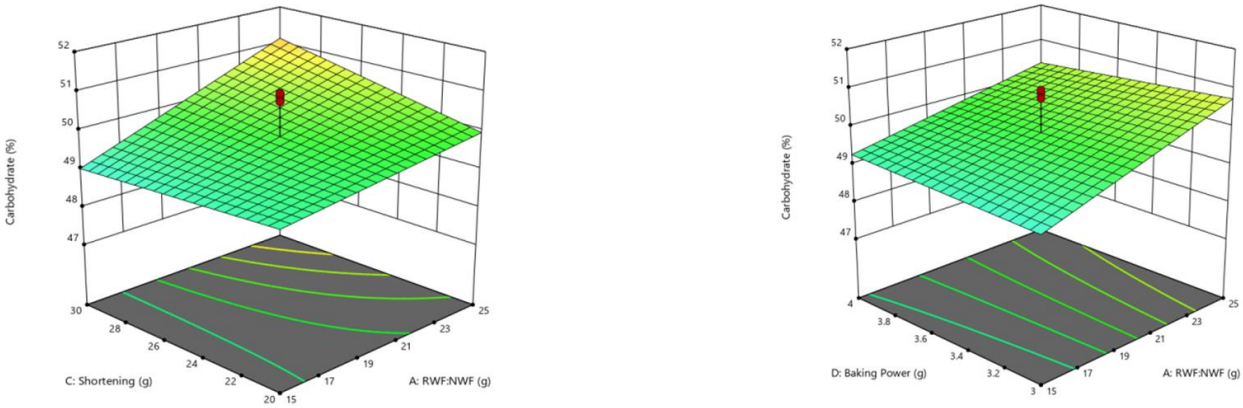

Fig. 5. Impact of RWF: NWF, shortening and baking powder on Carbohydrate.

The Fiber content of Niger fortified cookies ranged from 2.1-2.84percent Table 5 the minimum and maximum fiber of niger seed was found at treatment 1 and14 respectively. The minimum and maximum protein contain of Niger fortified cookies was 2.1-2.84 per cent for 15 percent and 14 percent Niger seed flour incorporated treatment respectively. The Model F-value of 2.47 is more than the table value i.e., 2.38 that implies the model is significant; also the R^2 value of model is 0.4288 percent.

Crude fiber = + 2.35 + 0.1358 × A - 0.0483 × B + 0.0117 × C + 0.0125 × D -0.0562 × AB + 0.0350 × AC + 0.0188 × AD - 0.0012 × BD - 0.0325 × CD

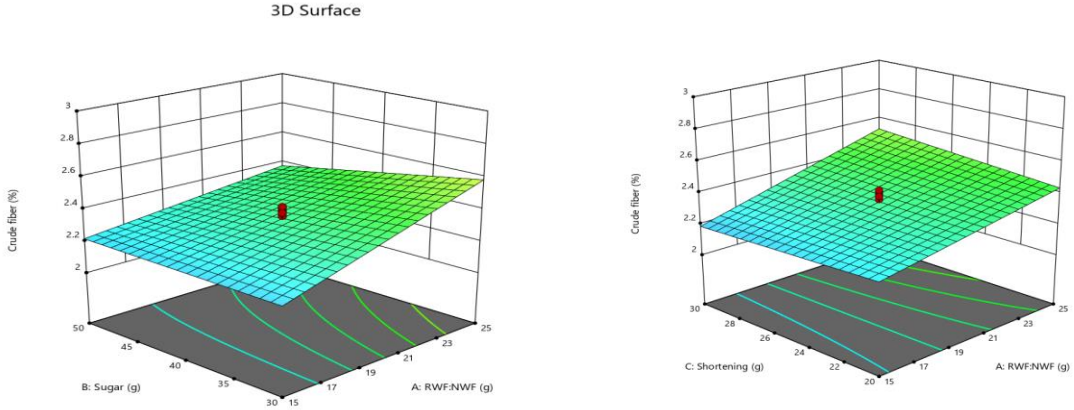

Fig. 6. Impact of RWF: NWF, sugar and shortening on Crude fiber.

(ii) Minerals Analysis. The Niger seed contain high amount of mineral like calcium, and minimal amounts of iron, calcium, phosphorus and zinc. It is important to know the retention of these minerals in final product. The results of mineral content in different treatments were found that the minerals content of cookies fortified with whole Niger seed improved significantly as compared to control. Calcium was present in high quantity as compared to iron, zinc, calcium, and phosphorus.

