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Physical Properties and Sensory Quality Attribute of Burger Buns from Ragi and Moringa Leaf Powder

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ABSTRACT: The bakery is a traditional activity that comprises an important place in the processing sector worldwide. In India, the bakery industry offers huge potential for growth of this segment among other food processing industries. Processing of ragi millet and moringa leaf powder to develop value-added food products would be the possible solution for enhancing consumption, nutritional status, and livelihood security of the tribal community. With the changing scenario of the utilization of processed products and awareness regarding the health benefits of ragi millet and moringa leaf powder, tremendous potential exists for its utilization in bakery products like burger buns, cupcakes, cookies, etc. Burger buns are sweet baked products highly appreciated by consumers because of their soft texture and characteristic taste. The height, volume, and specific volume of ragi flour and moringa leaf powder fortified burger bun baking range from 3.4 to 4.65 cm, 110-156.2 cm^3, and 1.642-2.215 g/cm^2. The crust color, crumb color, flavor, texture, taste, and overall acceptability sensory score of ragi flour are reported in the results. The hunter L* (Darkness), a* (Green), and b* (Yellow) values of ragi flour fortified burger bun crust color varies from 32.56-39.52, 12.16-15.23, 13.6-18.68, and crumb color values of the product varies from 52. 45-58. 88, 3.26-4.44, 12.4-14.83 respectively. The burger buns samples became darker when MLP was included in the dough, particularly in white bread samples. This was an expected result as Moringa oleifera leaves are naturally a dark green due to their high chlorophyll content.

Keywords: Burger buns, Moringa Leaf Powder, ragi millet, Physical properties, sensory quality.

INTRODUCTION

India is the *largest producer of various kinds of millet. Out of the total minor millets produced, Finger millet* (*Eleusine coracana*) (ragi) accounts for about 85% of production in India (Divya *et al.*, 2011). Major ragi-producing states in the country are Karnataka and Tamil Nadu. Ragi is rich in iron, calcium, phosphorus, fiber, and vitamins. It is also abundant in essential amino acids such as lysine and methionine, which are vital to human health and growth (McDonough *et al*., 2000). It contains two polyunsaturated fatty acids, namely, linoleic acid and α-linolenic acid metabolized products. These fatty acids help develop the central nervous system (Jacobson *et al*., 2008). Finger millet grain has a carbohydrate content of 81.5%, protein g), leucine (9.5 g), methionine (3.1 g), and phenylalanine (5.2 g) which are deficient in other starchy meals. Millets also contain B vitamins, niacin, B6, folic acid calcium, iron, potassium, magnesium, and zinc (Gull *et al.*, 2014).

Ragi is particularly effective at controlling blood glucose levels in diabetic people. Because of the bulkiness of the fibers and the slower digestion rate, we feel fuller on fewer calories, which may help us avoid overeating. As a result of its low sugar content and slow release of glucose/sugar in the body, ragi is regarded a good food for people with diabetes (Kang *et al.*, 2008). The ragi (*Eleusine coracana*) flour is rich in protein, energy, vitamins, and minerals. Ragi proteins are a good source of essential amino acids, and these are also a rich source of phytochemicals and micronutrients. Moringa (*Moringa oleifera*), also called "miracle plant," is found in abundance in the dry tropics, and it is completely edible from leaves to roots. The leaves of moringa could be cheaply dried with solar dryers and milled to form a fine powder that could be store for use in rural households (Glover *et al*., 2017). The evaluated nutrient content of moringa leaves, both fresh and powdered form, appears promising in terms of a nutritional supplement. The dried leaves contain proteins (6.5g), fat (0.55 g), carbohydrate (41.2g), carotene (4.54 mg), thiamine (0.63 mg), riboflavin (4.92 mg), calcium (480.72 mg), magnesium (88.32 mg), potassium (48.96 mg), leucine (468 mg), lysine (318 mg). The solar-dried leaf powder is an important source of vitamins and a phenolic compound, including phenolic acids and flavonoids (Makkar and Becker, 1996).

Considering that bread is still a staple food in many parts of the world, great efforts have been addressed to improve their nutrition. Different alternatives have been proposed, including agronomic fortification and nutritional improvement of breads during bread making

using different ingredients, or the development of balanced recipes reducing the content of salt, sugar, and fat and adding certain ingredients into the formulation Betoret and Rosell (2020).

