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ORIGINAL ARTICLE

Structural and Nutritional Composition of Ragi and Wheat Flour Blended Cake and their Sensory Evaluation

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ABSTRACT The demand for processed food, particularly bakery items, including cakes, muffins, biscuits, etc., is consistently increasing with urbanization. In particular, people of all ages enjoy the cake as a delicious baked dessert all time. The incorporation with nutritious cereals such as millets is further stimulating the appetite of the present generation. The current endeavor deals with the development of the ragi and wheat flour blended cakes through the sensible incorporation of the ingredients in requisite proportions and assessment of the quality and overall acceptability of the developed cakes by sensory evaluation. Accordingly, five cakes (Cakes C1-C5) of 100 g each were prepared with ragi and wheat flour as the base materials in different proportions impregnating simultaneously with the other ingredients such as jaggery, oil, and milk, baking soda, baking powder, to enhance the food qualities. The structural compositions and the nutritional qualities of the cakes were analyzed through X-ray diffraction (XRD) and Fourier Transform Infrared (FTIR) spectral probing and chemical analysis, respectively. The XRD data demonstrated the suitable grain size of the cake and FTIR data supported the presence of sufficient amount of protein in the cake. The presence of minerals in the cake was evident. The compositions of cakes were adjusted to make C1 and C5 as high calorie and the cakes C2-C4 as low calorie items. The control cake (C0) was prepared out of 100 g of ragi exclusively. All the cakes were free of artificial flavor or colour. On the basis of the 9-point Hedonic scale and numerical scoring test with respect to the color, flavor, texture, taste, appearance, and overall acceptability, the cake C2 was found to be best from a low-calorie, and cake C5 from a high-calorie viewpoint. The energy and protein content of the cake C2 was estimated to be 275.72 kcal and 5.95 g, respectively, which was about 75 kcal less and 1.10 g protein more than cake C5 per 100 g of the sample. The mean score for the overall acceptability of cake C2 and cake C5 yielded to be almost close to 9, i.e., 8.76±0.43 and 8.6±0.4, respectively. These findings confirmed the acceptability of both cakes with respect to quality. The correlation matrix between different sensory characteristics of cakes also depicted the same results. The evaluation of the likeness of cake using the hedonic scale further produced better results for Cake C2 and Cake C5. The costs of the prepared cakes were also found to be reasonably less, i.e., about two times lower than the commercial cakes. Overall results indicated that the incorporation of ragi flour as a major base material into the cake along with wheat flour and other ingredients offered highly nutritious healthy cakes, rich in minerals and nutrients, and hence, these cakes would attract a large group of customers as a therapeutic food item, undoubtedly.

Keywords: Hedonic scale, Low calorie, Numerical scoring test, Ragi, Sensory evaluation, Whole wheat flour

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INTRODUCTION

The popularity of bakery foods is increasing day by day due to urbanization, industrialization, and modernization. People

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of all ages like these foods for their sensory and nutritional quality as well as handy availability. Among these products, the cake is loved invariably by most people. It brings a sense of pleasure to the body and mind, and hence, it is used during the celebration of different ceremonies [1]. The cake is a fantastic mixture of refined wheat flour, sugar, eggs, milk, butter, and flavours, and therefore, its consumption leads to a sign of joy and delight. Yet again, due to the presence of adequate quantities of proteins, carbohydrates, vitamins, and minerals, it is highly nutritious and thus, serves as an excellent source of energy. In addition, a cake also boosts mental health and stimulates the senses. Hence, considerable attention is given by the food scientists and biotechnologists consistently towards the formulation of this food product [2-5]. However, the cake alone is not a wholesome food product as it has a high calorie and fat content and insufficient calcium, iron, dietary fiber. Therefore, it cannot fulfill the nutritional requirements of an individual. The incorporation of nutritional ingredients like cereals, legumes, millets, milk, nuts, etc., is essentially necessary for its nourishment, which is challenging and demanding.

Finger millet (*Eleusine coracana*), commonly called ragi, is an important millet grown largely in various regions of India and Africa. In India, it occupies the sixth position in production after wheat, rice, maize, sorghum, and bajra. It is mostly grown and consumed in State of Karnataka, and to a limited extent in Andhra Pradesh, Tamil Nadu, Odisha, Maharashtra, Uttarakhand and Goa [6]. The ragi contains about 5-8% protein, 1-2% ether extractives, 65-75% carbohydrates, 15-20% dietary fiber, and 2.5-3.5% minerals, and therefore, is considered one of the most nutritious cereals. Among all cereals and millets, ragi contains the highest amount of calcium (344 mg) and potassium (408 mg) minerals. This cereal has low-fat content (1.3%) and contains mainly unsaturated fat. Every 100 grams of ragi provides 336 kCal of energy. On the other hand, ragi contains phytates (0.48%), polyphenols, tannins (0.61%), trypsin inhibitory factors, which were earlier considered as "anti-nutrients" because of their metal chelating and enzyme inhibition activities [7]. But nowadays, these biomolecules are considered neutraceuticals. Being non-glutinous, the ragi is safe for people suffering from gluten allergy and celiac diseases. It is also non-acid forming and hence easy to digest. The ragi are rich in amino acids, like Tryptophan, Threonine, Valine, Isoleucine, and Methionoine [8]. Earlier reviewers also report that consumption of this grain exerts cardioprotective influence [8]. Besides, some other health benefits of ragi such as preventing osteoporosis, keeping blood sugar in control due to low glycemic index, reverting skin aging, fighting anemia, relaxing the body from depression, anxiety, stress are also known due to the presence of tryptophan and antioxidants in it. The weight loss due to the intake of this cereal has been also reported [9, 10].