The calcium (mg/100) varied from 93.03-94 (Table 5). It is clearly seen that the minimum and maximum calcium was treatment 13 and 24 respectively. The minimum and maximum calcium contain of Niger fortified cookies was 93.03-94(mg/100) for 15% and 20 %, Niger seed flour in corporate treatment respectively. The Model F-value of 40.6 is more than the table value i. e., 2. 38 that imply the model is significant, also the R2 value of model is 0.4763 percent Table no.5.

Calcium = + 93.55 - 0.00150 × A + 0.0500 × B - 0.0017 × C - 0.0250 × D - 0.1275 × AB + 0.1188 × AC + 0.0225 × AD + 0.0738 × BC + 0.0775 × BD - 0.0012 × CD

Phosphorus = + 236.03 - 0.1075 × A + 0.1308 × B - 0.0083 × C - 0.1025 × D -0.2987 × AB + 0.3125 × AC - 0.1112 × AD + 0.1938 × BC + 0.2900 × BD - 0.0787 × CD

Zinc = + 2.65 - 0.0117 A + 0.0133 B - 0.0267 C - 0.0425 D -0.0437 × AB + 0.01025 × AC + 0.0225 × AD + 0.0600 × BC + 0.0300 × BD - 0.0012 × CD

Iron = + 11.37 - 0.0388 × A + 0.0454 × B - 0.0571 × C - 0.0079 × D -0.0994 × AB + 0.0931 × AC + 0.0406 × AD + 0.0656 × BC + 0.0706 × BD + 0.0456 × CD

It is discovered that the phosphorus (mg/100) content of Niger fortified cookies varied from 235.01-237.23 with increased proportion of the Niger seed flour. The minimum and maximum phosphorus in Niger fortified cookies was at treatment 12 and 29, respectively The Model F-value of 8. 34 is more than the table value i. e., 2. 38 that implies the model is significant, also the R^2 value of model is 0.4094. percent.

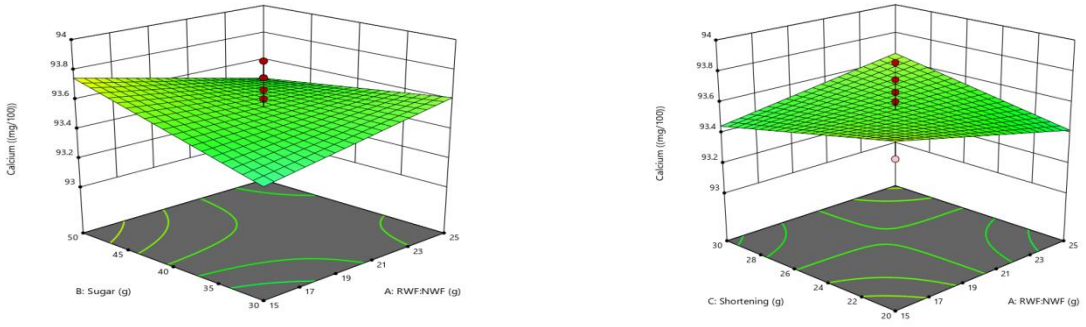

Fig. 7. Impact of sugar, RWF: NWF and shortening on Calcium.

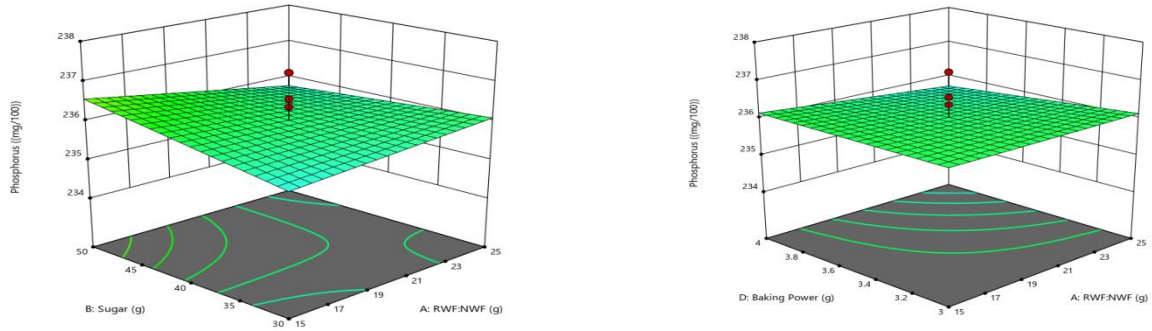

Fig. 8. Impact of RWF: NWF, sugar and baking powder on Phosphorus.