Researchers and the baking industry must optimize bread-making technology to enhance the quality, taste, texture. Bread making can be optimized by adding some constituents with reasonable bioactive compounds, nutraceutical, and functional characteristics so that formulated bread will be accepted by consumers (Dziki *et al.,* 2014). Ragi moringa fortified burger bun is more beneficial than normal buns. Calcium and iron are highly required for children and women, especially during pregnancy and lactation periods. The protein content of the dried MLP is similar to that of moth beans, soybeans, and kidney beans which have (22 - 24%) protein. Pulses being expensive is difficult to purchase by the poor people. The development of value-added food products based on these underutilized plants and cereals is the best possible way to enrich the nutritional value of the daily diet of women of reproductive age and also beneficial for their good health and wellbeing.

MATERIALS AND METHOD

The present investigation was carried out in the Department of Food Science and Technology, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, during the year 2020-2021. The methodologies for preparation of raw materials, analysis of raw materials, preparation of burger buns, and its quality evaluation

A. Ingredient required for bun preparation

The raw materials essential for burger bun preparation, namely, refined wheat flour, barley flour, common salt, crystalline sugar, and vegetable oil, were purchased from Priyadarshani Suvidha Sahaseva Kendra, Civic Centre Jabalpur. Bread improver, margarine, packaging material HDPE (High Density Polyethylene), Aluminum foil, and parchment paper were procured from Vipin Trading, Napier Town, Jabalpur. The fresh baker's yeast (*Saccharomyces cerevisiae*) was purchased from Makhija Provisions, Jabalpur.

B. Experimental Site, Geographical Situation, and Climatic Conditions

The experiment was conducted in the Cereal Science lab (Processing hall-2), Crop Quality Lab, and Sensory Evaluation lab of the Department of Food Science and Technology, JNKVV, Jabalpur (Madhya Pradesh). Jabalpur is situated at 23′ 90″ N longitude and 79′ 58″ E longitude at an altitude of 411.78 meter above the mean sea level. It falls under subtropical climatic conditions, which is characterized by the features of hot dry summers and cool dry winters. The 10-years mean annual rainfall of the area is 1284 mm and nearly 90% of the total annual rainfall is mainly received during the period between the end of June to the end of September. The maximum and minimum temperature ranges between 24°C to 45°C, and 4°C to 32°C, respectively within a year. In some of the years, maximum temperature reaches as high as 45°C in the month of May or June, while minimum temperature falls 2°C down to a limit of 4°C during the end of December or January months. The relative humidity varied from season to season. It ranges between 80 to 90% during the rainy season, which reduces to 60 to 70 and 30 to 40% during winter and summer seasons respectively.

C. Preparation of Burger buns

The composite flour was prepared by blending refined wheat flour, Ragi Flour, and Moringa Leaf Powder as per the treatments. The burger buns were prepared by a straight dough method given by Kamaliya and Kamaliya (2001). The process of barley fortified burger buns preparation is shown in the flow chart given in Fig. 1.

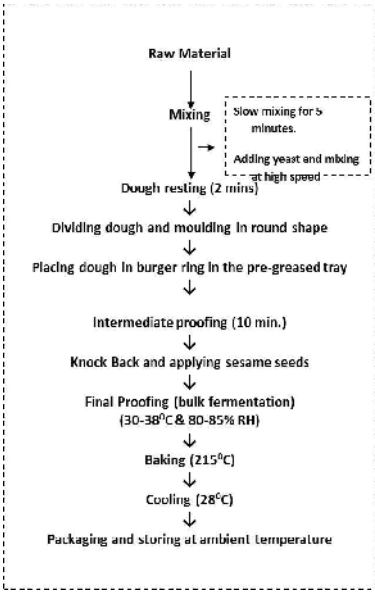

Fig. 1. Process flow chart for barley fortified burger buns preparation.

