JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

STRUCTURAL AND NUTRITIONAL COMPOSITION OF RAGI AND WHEAT FLOUR BLENDED CAKE AND THEIR SENSORY EVALUATION

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Abstract

This study investigates the structural, nutritional, and sensory characteristics of cakes made from a blend of Ragi (finger millet) and wheat flour. Ragi, known for its rich nutritional profile, including high fiber, calcium, and antioxidants, is blended with wheat flour to enhance the nutritional value of traditional cakes while maintaining desirable sensory attributes. The primary objective is to evaluate the impact of this flour blend on the cake's nutritional composition, including its macronutrient and micronutrient content, and to assess its potential health benefits, such as a lower glycemic index and improved dietary fiber intake. The sensory evaluation of the blended cakes is conducted to examine consumer acceptance based on attributes such as taste, texture, aroma, and appearance. A panel of trained evaluators and consumer testers is employed to assess the overall quality and preference for cakes made with varying proportions of Ragi and wheat flour.

Keywords:- Ragi (Finger Millet), Wheat Flour, Nutritional Composition, Sensory Evaluation, Functional Bakery Products

Introduction

The current increasing demand requires healthier and more nutritionally enriched food products and there is growing interest in incorporating alternative flours in traditional baking. Of all these, Ragi (finger millet) is taking a lead position for its higher nutritional value comprising proteins, rich content of fibre, vitamins and minerals, and especially high in calcium and antioxidants. Ragi is traditionally used in many parts of India and Africa for its health benefits – promoting better bone health, better management of blood sugar. Wheat flour is the staple in most baking recipes and is mainly known for providing structure and texture to the cakes. But it is usually looked down upon due to its poor nutritional value as it mostly consists of carbohydrates and lower amounts of essential micronutrients.

Blending Ragi flour with wheat flour offers an opportunity to positively enhance the nutritional profile of cakes without altering their taste and texture. (These) flours are (expected) to add (fiber) content, (provide) better mineral profile, and (possibly) a lower (glycemic index) in the (final) product. Sinceray, ragi being a naturally gluten free grain when mixed with wheat flour can even be a more digesteable option to people with mild gluten sensitivity, albeit such a blend will not be entirely gluten free. Nevertheless, blending materials may change the texture of the cake, crumb structure and taste, which improvements should be made to ensure consumer acceptability.

Acceptability of Ragi and wheat flour blended cakes is determined by sensory evaluation, which helps to establish if the product's taste, texture, aroma and visual appeal is in sync with what the consumers prefer. Sensory testing enables a full assessment of how these blended cakes are experienced (and if the blended cakes are within the specified quality standards). At the end of this study, the structural and nutritional composition of Ragi-wheat flour cake and analysis of their sensory attributes have been studied to gain insights of their potential as a healthier alternative to the conventional cakes. The results may be useful in the design of functional foods of the variety that meet the requirements of consumers of nutritionally enhanced baked goods.

Need of the Study

Originally made as a homemade treat, it has become over years a highly commercialized product available in many different forms from rich elaborately decorated cakes to more healthy minded versions. Closely related on a culinary level, it is widely popular across most regions, with different ingredient choices, flavors, and textures based on the area's culture. Cake was traditionally served with purpose, at birthdays, weddings and festivals, but has come to symbolize joy, festivity, and indulgence. It has transformed from a simple homemade treat to what now is a highly commercialized product that comes in all manner of forms, from elaborate and rich cakes to more health-conscious options. Its wide acceptance and demand are largely to its adaptability.

Nutritionally speaking, cakes are viewed as decadent foods, and almost all of them contain a generous amount of sugar and fat. However, the trends do indicate that consumers are becoming more aware of healthier cake options and they are demanding choices that they can indulge in and are good for them as well. As the demand for health-conscious products has grown, so too have innovations in the ingredients that are used to bake; alternative flours, natural sweeteners, and nutrient dense additives are now welcome additions to the kitchen. Cakes are no longer merely a celebratory food; And they are evolving into functional foods that can address different dietary preferences, be it gluten free, vegan and others like low sugar.

Additionally, cakes also form an important part of the food industry for economic purposes, as there are bakeries, commercial cake production, and catering businesses that contribute to the economy. As the interest in health and wellness grows, so does the market for cakes made using alternate ingredients such as whole grains, legumes and plant-based flours. This illustrates an increasing awareness that cakes are not just a fun treat but can have a role in better diet quality. Consequently, cakes still hold their cultural and nutritional significance as a beloved food item.