Despite the huge nutritional and health benefits as stated above, the consumption of ragi-based products has been decreased substantially due to urbanization, the recent trend in food habits, and the unavailability of food products conducive to the taste of rural and urban dwellers. Our long-term objective is to develop ragi-based ready-to-eat products which would fulfill the satiety value of all segments of people providing health benefits concomitantly. With these facts in mind, in the current endeavour, the goal has been accomplished through the development of six cakes with different compositions of ragi and wheat, estimation of the nutritive value of the cakes by chemical analyses, structural analyses through X-ray diffraction (XRD) and Fourier Transform infrared (FTIR) techniques, ascertaining the quality of these developed cakes by sensory evaluation and Hedonic rating test, and comparison of the cost of the developed cakes with the commercial samples.

MATERIAL AND METHODS

The experimental works were conducted in the Food and Nutrition laboratory of Post Graduate Department of Home science, Sambalpur University in collaboration with the Centre of Studies in Surface Science and Technology, School of Chemistry and P. G. Department of Food Science Technology and Nutrition, of Sambalpur University during the year 2020.

Procurement of Raw Materials

The food ingredients such as whole wheat flour, ragi flour, jaggery, cashew nuts, raisins, cooking oil, baking powder, baking soda, milk, and vanilla essence were chosen as the base materials for the preparation of Ragi-Whole wheat flour composite cake. These ingredients were obtained from the local market of Sambalpur University.

Formulation of the Cakes

The cakes were formulated by mixing different proportions of ragi and wheat along with other components to boost up the nutritive values and digestibility of the cakes. Table 1 provides the proportions of whole wheat flour to ragi flour and the amounts of jaggery, cooking oil, and milk used for the formulation of desired cakes. The other minor ingredients included were cashew nut (10 g), raisins (10 g), baking powder (1 teaspoon), and baking soda (1/2 teaspoon). The cakes were prepared by mixing the whole wheat flour with ragi flour at 0, 30, 40, and 50 ratios for the development of low-calorie and high-calorie cakes. Jaggery was used as a sweetener, and refined oil was used as a tendering and lightening agent. Baking powder and baking soda were mixed as leavening agents for raising the product and making the cake to be easily

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digestible. All the above ingredients were mixed thoroughly and baked in preheated OTG at 180 °C for 30-35 minutes till the completion of the formulation process was ensured. The consecutive steps of cakes formulations are demonstrated in Figure 1.

Composition Analysis

The proximate composition of the developed cakes was analyzed by the method AOAC [11]. The moisture was determined by the hot-air oven drying method. The sample was heated under specific conditions, and loss of weight was used to calculate the moisture content of the sample. The estimation of ash was carried out by burning the samples in a muffle furnace at 550 °C for 6 hours. Micro Kjeldahl method was used to estimate the total protein content, and a Soxhlet apparatus was used to estimate the fat content in the samples. The AOAC procedure was followed in each case [11, 12]. The carbohydrate was calculated by the difference using the equation: 100-(Moisture+Fat+Ash+Protein). The calorific value (kcal per 100 gm) of the sample was calculated by summing up the product of multiplication of percent crude protein, crude fat, and carbohydrate present in a sample by 4, 9, and 4, respectively [13]. The mineral content of cakes was obtained by the calculation of the nutritive value of ingredients with the use of the ICMR food composition table [14].

Structural and Functional Group Analyses of the Formulated Cakes

The cakes were dried for 24 h at ambient temperature and stored in a desiccator (containing silica as the dehydrating material) [12]. The crystallinity of the cakes was investigated with the help of an X-ray diffractometer (Shimadzu, XRD-6000, Japan) operating with Cu Ka radiation, 40 kV, 30 mA, and a scanning speed between 10° to 40° (2θ). The Fourier Transform Infrared spectrum of cakes was analyzed with the help of an AVATAR 360 spectrophotometer (Thermo Electron, USA) using a KBr disc in the range 400-4000 cm^{-1} with a resolution of 4 cm^{-1} at 25 °C [15, 16].

Sensory Evaluation

The method of assessing the quality of food products by means of human sensory organs is known as sensory (also subjective/organoleptic) evaluation. A panel of ten trained members of the P.G. Department of Home