D. Method of burger preparation

The ingredients such as refined wheat flour, ragi flour, moringa leaf powder salt, sugar, fresh baker's yeast, bread improver, and shortening were weighed as per standard recipe and experimental plan. The refined wheat flour, ragi flour, and moringa leaf powder were sieved together through a 40-mesh sieve and kept in a bowl. The weighed ingredients were put into the spiral dough mixer and the required quantity of water and allowed to mix at slow speed for 5 minutes. After 5 minutes of slow mixing, fresh baker's yeast (*Saccharomyces cerevisiae*) was added, and the mixture was set to mix the dough at high speed for 12.5-15 minutes. After series of mixing stages and the clean-up stage, a formation of cohesive dough mass is obtained. The dough mass was rested for 2 minutes, after which it was divided with the help of a scrapper into uniform pieces (75 gm), rounded equally, and placed into pre-greased rings kept in a greased tray. The tray having dough was held for intermediate proofing in the incubator for 10 minutes with 80-85% relative humidity. Knock back process of the buns was

performed, followed by adding sesame seeds on their top. The dough was then subjected to final proofing (bulk fermentation) under suitable conditions (35-40°C temperature and 80-85% relative humidity) for 55-65 minutes. The finally-proofed dough was put in the pre-heated rotary baking oven and allowed to bake at 215°C for 18-20 minutes. After the baking process, the buns were taken out and cooled at room temp 27 ± 30°C. Cooled burger buns were packed and stored for further analysis.

E. Physical characteristic of the burger bun

(i) Weight The weight of the burger bun was determined by using a weighing balance and expressed in grams as an average of three replications.

Table 1: Recipe for the control burger bun.

Ingredients	Quantity (g per batch)
Wheat four	100.0
Water	55.0
Sugar	7.0
Vegetable Fat	6.0
Salt	1.0
Baker's Yeast	1.5

(ii) Diameter: The diameter of biscuits and cake was measured by a digital Vernier caliper and expressed in mm units.

(iii) Volume: Volume was measured using the rape-seed displacement method, in which each burger bun was put in a container and covered with rape-seeds to fill the container. The burger buns were then further removed from the container. The reduction in the volume of the rape-seed was recorded by the method given by AACC, (1969).

(iv) Specific volume: Specific volume is calculated as the ratio of the volume of burger buns to the mass of burger buns as per the method of AACC (2000). Specific volume is denoted in g/cm^3 units.

$$\text{Specific volume}\left(\frac{\text{g}}{\text{cm}^3}\right)=\frac{\text{Volume of Buns}}{\text{Mass of Buns}}$$

(v) Measurement of color: The color scanning machine (Model: Color Flex EZ) measured the color of crust and crumb of burger bun samples. The color was measured using the CIELAB (1976/D65) scale at ten observers at D65 illuminant. The instrument was calibrated before placing the sample by placing black tile and white tile provided with it. Once the instrument was standardized, it was ready to measure the color of the crust and crumb of the burger bun. It can also be cross-checked by placing the white tile provided for the L*, a*, b*, C*, and H* values. The burger bun was placed in a sample cup. The deviation of the color of the sample to standard was also observed and recorded in the computer interface. It provides readings in terms of L*, a*, b*, C*, and H* where L* indicates darker, a* indicates green, b* indicates yellow, C* indicates brighter, and H* indicates hue.

(vi) Experimental Design: The factorial composite rotatable design was used to determine the effect of the combination of variable levels in each experiment. The burger buns were prepared by using different combinations of variables, as indicated in Table 2.

Table 2: Complete Randomized Design (CRD) for refined wheat flour, moringa leaf powder, and ragi flour burger buns.

Sr. No.	Treatments	RWF*	RF*	MLP*	Sugar	Yeast
1.	T_0	100	0	0	7	1.5
2.	T_1	85	10	5	4	1.5
3.	T_2	80	15	5	5	1.75
4.	T_3	75	20	5	6	2.0
5.	T_4	82.5	10	7.5	4	1.5
6.	T_5	77.5	15	7.5	5	1.75
7.	T_6	72.5	20	7.5	6	2.0
8.	T_7	80	10	10	4	1.5
9.	T_8	75	15	10	5	1.75
10.	T_9	70	20	10	6	2.0

F. Experimental variables

The specific experimental variables involved in this work are RWF – (Refined Wheat flour), RF – Ragi flour, MLP – Moringa Leaf Powder), sugar and yeast.