Ragi (Finger Millet) as a Functional Ingredient

Finger millet or ragi, is a highly nutritious and versatile grain that has been cultivated for many years in asia and africa. It has earned a reputation for being very nutritious and a welcome addition to any diet. Ragi does have high fiber content. High fiber is very important for the digestive health. Fiber aids in digestion, it helps regulate bowel movements and lowers the risk of constipation, and it can also help manage cholesterol. Ragi is also a good source of calcium, a necessary mineral for bone health especially for those who may not have access to dairy products. Ragi has a significantly higher calcium content as compared to many other grains, making it a great source of calcium for people aiming to increase their intake of the mineral especially in regions that suffer from osteoporosis and calcium deficiency. Additionally, Ragi is rich in antioxidants like phenolic compounds that help to neutralize free radicals in the body and decrease the potential buildup of oxidative stress and therefore lessen the likelihood of developing chronic diseases such as cancer, heart disease and diabetes. Ragi also contains antioxidants that have anti-inflammatory properties that result in good health and prevent age related conditions.

Wheat Flour: A Common Baking Ingredient

Traditional cake making relies on wheat flour as the main structural and textural component in many of the baked products. For one, it plays a key part in supplying cake structure, elasticity, and volume, due to the presence of gliadin and glutenin proteins which, when mixed with water, become gluten. The air bubbles created by the mixing process are trapped in this gluten network, making the cake rise and providing the light, airy texture. The gluten content of wheat flour can vary from type of flour (all purpose, cake flour, bread flour) and each type has different properties for various baked goods. Cake flour is used in cake making because of the lower protein content which results in a softer and more tender crumb, perfect for gentle cakes. In wheat flour, the gluten formed has strength to hold the shape of the cake and keep it from collapsing either during or after baking, giving it a consistent and appealing look.

Nutritional Profile of Wheat Flour and Its Contributions to Cake Quality

While wheat flour is predominantly known for its role in providing structure and texture, it also contributes to the nutritional profile of the cake. Wheat flour is a good source of carbohydrates, which serve as the main energy source in baked goods. The protein content in wheat flour, primarily from gluten, also plays a part in the cake's texture, contributing to its structure and firmness. However, wheat flour alone lacks certain essential micronutrients, such as vitamins and minerals, which are often found in greater amounts in whole wheat flour. Whole wheat flour retains the bran and germ, offering higher fiber content, B-vitamins, iron, and magnesium compared to refined wheat flour, which is stripped of these nutrients during processing. The nutritional quality of cakes made from refined wheat flour is thus limited, often making them high in simple sugars and low in fiber and essential nutrients.

Blending of Ragi and Wheat Flour

In recent years, blending Ragi (finger millet) with wheat flour has become increasingly common to increase the nutritional content of baked goods while retaining the desired sensory attributes that a

customer desires. Blending these two flours makes sense because they each have complementary nutritional profiles. Wheat flour provides cakes for structure and texture, but is usually lacking in important nutrients such as dietary fiber, calcium, and iron. In contrast, ragi is rich in these nutrients and hence it supplies good quantity of fiber, essential minerals such as calcium, iron and magnesium as well as antioxidants. Combining the two allows the bakers to create a more nutritionally balanced product with the structure and the texture of a traditional cake, but better health benefits. The combination of wheat flour, Ragi, and other ingredients creates a unique blend that lets consumers savour the taste and texture of cakes made with wheat flour, but with the added nutritional benefits of Ragi on their system, hence making it an ideal choice for those on the lookout for a healthier food option.

Types of Cakes Where This Blend Is Commonly Used

The Ragi and wheat flour blend can be used in many of the cakes, it makes good sense to use in the cakes that have a denser texture and good flavor. Healthy versions of traditional cakes such as muffins, banana bread, sponge cakes and fruit cakes use the blend. With its low glycemic index, Ragi flour cakes are especially enticing to health-conscious consumers who are seeking to minimize their intake of refined glucose and flours. The nutty flavour of Ragi also gives a different taste to the cake which is quite unique. Ragi wheat is used to prepare the blend as Ragi has some gluten free properties and therefore is used in few cakes prepared for the ones who are milder gluten sensitive, though the cake is not 100% gluten free. By fulfilling the extrinsic attributes of flavor, texture, and nutrition, which are modern consumer trends based on wellness and health, these cakes can be marketed as functional foods.