Figure 1: Flow Chart of Cake Formulation

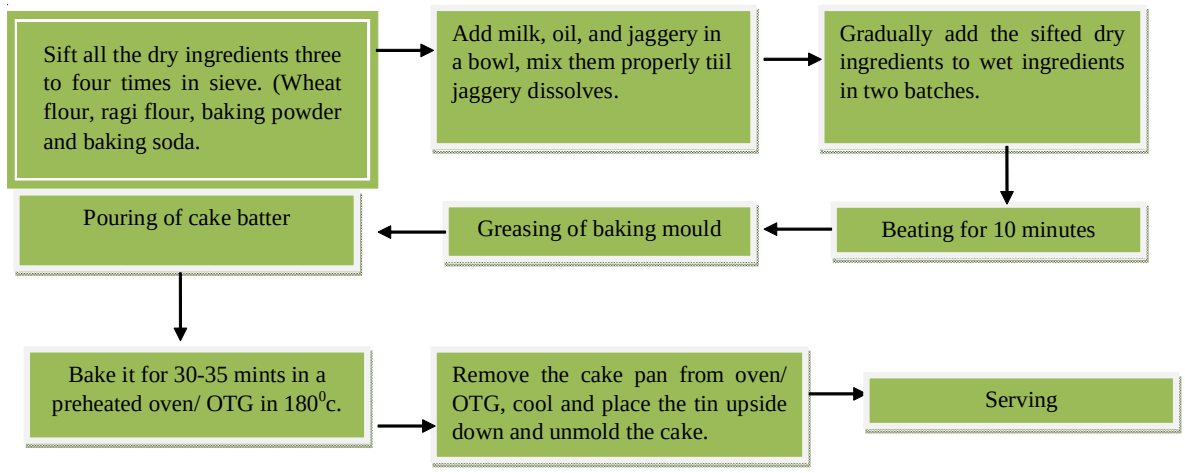

Table 1: Proportion of Ingredients in the Formulated Cakes

Cakes	Proportion	Ingredients
Cake-0	10:0:6:5:9:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk, kaju, kismis
Cake-1	7:3:6:5:9:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk kaju, kismis
Cake-2	5:5:2.5:2.5:15:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk, kaju, kismis
Cake-3	7:3:3:2.5:14.5:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk, kaju, kismis
Cake-4	6:4:2.5:2:15.5:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk kaju, kismis
Cake-5	5:5:5:5:10:1:1	Ragi flour, whole wheat flour, jaggery, cooking oil, milk, kaju, kismis

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Science assessed the sensory characteristics of cakes under controlled condition in the laboratory [17]. The panel members for the evaluation were chosen by conducting the sensitivity taste, threshold tests for sweet, salty, sour, and bitter tastes. The members also offered their written consent for participation in the test. The concentration of sucrose, sodium chloride, citric acid, and magnesium sulfate used in the tests were 0.01, 0.1, 0.5, and 1.0 g, respectively per 100 mL of water. The samples were developed as well as evaluated five times by numerical scoring test with respect to six characteristics features, namely colour, flavour, texture, taste, appearance, and overall acceptability.

Numerical Scoring Test

The ten semi-trained panelists evaluated each sample on a specific scale for a particular characteristic indicating the rating of the samples. The panelists were trained to follow the six sensory characteristics corresponding to the agreed quality descriptions and scores. Without this understanding, the rating is not of any use.

Hedonic Rating Test

The hedonic rating test was used to measure the consumer acceptability of food products. Six samples were served to the panelist at one session. They were asked to rate the acceptability of the product on a 9-points scale ranging from 'like extremely' to 'dislike extremely'. Ten semi-trained panels were selected to rate the products for consumer preference studies and separate cards were used for each product [18].

Statistical Analysis

The obtained data were tabulated and statistically analyzed for percentage, mean standard deviation, and one-way ANOVA with the help of MS Excel on a computer [19].

RESULTS AND DISCUSSION

Analyses of Nutritional Quality of Formulated Cakes

The analyses of nutritive value of the formulated cakes are presented in Table 2. Examination of the data reveals that the moisture content of cakes varies from 21 g to 40 g, being highest for cake C2 (40 g) and lowest for cake C0 (21 g); the ash content of cakes varies from 1.324 g to 1.685 g with highest value for cake C3(1.685 g) and lowest for cake C4 (1.324 g); the protein content varies from 4.25 g-5.95 g with highest value for cake C2 (5.95 g) and lowest for cake-C0 (4.25 g) possibly due to variation of the amount of milk. The fat content among the cakes follows the order: C1>C5> C0>C2>C3>C4, which is in line with the amount of oil. Similarly, the order of carbohydrate content decreases in the order: C0>C1>C3>C4>C5>C2. Based on the nutrient content, the total energy content (in kilo calorie) is found to be in the order C0>C1>C5>C3>C4>C2. In comparison with the commercially available cake, it is seen that the protein and fat contents of the developed cakes are almost at par with the marketed cake, whereas the energy content is on the lower sides. Among the developed cakes C0-C5, the energy content of the lowest calorie cake and highest calorie cake are found to be lower by 112 kcals and 36.3 kcals, respectively than the commercially available cakes.

Literature survey reveals that usually the cakes developed with ragi and peanut butter as the major constituents, the moisture content decreases with the increase in the content of ragi and peanut butter in the cake [20], which, therefore, supports the results of the present study. Similarly, the ash content is found to be lower in the cakes prepared exclusively from wheat flour in comparison to cakes prepared by substituting a part of the wheat flour with ragi flour [20]. However, the reverse trend is observed in the present case, the ash content of the cakes increased with the incorporation of the wheat flour. Deshpande *et al.* [3] have reported the formulation of a ragi-

Table 2: Proximate Composition and Nutritive Values of Formulated Cake

Parameters	Moisture (g/100 g)	Ash (g/100 g)	Protein (g/100 g)	Fat (g/100 g)	Carbohydrate (g/100 g)	Energy Content (Kcal)
Cake-C0	21	1.64	4.25	14.419	58.691	381.535
Cake-C1	23.86	1.468	4.91	15.6	54.162	376.688
Cake-C2	40	1.571	5.95	8.4	44.079	275.716
Cake-C3	35	1.685	5.22	8.2	49.895	294.26
Cake-C4	37	1.345	5.39	7.8	50.465	293.62
Cake-C5	30	1.324	4.85	15.4	48.426	351.704
Marketed cake	-	-	03-Jul	15.2-20	-	387-424