G. Sensory evaluation

The burger buns were evaluated for sensory quality attributes using a nine-point Hedonic scale (Amerine et al., 1965) by a semi-structured panel of 16 judges comprising staff and students of the Department of Food Science and Technology JNKVV, Jabalpur. Samples were served to the panelists, and they were asked to rate the acceptability of the product on a 1-9 points scale, ranging from strongly like as 9 to strongly dislike as 1.

H. Statistical analysis

Analysis of different variables was carried out to know the degree of variation among all the treatments. The data were statistically analyzed by the method given by Panse and Sukhatme (1978). The analysis of variance is done as per the ANOVA method, and the skeleton of ANOVA for completely randomized design is presented in Table 3.

Table 3: Skeleton of analysis of variance.

Source of variation	Df	SS	MS	F cal.	F tab. Value	
					5%	1%
Treatment	t-1(3)	SSt	Mst	Mst/Mse		
Error	n-t(8)	SSe	Mse			
Total	n-1(11)					

n = Total number of observation t = Number of treatments

RESULTS AND DISCUSSION

A. Physical properties of refined wheat flour burger bun fortified with ragi flour and moringa leaf powder

(i) Height (post-baking): The fortified burger buns made through this work are shown in Fig. 2. The effect of different ingredients and their combination on the height (post-baking) of ragi flour and moringa leaf powder fortified burger bun is given in Table 4. The height (post-baking) of the burger bun varied from 3.4 to 4.65cm. The minimum and maximum height (after baking) of the burger bun was at treatment T_5 and T_4 respectively. These experiments represented the combination of ingredients as 77.5:15:7.5, 05, 1.75 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF: RF:MLP, sugar, and yeast, respectively. The height of burger buns (after baking) ranged from 3.4 to 4.65 cm.

Fig. 2. Prepared burger buns in different ratios of refined wheat flour, ragi flour, Moringa leaf powder.

The graded levels of ragi flour and moringa leaf powder have a positive linear significant effect on the height of burger buns. A similar finding of a change in the height of burger buns during baking was also reported by Laeeq, (1996); Farooq *et al.*, (1996). This decrease in the height of the burger buns containing millet flour and moringa powder may be attributed to fewer air cells and limited gas cell stability due to the dilution of gluten (Symons & Brennan, 2004). The dough did not rise during proofing due to a decrease in structure-forming protein, leading to low bread volume (Bibiana *et al.*, 2014). A similar decreasing trend in loaf volume and specific volume was also reported by Amandikwa *et al.*, (2015).

(ii) Volume and Specific Volume of the burger bun: The effect of different ingredients and their combination on the volume of ragi flour and moringa leaf powder fortified burger bun is given in Table 4. The volume of burger buns varied from 109-152.4 cm^3. The minimum and maximum volume of burger bun were at treatment T5 and T4 respectively. These experiments represented the combination of ingredients as 77.5:15:7.5, 05, 1.75 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF:RF:MLP, sugar, and yeast, respectively.

The finding indicates that the model was non-significant, i.e., levels of ragi flour and moringa leaf powder had a negative but non-significant effect on the volume of burger bun at a 5% level of significance. The volume and specific volume of burger buns varied from 110-156.2 cm^3 and 1.642-2.215 g/cm^2, respectively. The Specific volume of ragi flour and moringa leaf powder fortified burger bun varied from 1.642-2.275g/cm^2 (Table 4). The minimum and maximum Specific volume of the fortified burger bun were recorded at treatment T9 and T4, respectively. These experiments represented the combination of ingredients

as 70:20:10, 06, 02 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF: RF: MLP, sugar, and yeast, respectively. The finding indicates that the model was found to be non-significant. The ragi flour and moringa leaf powder fortification had a non-significant effect on the volume and specific volume of burger buns prepared using refined wheat flour and ragi flour. These results agree with those reported by Föste *et al.,* (2014). These results are similar to those reported by Rao *et al.,* (2017), i.e., spread volume is significantly influenced by the millet-based bun. The specific volume obtained for different millet-based products were ranged from 0.065-0.085 cm3/g.