As described under Table 5 that the zinc contain of Niger fortified cookies varied from 2.17-3.00(mg/100). It was revealed that the minimum and maximum protein contain of Niger fortified cookies was 3.00 (mg/100) for 25 percent incorporated treatment and 2.17(mg/100) for15 per cent Niger seed flour incorporated treatment respectively. The Model F-value of 15.81 is more than the table value i. e.,2.38 that implies the model is significant, also the R^2 value of model is 0.3268 percent.

The iron content to Niger fortified cookies varied from11.02-11.78 (Table 5). The lower and higher of fortified Niger cookies was found at treatment 13 and 2respectively.The minimum and maximum protein contain of niger fortified cookies was15-25 per cent Niger seed flour incorporated treatment respectively. The Model F-value of 21. 83is more than the

table value i. e., 2.38 that implies the model is significant; also the R^2 value of model is 0.3664 percent.

Mineral content of niger seed and developed cookies reported in Table6 and minerals like iron, zinc, calcium and magnesium were as seceding raw and Niger seed fortified cookies. The iron content of Niger seeds was observed 5.77mg/100g, zinc 6.60mg/100g, calcium 85.30mg/100g and magnesium 182.40mg/100g. In general, all treatment sir on content was ranged from10.86 to11.94mg/100g, zinc between 2.33 to3.0mg/100g, calcium from 93.01to93.89mg/100g and phosphorus was exhibited from 235.01to237.57mg/100g. The results obtained from Table 6 showed that mineral content slightly decreased in baking. The obtained results showed significant difference from each other.

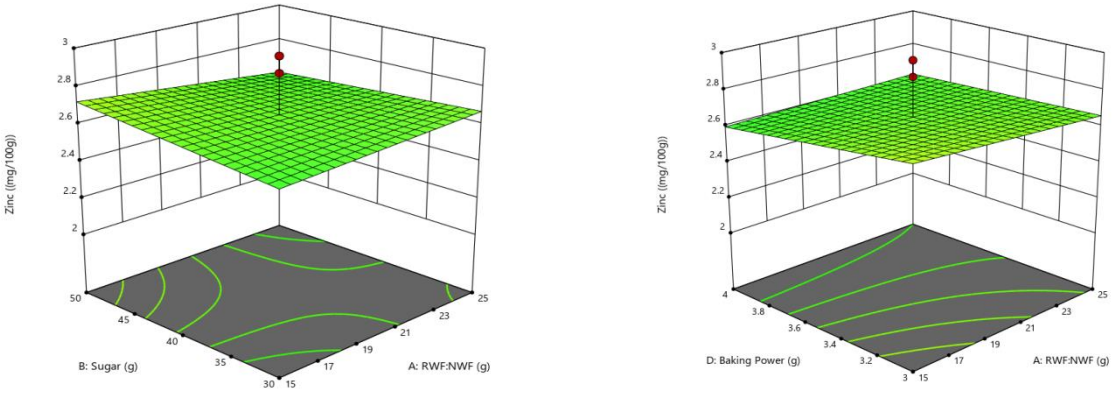

Fig. 9. Impact of RWF: NWF, sugar, and shortening on Zinc content.

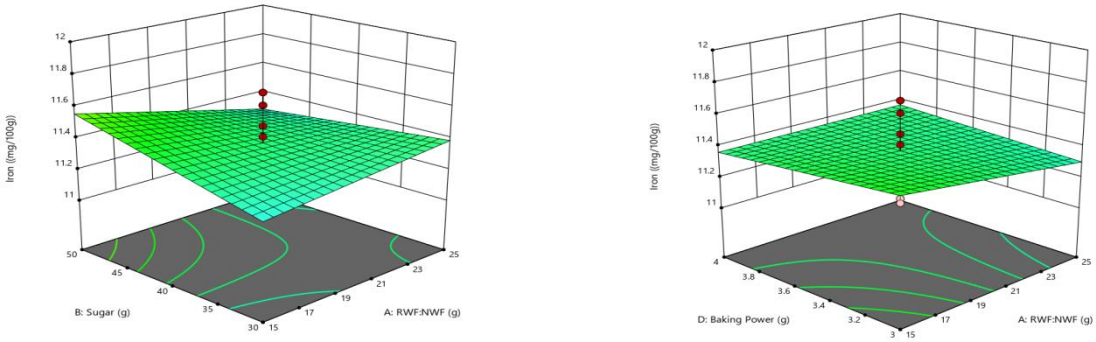

Fig. 10. Impact of RWF: NWF, sugar, and baking powder on Iron content.