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Table 3: Mineral Content per 100 gram of the Formulated Cakes

Serial No.	Calcium (mg)	Phosphorus (mg)	Iron (mg)	Fibre (g)
Cake- 0	160.531	137.812	2.192	1.2
Cake -1	132.781	144.562	2.285	0.822
Cake -2	128.03	161.562	1.856	0.934
Cake -3	145.906	156.281	2.073	0.822
Cake -4	139.156	160.718	2.069	0.987
Cake -5	115.531	150.625	2.272	0.934

wheat-based cake (20:20) in which the moisture content was 12.40%; protein, fat, and ash are 7.80 g 13.20 g, and 1.2 g, respectively [4]. The difference in the proximal composition from the present study might be due to the incorporation of 30-50% wheat flour in the preparation of the cake.

Cookies cake developed by the other researchers with ragi and wheat flour in 1:1 ratio are found to contain more protein (14.198 g) and carbohydrates (65.63 g), and less moisture in comparison to the presently developed cake, which may be due to the incorporation of milk product and dry nuts [21]. The cake developed by Upadhyay *et al.* [22] had low protein as well as low-fat content, which may be due to the incorporation of carrot powder and soybean powder.

Thus as the nutrient content of the cakes depends on the nutritive value of incorporated materials, selection of right ingredients in correct proportions can enhance the nutritional properties of cakes.

Mineral Content of Formulated Cakes

Minerals in food are essential for maintaining a healthy body. It strengthens tissues, bone, teeth, nerves, muscles, and it also regulates nerve function. Hence it is always necessary to maintain it in an adequate amount in the food. The mineral content of formulated ragi-whole wheat flour blended cakes obtained by calculating the values using Food Composition Table of ICMR is exhibited in Table 3. The analysis of the data discloses that the replacement of ragi flour by wheat flour affects the mineral contents significantly. The calcium content of the developed cakes lies in the range 115-161 mg per 100 g of the cake and follows the order: C0>C3> C4>C1>C2>C5, whereas, the phosphorus content varies from 137.81 mg to 161.56mg, cake C2 being topping the list, i.e., C2>C4>C3>C5>C1>C0 . The iron and fibre content follows the order: C1>C5>C0>C3>C4>C2 and C0>C4>C2 =C5>C1=C3, respectively. Thus, in most cases, the substitution of the ragi flour by wheat flour decreases the mineral contents of the cakes. The increase in the proportion of jaggery, milk, and oil in the cake increased the calcium, phosphorus, iron, fiber contents appreciably. However, the phosphorus content in cake is found to be less in Cake C0, i.e., 137.82 mg in comparison to wheat flour blended cakes. The iron and calcium content of sponge cake developed by other researchers through the incorporation of maida with ragi was found to vary from 87.76 mg to 114.11 mg, and 1.5 mg to 8.2 mg, respectively, which are reasonably lower than the values of the presently developed cakes [23, 24].

pH and Titratable Content of the Developed Cake

Table 4 illustrates the pH and Titratable acidity of the developed Ragi cakes. On analysis of the data, it is observed that a decrease in pH and increase in titratable acidity occurred with an increase in the amount of wheat flour in the cake. The increased acidity and low pH can enhance the keeping quality of the Ragi by inhibiting microbial growth and also contribute to the flavor of the processed Ragi-based products. Thus, cake C5 could be a suitable composition for the development of different ragi-based food products with better shelf life.

Table 4: pH and Titratable Acidity of the Formulated Cake

Serial No.	pH	Titratable Acidity
Cake-0	7.85	0.031
Cake-1	7.54	0.033
Cake-2	7.48	0.036
Cake-3	7.21	0.039
Cake-4	6.97	0.042
Cake-5	6.55	0.047

Structural and Functional Analyses of the Ragi Flour-Wheat Flour Blended Cake

XRD Analysis

X-ray diffraction pattern probing of the food is extremely useful in analyzing the crystalline states and crystal structure of food components such as starch, amylose-lipid complexes, sugars, and protein [25-27]. The peaks intensity of the pattern relates to the arrangement of semi-crystalline structure and variation in electron density between crystalline and amorphous lamellae [25]. During the food processing, the

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food components get affected; the investigation of the diffraction patterns of the processed food is, therefore, imperative. The major compositions of all cakes being the same, the XRD pattern of the C5 cake was selectively investigated as the representative sample, which is more acceptable in terms of calories and sensory value as compared to other cakes. Figure 2 depicts the XRD pattern of the C5 cake. The distinct peaks in the pattern reveal that the C5 cake exhibits an A-type XRD pattern, with a major deflection at 2θ: 15.91°, 21.25°, and 25.54°. Literature also reports similar peaks in ragi and wheat flour with strong diffraction intensities with peaks occurring at 2θ: 15.2°, 18°, 23.3°, 26.1°, and 15.28°, 17.48°, 18.38°, 23.18°, respectively [28]. The A-type arrangement observed in the present study is similar to the pattern exhibited by the other cereal flours [25]. The major peaks in barley mill spray-dried (19.32°), native ragi flour (23.02°), ragi malt (17.03°), Ragi malt spray-dried (18.75°) have been also described in the literature confirming the occurrence of suitable food components in the present case [28].