B. Hunter Color Value of refined wheat flour burger bun fortified with ragi flour and moringa leaf powder

(i) L*(Darkness): The effect of different ingredient and their combination on L* (Darkness) crust color values of ragi flour and moringa leaf powder fortified burger bun is given in Table 5. The minimum (32.56) and maximum (39.52) value was obtained at Treatment T_7 and T_4, respectively. They represented the combination of ingredients to be 80:10:10, 0.4, 1.5g and 82.5:10:7.5, 04, 1.5g per 100 g of sugar and yeast, respectively. A similar observation was also reported by Mariotti *et al.,* (2014) for the crumb of bread added with barley flour. Govender and Siwela (2020) also reported that bread samples became darker as the concentration of MOLP was increased while nutrient levels increased.

(ii) a*(Green): Table 5 comprises the results of the effect of different ingredient and their combination on a* (Green) crust color values of burger bun fortified with ragi flour and moringa leaf powder. The minimum and maximum a* (Green) values were 12.16 and 15.23 at treatment at T_1 and T_4 respectively, representing the combination of ingredients to be 85:10:5, 4, 1.5 and 82.5:10:7.5,4,1.5g per 100 g of RWF:RF:MLP, sugar, and yeast, respectively.

(iii) b*(Yellow): The findings presented in Table 5 reveal the effect of different ingredients and their combination on b* (Yellow) crust color values of burger bun fortified with ragi flour and moringa leaf powder. It varies from 13.6 to 18.68 value at Treatment at T_4 and T_7 respectively, representing the combination of ingredients to be 82.5:10:7.5, 04, 1.5 and 80:10: 10, 04, 1.5 g per 100 g of RWF:RF:MLP, sugar, and yeast, respectively.

C. Crumb Color

(i) L*(Darkness): The effect of different ingredient and their combination on L* (Darkness) crumb color values of burger bun fortified with ragi flour and moringa leaf powder are given in (Table 5).

Table 4: Physical characteristics of different ratios of refined wheat flour, ragi flour, Moringa leaf powder.

Treatment (RWF: RF: MLP)	Diameter	Height (pre baking)	Height (post baking)	Initial Weight	Volume	Weight (After baking)	Specific Volume
Unit	cm	cm	cm	g	ml³	g	g/cm³
T_0 (100:0:0: 7:1.5)	8.5	4.6	4.8	75	156.2	66	2.367
T_1 (85:10:5: 4:1.5)	8.5	4.1	4.3	75	118.0	64	1.844
T_2 (80:15:5: 5:1.75)	8.5	4.2	4.4	75	146.0	66.5	2.195
T_3 (75:20:5: 6:2.0)	8.5	3.4	3.6	75	110.0	65	1.692
T_4 (82.5:10:7.5:4:1.5)	8.5	4.9	4.65	75	152.4	67	2.275
T_5 (77.5:15:7.5:5:1.75)	8.5	3.2	3.4	75	109.0	64	1.703
T_6 (72.5:20:7.5:6:2.0)	8.5	4.1	4.2	75	138.5	65	2.131
T_7 (80:10:10: 4:1.5)	8.5	4.1	4.2	75	110.0	63	1.746
T_8 (75:15:10: 5:1.75)	8.5	4.2	4.2	75	144.0	65	2.215
T_9 (70:20:10: 6:2.0)	8.5	3.7	4.1	75	110.0	67	1.642
SE (m)	0.005	0.027	0.019	0.006	0.647	0.043	0.398
CD @5%	0.013	0.008	0.011	0.017	NS	0.015	NS

Table 5: Hunter color analysis of the different ratios of refined wheat flour, ragi flour, Moringa leaf powder.

Experiment	Hunter Color Value					
	Crust			Of Crumb		
	L*	a*	b*	L*	a*	b*
T_0	36.34	14.4	15.7	54.31	3.78	15.35
T_1	37.56	12.16	15.78	56.04	3.45	12.56
T_2	36.78	14.02	15.4	56.4	3.56	12.65
T_3	35.43	14.52	15.54	52.45	3.52	13.45
T_4	39.52	15.23	13.65	58.88	4.44	14.83
T_5	36.65	15.15	16.5	56.49	3.48	14.12
T_6	34.32	12.95	14.56	57.38	3.47	13.9
T_7	32.56	13.22	18.68	56.48	3.26	12.4
T_8	38.45	13.75	15.7	54.62	3.42	12.26
T9	22.43	14.12	14.76	53.12	3.48	14.62

The minimum (52.45) and maximum (58.88) value was at Treatment at T3 and T4 respectively, representing the combination of ingredients to be 75:20:05, 06, 2.0 and 82.5:10:7.5, 04, 1.5 g per 100 g of refined RWF: RF: MLP, sugar, and yeast, respectively.