DISCUSSION

The refined wheat flour employed in cookies preparation had 10.59 % moisture, 0.79% ash, Fat 2.4 %, 12.21 % protein, carbohydrate 72 %. Proximate analysis of management cookies and Niger seed flour incorporated cookies are given in Table 5. Moisture content of Niger seed flour cookies considerably magnified (4.14 to 4.92%) as compared with control cookies (4.23%). this will be attributed to fibre (gum mucilage) gift in Niger seed that has higher moisture retention property. The dietary fibre of Niger seed hull is concerning equally split between an insoluble fibre fraction and extremely soluble, periodic viscous fibre fraction which supplies the Niger seed hull a high-water absorption, wetness binding capability also as lubricity. Ash content of Niger seed flour cookies (0.82%) magnified considerably as compared with control cookies (0.43%). This may be credits to higher mineral content of Niger seed flour. Tiny low however insignificant increase within the fat content of optimized cookies was observed. Moreover, protein content (13.89 to 15.69 %) and crude fibre (0.7 to 1.69 %) of Niger seed flour cookies increased significantly as compared with control cookies. this might be accounted by the very fact that Niger seed is way higher in oil and crude fibre content compared with refined flour as their proximate analysis is mentioned previously. The low moisture content in the control and supplement product was the result of a long cooking time at medium temperature. Chetana (2010) according similar results for linseed incorporated muffins. Gambus *et al.*, (2004) conjointly ascertained that bread with ten and 13% share of flaxseeds was characterized by higher amounts of protein, fat, dietary fibre, macro- and microelements compared to plain one. This confirmed that the biological process sweetening may be finished the fortification of Niger seed flour in cookies while not moving its sensory quality.

The calcium (mg/100) varied from 93.03-94 (Table 5) and the phosphorus (mg/100) content of Niger fortified cookies varied from 235.01-237.23 with increased proportion of the Niger seed flour. The zinc contains of

Niger fortified cookies varied from 2.17-3.00(mg/100) and the iron content of Niger fortified cookies varied from 11.02-11.78 (Table 6). The iron content values in the developed products were higher than in their respective control samples (0 percent supplement) (p 0.05). Barnwal *et al.* (2011) found that one serving (25 g) of ladoo prepared with a 2:1 ratio of Niger seed and brown sugar had an iron content of 10.65 mg/100g. Kumari and Bhatnagar (2011) reported a total iron content of 25.33 mg/100 g in the seed of Niger ladoo (Rachtanapun, 2007). No research were found in Niger fortified cookies and nutrient content.

The nutritional makeup of Niger seeds, a special type of oil seed that is incredibly high in iron, protein, and energy, adds enormous value. The general additional value offering ingested recipes incorporated in regular meals as an effective strategy in the battle against dominating nutrients defect.

CONCLUSIONS

This study's findings demonstrated the enormous potential of Niger seed by demonstrating how adding more protein, fiber, and minerals to cookies boosted their nutritious value. The analysis showed that the fortified cookies' chemical parameter was superior to the control. In comparison to their control, the fortified items were shown to have greater levels of protein (13.89% to 15.76%), fat (28.04% to 30.34%), fiber (2.1-2.84%), and iron (11.02-11.78%). (0%Niger flour supplement). The ideal proportions of the composite ingredients needed to make biscuits with the desired nutritional and mineral properties were as follows: moisture content 22.388%, protein 14.945%, fat 29.307%, carbohydrate 50.135%, crude fiber 2.394%, calcium 93.534%, phosphorus 235.948%, zinc 2.640%, iron 11.354 at WNF: RWF 22.388g, sugar 41.617g, shortening 24.143g, and baking powder 3.5g. The consumption of cookies enriched with Niger flour should therefore be encouraged as part of a regular diet to improve people's reputations for good nutrition.

FUTURE SCOPE

Diverse cereals, millets, and leafy vegetables in combination with Niger seed flour can be explored for nutrient-enriched products. These products can eradicate calorie protein malnutrition.

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Conflicts of Interest. None.

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