FTIR Analysis

FTIR analysis assesses the interaction among the different food components present in the formulated cake. FTIR spectrum (Figure 3) of high calories cake C5 was categorically investigated because of its acceptability in terms of calories and sensory value in comparison to the other cakes.

Figure 2: XRD Pattern of Ragi and Wheat Flour Blended of the Cake C5

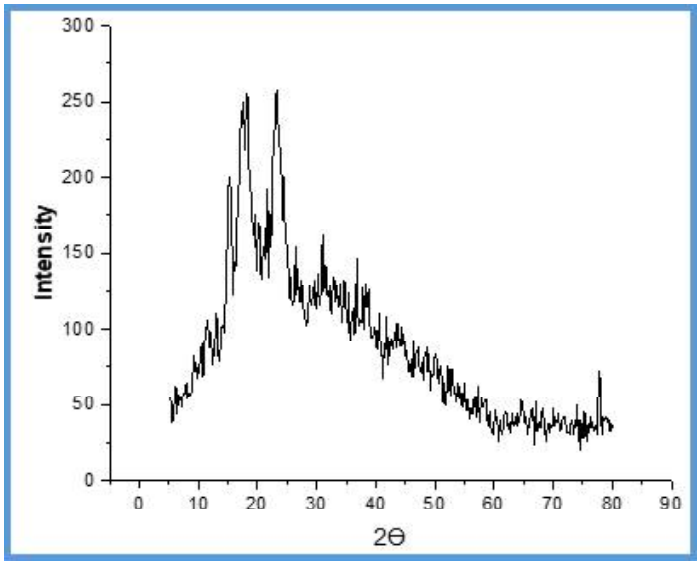
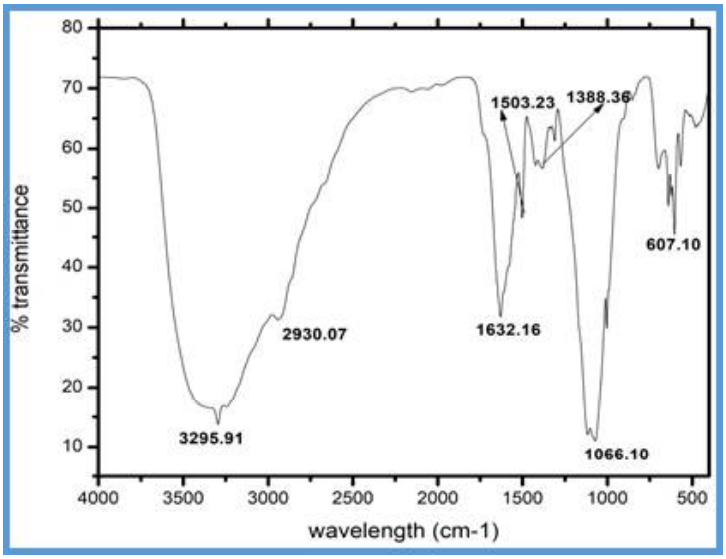


Figure 3: FTIR Spectrum of Ragi and Wheat Flour Blended Cake C5



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The most intense peak appeared at 3295.91 cm^{-1}. In this region, usually the O-H stretching vibration from the functional groups of alcohols, phenols, carboxylic acids, or N-H stretch from the functional groups of 1°, 2° amines, or amides, or a combination of these groups occur. Thus, this peak may be attributed to the N-H bending vibration of gluten proteins, or the O-H stretching vibrations of the carbohydrates present in wheat as well as ragi flour, as both contain similar carbohydrate compositions. The broad and intense peak suggests the amalgamation of all these vibrations. The literature reveals the appearance of similar peaks in both wheat and ragi flour [27]. The peak at about 2930.07 cm^{-1} may be ascribed to the C-H stretching vibration of the lipids and lipid-starch complexes [28]. Since wheat flour does not show a peak in this region, whereas ragi flour does, the occurrence of a peak clearly evidences the blending of wheat and ragi flour in the cake, and the lipid content of the cake is mostly due to ragi flour content in the cake. The intense band at about 1632.16 cm^{-1} is ascribed to Amide I groups, which results from the C=O stretching vibrations of the peptide bond. Such peak is also found in ragi and wheat flour a 1650cm^{-1} [28]. This band signifies the secondary structure of the protein present in the flour [27]. The peak appearing at 1503.23 cm^{-1} is due to the N-O asymmetric stretch of nitro compounds present in the cake, which is similar to the band found in ragi and wheat flour [28]. The peak close to 1400 cm^{-1} results from protein side-chain COO-. The wideband centered at 1066.10 cm^{-1} is related to C-O and C-C stretching vibrations, and C-O-H bending vibrations associated with carbohydrates. The region at about 1080-950 cm^{-1} is linked to the molecular organizations of starch chains [27, 28]. The out-of-plane NH bending appears in the region of 640-800 cm^{-1} [28]. Akin to this peak, a peak appeared at 607.10 cm^{-1} in C5 cake flour. Thus, the FTIR study confirmed the existence of all food components like protein, carbohydrates, and lipids in our formulated cake C5 and hence, in the rest of the cakes supporting the nutritional value of the formulated cake products.

Sensory Evaluation of Cakes by Numerical Scoring Test

The present study developed three high calories and three low-calorie cakes. The distinguished panel members conducted the sensory evaluation of the cakes. Table 5 demonstrates the average mean and standard deviation of numerical scores of sensory evaluation of cakes concerning appearance, taste, color, flavor, texture, and overall acceptability.