(ii) a*(Green): Table 5 comprises the results of the effect of different ingredient and their combination on a* (Green) crumb color values of burger bun fortified with ragi flour and moringa leaf powder. The minimum and maximum a* (Green) values were 3.26 and 4.44 at Treatment T7 and T4 respectively, representing the combination of ingredients to be 80:10:10, 04, 1.5 and 82.5:10:7.5, 04, 1.5 g per 100 g of RWF: RF:MLP, sugar, and yeast, respectively.

(iii) b*(Yellow): The findings presented in Table 5 reveal the effect of different ingredients and their combination on b* (Yellow) crumb color values of burger bun fortified with ragi flour and moringa leaf powder. It varies from 12.4 to 14.83 values. The respective value was observed in Treatment T7 and T4, respectively, representing the combination of ingredients to be 80:10:10, 04, 1.5 and 82.5:10:7.5, 04.1.5 g per 100 g of RWF: RF: MLP, sugar, and yeast, respectively.

The hunter L*(Darkness), a*(Green) b*(Yellow) values of ragi flour fortified burger buns for the crust and crumb color of product varies from 32.56-39.52, 12.16-15.23, 13.6-18.68 and 52.45-58.88, 3.26-4.44, 12.4-14.83 respectively. Similar findings of the color of the baked product were also reported by Rahman *et al.*, (2015).

C. Sensory quality attributes of refined wheat flour burger bun fortified with ragi flour and moringa leaf powder

(i) Crust Color score: The sensory score for the crust color of ragi flour and moringa leaf powder fortified burger bun was minimum (7.5) in Treatment T9 and maximum (8.0) in Treatment T4. These experiments represented the combination of ingredients as 70:20:10, 06, 02 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF: RF: MLP, sugar, and yeast, respectively. The finding indicates that the model is significant; thus, levels of ragi flour and moringa leaf powder had a positive linear significant effect on the crust color of burger buns at a 5% level of significance. Raihan and Saini (2016) also reported a similar observation (2016), i.e., the crust color of the composite flour bun formed by 15% blend was less brownish with higher L* values than all other buns.

(ii) Crumb Color score: The effect of different ingredients and their combination on the crumb color of ragi flour and moringa leaf powder fortified burger bun is given in Table 6. The sensory score for the crumb color of the burger bun varied from (7.0) to (7.5) score. The minimum and maximum score of crumb color of the prepared burger bun was found in Treatment T3and T4, respectively. These experiments represented the combination of ingredients as 75:20:05, 06, 02 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF:RF: MLP, sugar, and yeast, respectively. The finding indicates that the model significantly affected the crumb color of prepared burger buns at a 5% level.

(iii) Flavor score: The sensory score for the flavor of ragi flour and moringa leaf powder fortified burger bun varied from 6.75-7.7. The minimum and maximum flavor score of the burger bun was obtained in treatment T9 and T4, respectively. These experiments represented the combination of ingredients as 70:20:10, 06, 02 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF:RF: MLP, sugar, and yeast, respectively. The finding indicates that the model had a significant effect.

(iv) Texture score: Texture analysis instruments give numbers to the physical properties Rolle *et al.,* (2012). Consequently, analytical techniques are needed to test foods to ensure that they have the appropriate physicochemical properties that meet consumer demands Owusu-Apenten (2004).

The minimum (6.5) and maximum (7.5) texture scores of ragi flour and moringa leaf powder fortified burger bun was observed in treatment T5 and T4, respectively. These experiments represented the combination of ingredients as 77.5:15:7.5, 05, 1.75 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF:RF: MLP, sugar, and yeast, respectively. The finding indicates that the model is non-significant. Nasir *et al.,* (2020) also reported that textural measurement depicted that hardness, chewiness, gumminess, springiness, and cohesiveness increased with the substitution of amaranth flour. All dough samples also observed rheological parameters like complex viscosity, loss modulus, and storage modulus. Bread samples with 5%, 10%, and 15% of AF showed lower yellowness and higher redness values for crust color. The bread prepared by replacing 5% and 10% of AF is nutritionally and sensorially acceptable. Rathnayake *et al.,* (2018) also reported a product with a well-developed porous crumb structure containing the property of higher gas retention capacity, which resulted in a product with increased volume and reduced crumb hardness with appealing sensorial properties.