Organoleptic Evaluation of the Cakes

Colour: The colour is a major attribute towards acceptance of any baked food. The cake-C2 had the highest score, i.e., 8.8±0.447 as a low-calorie cake and C5 had an 8.5±0.5 mean score as a high-calorie cake. As the percentage of whole wheat flour in the cake increases, the colour of the cake changes from chocolate brown to light brown, hence the increase in the acceptance was mostly based on colour. Similar results have been also reported in the literature [4, 5].

Flavour: The flavor of any baking food is an important characteristic of its perception. The increase in the score up from 40% to 70% indicated that the improved flavor is due to the increase in the amount of whole wheat flour in the developed cakes. The numerical score for cake C2 was the highest, i.e., 8.5±0.353 in low-calorie cake followed by high-calorie cake C5, with a score of 8.1±0.233.

Taste: The acceptability of any cake is mainly dependent on its taste. The score of cake for low-calorie cake, C2 with 50:50 whole wheat flour to ragi flour, was found to be highest, i.e., 8.8±0.273. The high-calorie cake, C5 with a larger amount of oil and jaggery, also attained a good score of 8.8±0.273. This indicates that the replacement of ragi flour with whole wheat flour in cake improves its taste. This was also further supported by the score of the cake C0, i.e., 4.6±1.140, which was prepared by using only ragi flour. Tayanath *et al.* [4] reported that the taste of the cake was improved when 20% ragi flour was blended with 80% wheat flour, thereby, confirming our proposition.

Table 5: Mean Sensory Evaluation of the Cakes by Numerical Scoring Test

Characteristics	Cake-0	Cake-1	Cake-2	Cake-3	Cake-4	Cake-5
Color	8±0.707	8.6±0.547	8.8±0.447	7.4±0.547	7.8±0.836	8.5±0.5
Flavor	5±1.581	7.8±0.447	8.5±0.353	7±1	7.4±0.547	8.1±0.223
Taste	4.6±1.140	7.8±0.447	8.8±0.273	7±1	7±1.224	8.8±0.273
Texture	6±1.224	7.8±0.447	8.3±0.447	7.4±0.894	7±1.224	8.8±0.273
Appearance	8±1.224	8±0	8.8±0.447	7.6±0.547	7.8±0.836	7.9±0.418
Overall acceptability	6.6±0.651	8.2±0.758	8.76±0.433	7.3±0.570	7±0.707	8.6±0.418

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Texture: The texture of the cake, C5, was found to be the most excellent with a score of 8.8±0.273 followed by cake, C2, i.e., 8.3± 0.447, and cake, C1 with a score of 7.8±0.447. The literature reports the best texture for the combination ratio of 20:80 ragi flour to wheat flour, whereas, in the present study, the best texture was obtained with a 50:50 ratio [4].

Appearance: The numerical score for the appearance of cake C2 was found to be best, i.e., 8.8±0.447 followed by cake C1 and cake C5, i.e, 8±1.24, and 7.9±0.418, respectively, which is similar to the findings of other research studies [4].

Overall Acceptability: The overall acceptability of the cakes was found to be best for cake, C2, i.e., 8.76±0.433 followed by cake, C5, i.e., 8.6±0.418. It is mainly based on the mouth feel, hardness, and taste of the ragi-wheat composite cake. Similar findings were also observed by studies [29, 30] for mouth feel hardness and taste of ragi-wheat composite biscuit. It is found that incorporation of more ragi flour with whole wheat flour decreases the overall acceptability of cakes, which differs from the results of the present study. This might be due to variations in the use of ingredients in the preparation of cake [4].

Thus, based on the sensory evaluation scores of ragi and wheat blended cakes, it can be concluded that cake C2 is most suitable from the low-calorie viewpoint, and cake C5 is most suitable from the high-calorie viewpoint for the overall acceptability of the developed cakes and human health.

Correlation Between Different Sensory Characteristics of Cakes

Rank correlation was used to assess the ranks of different cakes according to their different sensory characteristics. The correlation among all cakes is presented in Table 6.

Appearance: It is observed that the scores of cake C1, cake C2, cake C3, and cake C4 are higher than the other cakes. From further statistical analysis, it is found that cake C2 has a better appearance in comparison to all other cakes.

Color: It was observed that cake C1, cake C2, and cake C5 scored higher in colour. Among them, the colour of cake C2 has a better color as per the scores of the judges.

Flavor: The analysis of the six cakes demonstrates that the cake C0 and cake C3 had higher scores regarding their flavour, and cake C3 was found to have the best flavour as per the judges' examination.

Taste: Table 6 shows that all cakes except C0 and C3 got high scores on taste as per the judgment of the panel. Among them, the cake C2 and cake C5 had better taste in comparison to the rest on the low-calorie and high-calorie content categories, respectively.

Texture: The analysis of the correlation rank on the texture of the six varieties of cakes, it is seen that except C0 and C4, the rest other cakes higher score in their texture, and C5 was found to be the best among all.

Overall Acceptability: The rank on the overall acceptability of cake C0, C2, C3, and C5 was higher. But among them, the C2 and C5 were accepted by all as indicated by their higher score on this parameter.

Thus, the overall acceptability of cake, C2, and C5 is adjudged to be better in comparison to the rest cakes on the basis of the scores on their six sensory characteristics.

Sensory Evaluation of Cakes Using Hedonic Scale

Table 7 presents the sensory evaluation of the developed cakes on the basis of the 9-points Hedonic scale. Analysis of the data reveals that Cake C2 is liked extremely by 85% followed by Cake C5 by 83% of the respondents. Thus, these two cakes can be considered to be better from low-calorie C2 and high-calorie C5 standpoint.

Digestibility of Cakes

Digestibility is one of the most important criteria for the evaluation of any food product. As cake C2 was found to be best among all developed cakes, 20 gm per day of it was fed

Table 6: Rank Correlation of the Cakes

Characteristics	C01	C02	C03	C04	C05	C12	C13	C14	C15	C23	C24	C25	C34	C35	C45
Appearance	0.54	0.44	0.54	0.43	0.76	**0.95**	**0.95**	0.81	0.77	0.87	**0.95**	0.58	0.94	0.75	0.88
Color	0.88	0.75	0.88	0.66	0.58	**1**	0.94	0.84	0.65	0.94	0.9	**1**	0.84	0.65	0.9
Flavor	0.98	0.97	**0.99**	0.97	0.35	0.94	0.97	0.94	0.18	0.97	0.97	0.6	0.94	0.36	0.6
Taste	0.99	0.99	0.99	0.97	0.55	**1**	0.98	0.99	0.6	0.98	**1**	0.6	**0.91**	**1**	0.93
Texture	0.73	0.88	0.82	0.66	0.57	**0.97**	0.96	0.76	0.41	**0.97**	0.85	**0.97**	0.76	0.41	0.09
Overall acceptability	0.98	0.97	**0.99**	0.94	0.71	**0.99**	0.95	0.95	0.75	0.95	0.74	**0.99**	0.92	0.7	0.72

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Table 7: Mean Sensory Characteristics of Cakes Using Hedonic Scale

Nine Point Hedonic Scale	Cakes (%)					
	C0 100:00	C1 70:30	C2 50:50	C3 70:30	C4 60:40	C5 50:50
Liked extremely	68	82	85	76	74	83
Liked very much	10	6	8	4	5	7
Liked moderately	7	8	5	6	13	6
Liked slightly	9	4	2	8	8	4
Neither like nor dislike	4			6		
Dislike slightly	2					

to panel members for one week. No significant health complications such as diarrhea, skin allergy, Indigestion, etc. were observed among the members. This envisages that there is no concern relating to the digestibility of ragi flour-based developed cakes.

Comparative Analysis of the Cost

The cost of the developed cakes was compared with the commercially available cakes. The price of the cakes per 100 gm of each decreases in the order, C1(Rs. 19.82)>C5(Rs. 18.36)>C3(Rs. 18.12)>C2(Rs. 17.31)>C4(Rs. 17.14)>C0(Rs. 16.31) in line with the ingredients incorporated to the cakes. On the other hand, the price of the commercially available cakes is about Rs. 30/- per 100 gm of it. Thus, the developed cakes are cheaper than the marketed cakes by about two times and hence these cakes can be easily affordable by all categories of people.

CONCLUSION

Due to the population explosion and consequent amplification of urbanization and demand for food production, the development of food that is easily affordable, healthy, and handy is the need of the hour. Additionally, the ragi-based food products are getting recognized from a health point of view with the progress of time due to their high nutritional content. The present endeavuor deals with the formulation of a series of cakes comprised of different proportions of wheat and ragi flour so as to get both low-calorie and high-calorie products that will be suitable for diseased people as well as growing children, respectively. Different ingredients were mixed with the flour to enrich the products with protein, fat, iron, calcium, and other nutrients. The results divulge that both the categories of the products are acceptable, the low-calorie cakes being acceptable at 5:5:2.5:2.5:1.5:1:1ratio, and that high-calorie cakes at 5:5:5:5:10:1:1 ratio. The developed low-calorie cakes products can be used by people of all age groups as a therapeutic diet. Whereas, the high-calorie product can be used by children for their growth and development. In a nutshell, intake of these cakes as per the requirement may be a vehicle to solve the problem of protein-calorie malnutrition, iron deficiency anemia, osteoporosis, rickets, etc., from society.

REFERENCES

1. Wang CY. Hong Kong identities through food: tracing developments and variations of pineapple buns in modern complexities. Food, Culture & Society (2021); 1-17.
2. Wandhekar SS, Bondre N, Swami A. Formulation and Quality Evaluation of Finger Millet (Ragi) Fortified Cookies. International Journal of Innovation, Leadership, Society and Sustainability (2021); 1(1).
3. Deshpande S, Tripathi MK, Mohapatra D, Jadam RS. Product Development from Millets. In Millets and Millet Technology (2021); (pp. 143-160). Springer, Singapore.
4. Tayanath SJ, Adhau GW, Said, PP. Development and snsory evaluation of ragi wheat composite cake, Current Research in Nutrition and Food Science (2018); 6(1); 142-147.
5. Zubairuddin SM, Sonkar C, Masih D, Sonkar N. Development and quality evaluation of ragi fortified cake. The Allahabad Farmer Journal (2015); 70(2).
6. Devi P, Saroha A.K. Synthesis of the magnetic biochar composites for use as an adsorbent for the removal of pentachlorophenol from the effluent. Bioresource Technology (2014); 169; 525-531.
7. Sathiyabama M, Manikandan A. Foliar application of chitosan nanoparticle improves yield, mineral content and boost innate immunity in finger millet plants. Carbohydrate Polymers (2021), 258; 117691.
8. Nakarani UM, Singh D, Suthar KP, Karmakar N, Faldu P, Patil H.E. Nutritional and phytochemical profiling of nutracereal finger millet (*Eleusine coracana* L.) genotypes. Food Chemistry (2021); 341; 128271.