(v) Taste score: The taste score of ragi flour and moringa leaf powder fortified burger bun varied from 6.75 and 7.8 (as shown in Table 6). The minimum and maximum taste score of the burger bun was at treatment T5 and T4, respectively. These experiments represented the combination of ingredients as 77.5: 15:7.5, 05, 1.75 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF: RF:MLP, sugar, and yeast, respectively. The finding indicates that ragi flour and moringa leaf powder levels had a positive significant effect at 5% level of significance.

(vi) Overall Acceptability: The Overall acceptability of ragi flour and moringa leaf powder fortified burger bun varied from 6.9-7.6 at treatment T5 and T4, respectively (Table 6). These experiments represented the combination of ingredients 77.5:15:7.5, 05, 1.75 g and 82.5:10:7.5, 04, 1.5 g per 100g of RWF: RF: MLP, sugar, and yeast, respectively. Effect of levels of ragi flour had a negative significant effect at 5% level of confidence on overall acceptability score of the burger bun. The crust color, crumb color, flavor, texture, taste, and overall acceptability sensory score of ragi flour and moringa leaf powder fortified burger bun varied from 22.43-39.52, 52.45-58.88, 6.75-7.7,6.5-8,6.75-7.8, and

6.9-7.8, respectively. The addition of ragi flour and moringa leaf powder significantly affected the sensory quality attributes of burger bun prepared by composite flour blend of refined wheat flour and ragi flour and moringa leaf powder. The findings obtained in the present investigation regarding the significant effect of ragi flour and other ingredients conform with results given by Acosta *et al.*, (2011).

Table 6: Sensory quality attributes of refined wheat flour burger bun fortified with ragi flour and moringa leaf powder.

Experiment	Crust Color	Crumb Color	Flavor	Texture	Taste	Overall acceptability
T_0	8.0	7.5	7.75	8.0	7.5	7.75
T_1	7.25	7.0	7.25	7.5	7.0	7.2
T_2	7.0	7.5	7.75	7.5	7.5	7.45
T_3	7.5	7.0	7.25	6.75	7.5	7.2
T_4	8.0	7.5	7.5	7.5	7.5	7.6
T_5	7.0	6.75	7.5	6.5	6.75	6.9
T_6	7.0	7.5	7.5	7.5	7.5	7.4
T_7	7.5	7.0	7.5	6.75	7.0	7.15
T_8	7.5	7.5	7.0	7.5	7.5	7.4
T_9	7.5	7.5	6.75	7.0	7.0	7.15
SE(m)	0.011	0.013	0.017	0.012	0.009	0.010
CD @ 5%	0.021	0.017	0.009	NS	0.028	0.019

D. Challenges faced during the experimentation

The volume, texture, taste, flavor, crust color, crumb color, and overall acceptability were decreased with an increased percentage of ragi flour in Burger bun. The minimum amount of MLP to be added to a burger bun mix observe significant improvements in its nutritional value was estimated to be about 10 percent. However, at this 10 percent fortification level, the sensory attributes of the products also begin to become less desirable.

CONCLUSION

The ragi flour and moringa leaf powder can be fortified up to 10% and 7.5%, respectively, for treatment T4 (82.5:10:7.5:4:1.5) in refined wheat flour and other baking ingredients viz. sugar 40 g, yeast 15 g for preparation of burger buns. The above findings suggest that the best product can be developed using the above levels of ingredients at household and commercial-scale bakery industry levels. Millet grains as a replacement in wheat composite flours, complimentary food, and food blends seem the best method that can be used for the preparation of nutritional, “healthy,” and safe, high-quality, and shelf-stable food products at household and commercial scales to promote utilization of millet grains. Moringa leaves powder is considered a rich source of Ca, Mg, and Fe, could be used to fortify many bakery products, but there is a need to carry out more studies to evaluate these minerals bioavailability in bakery products in the future.

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