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9. Gunashree BS, Kumar RS, Roobini R, Venkateswaran G. Nutrients and antinutrients of ragi and wheat as influenced by traditional processes. International Journal of Current Microbiology and Applied Sciences (2014); 3(7); 720-736.
10. Devi P.B, Vijayabharathi R, Sathyabama S, Malleshi N.G, Priyadarshini V.B. Health Benefits of Finger Millet (Eleusinecoracana L.) Polyphenols and Dietary Fiber: A Review. Journal of Food Science and Technology (2014); 51(6); 1021-1040.
11. A.O.A.C. Association of Official Analytical Chemists. Official Methods of Analysis 15th ed. 1995 Washington.
12. Biswal AK, Panda P.K, Yang JM, Misra P.K. Isolation, process optimisation and characterisation of the protein from the de-oiled cake flour of *Madhuca latifolia*. IET Nanobiotechnology (2020); 14(8); 654-661.
13. Math R, Addangadi K.C, Awasthi D.P. Current Status of Bajra/Pearl Millet Diseases and Their Management. In Diseases of Field Crops: Diagnosis and Management (2020); (pp. 89-104). Apple Academic Press.
14. Longvah T, An2antan2 I, Bhaskarachary K, Venkaiah K. Indian food composition tables. Hyderabad: National Institute of Nutrition, Indian Council of Medical Research (2017).
15. Biswal A.K, Samal A.K, Tripathy M, Misra P.K. Identification of the secondary structure of protein isolated from deoiled cake flour of Mahua (*Madhuca latifolia*). Materials Today: Proceedings (2019); 9; 605-614.
16. Biswal A.K, Misra P.K. Biosynthesis and characterization of silver nanoparticles for prospective application in food packaging and biomedical fields. Materials Chemistry and Physics (2020); 250; 123014.
17. Lenka C, Kumari T, Pradhan T, Biswal A.K, Misra P.K. Qualitative analysis of low calorie cake formulated with whole wheat flour and its cost-effectiveness. *International Journal of Food and Nutritional Sciences* (2020); 9(4); 44.
18. Srilakshmi B. Evaluation of food Quality, *Food Science,* New Age International (P) Limited, Publishers (2015); 308-337.
19. Biswal, A. K., Lenka, C., Panda, P. K., Yang, J. M., & Misra, P. K. (2021). Investigation of the functional and thermal properties of Mahua deoiled cake flour and its protein isolate for prospective food applications. *LWT*, 137, 110459.
20. Salunke, J. S., & Bhosale, M. G. Nutritional Analysis of Cake Formulated with Ragi Flour and Peanut Butter. international journal of innovations and technology, 5(4): 294-297.
21. Muktar, S. S., Maroti, K. S., & Subhash, W. K. (2018). Development and quality evaluation of ragi flour incorporated cookie cake. *International Journal of Pure & Applied Bioscience*, 6(5), 872-876.
22. Upadhya, S., Dhami K., Tiwari R., Kumar S., Kahil. D., Mukharji, P.(2018), effect of enrichment on quality evaluation of finger millet mix carrot cakes, international journal of food science and nutrition, 3(2): 133-139.
23. Yousaf, L., Hou, D., Liaqat, H., & Shen, Q. (2021). Millet: A review of its nutritional and functional changes during processing. *Food Research International*, 142, 110197.
24. Patel Priya and Thorat SS,(2019) studies on chemical, textural and colour characteristic of decorticated finger millet fortified sponge cake. The pharma innovation journal: 8(3): 64-67.
25. Dharmaraj, U., Parameswara, P., Somashekar, R., &Malleshi, N. G. (2014). Effect of processing on the microstructure of finger millet by X-ray diffraction and scanning electron microscopy. *Journal of food science and technology*, 51(3), 494-502.
26. Smitha, V. K., Samir, O. M., Urs, R. G., Mahesh, S. S., Malleshi, N. G., &Somashekar, R. (2008). The Effect of Cooking on the Nano-Sized Crystallites in Finger Millet and Barley Using Waxs Data. *International Journal of Food Properties*, 11(4), 781-790.
27. Leblanc, N., Saiah, R., Beucher, E., Gattin, R., Castandet, M., &Saiter, J. M. (2008). Structural investigation and thermal stability of new extruded wheat flour based polymeric materials. *Carbohydrate polymers*, 73(4), 548-557.
28. Kudake, D. C., Bhalerao, P. P., Chaudhari, N. S., Muley, A. B., Talib, M. I., &Parate, V. R. (2018). Fortification of wheat flour with ragi flour: Effect on physical, nutritional, antioxidant and sensory profile of noodles. *Current Research in Nutrition and Food Science*, 6(1), 165-173.
29. Saha S, Gupta A, Singh S.R. K, Bharti N, Singh K. P, Mahajan V, Gupta H.S. Compositional and varietal influence of finger millet flour on rheological properties of dough and quality of biscuit. LWT - Food Science and Technology: 44(3), 616-621: 2011.
30. Lenka Chandrashree , Kumari Tripti, and Pradhan Trupti. (2020), Fortification of cake with chickpea flour as a Protein enhancer. The journal of research ANGRAU, XLVIII(3), 49-56.