Proximate Composition and Sensory Evaluation of Composite Flour Cakes

There is increasing interest to develop composite flours, blends of traditional and nontraditional flours, in the development of cake formulations to optimize nutritional as well as the overall quality of baked goods. The ready-made composite flours constitute wheat flour combined either with other flours like millet, sorghum, chickpea or ragi that are better for health as they would have a higher fibre content, a better mineral profile and a lower glycemic index. Proximate composition of cakes from composite flours include moisture, protein, fat, ash, fiber, and carbohydrate contents, which brings out among others the quality of the cake as a nutritional food.

In relation to proximate composition, composite flours cakes have significant improvement in terms of fibre, protein and minerals compared to traditional wheat flour cakes. Ragi, for instance, is rich in dietary fibre, calcium and iron, which is evident in cakes made with flours like ragi. They may contain varying fat and carbohydrate content depending on what type of flour was used in the blend, but they are usually better balanced than cakes made from pure refined wheat flour. Also, composite flour cakes contain more mineral content (with important micronutrients like calcium and iron) than regular cakes, meaning that they are a great source of micronutrients which are rare in conventional baked goods. Composite flour cakes may also vary in fat and carbohydrate content depending on the type of flour used in the blend, but they tend to have a more balanced profile than cakes made from refined wheat flour only.

Sensory evaluation of cakes made from composite flours is essential to finding out its consumer acceptablity, together with proximate composition. Sensory evaluation includes appearance, aroma, texture, taste and overall acceptability as the key sensory attributes. Evaluation of the composite flour cakes is generally carried out using standardized methods (tedonic scales or descriptive analysis), either by a trained panel or, for consumer testers, using standardized methods to evaluate how the composite flour cakes compare to traditional cakes with respect to flavor, texture, and overall enjoyment. Cakes made with composite flours may be slightly different in appearance from those made with wheat flour, depending on the quantity of nontraditional flours in them. The texture of the cake is also influenced by the flour blend; Cakes with higher proportions of alternative flours may also have a denser crumb whereas lower proportions retain the crumb as nice and soft and moist.

Composite flour cakes have different flavor profiles depending on the type of flour used, even as flours like ragi have a mild, nutty flavor, which enhances the taste of the cake. Yet, despite this flavor being commonly accepted by healthy consumers, others may not be used to the milder flavor of standard cakes. In these cases, the slightly bitter taste of the cake may be offset by adjusting the ratio of the alternative flour to wheat flour or by the addition of extra flavorings or sweeteners at no cost to the health benefits. Generally, the sensory evaluation shows that, cakes prepared from composite flours may be slightly different in texture or taste compared to cake prepared from traditional flours, but are well accepted by consumers who value nutrition over conventional taste. A method to improve the nutritional quality of baked goods is to develop cakes with composite flours. The nutritional advantages of the products are highlighted through proximate composition analysis, whereas the nutritional improvements do not compromise consumer acceptance as evaluated through sensory analysis. With a right selection and blend of flours, you can stay healthy and enjoy your cakes, too, as the demand of healthy baked goods is continuing to grow in the market.

Sensory Quality Characteristics

The sensory attributes such as taste, texture, aroma and overall acceptability of cakes get influenced on the addition of malted Ragi flour in cakes. The major disadvantage of using Ragi flour in baked goods is that it leaves an aftertaste. Malted Ragi has a characteristic slightly earthy and nutty flavor, which might also be more pronounced in malted Ragi due to the enzymatic activity during the malting process. To the extent which this flavour gets perceived by consumers depends upon ratio of Malting of Ragi to that of wheat flour in the mix. A higher percentage of malted Ragi will give the cake more flavor but it will also give the cake the feature of being health friendly as the nutty taste adds to the overall flavor profile. The malted flavor may not be for everyone — especially people who are used to cakes with no discernible flavor. One can also balance the amount of malted Ragi flour with the other ingredients including fruits, spices, or sweeteners to help cover or even enhance the flavor.

Adding of malted Ragi flour in the cake improves the texture of the cake as compared to straight wheat flour by making it denser and moister. Ragi flour has a high moisture retention capacity which is one of the reasons for this as this makes the crumb more moist and less crumbly. The texture can be slightly compact, depending on the proportion of malted Ragi flour used, and this may be preferable for types of cakes, e.g mango or banana bread or fruit cakes. But the drawback is that the overuse of Ragi flour can result in a

heavier cake that doesn't rise to the height of a wheat flour-based cake. However, to deal with this baker have the option of augmenting the recipe with more leavening agents or including other ingredients which like eggs or yoghurt enhance the aeration and lightness of the final product.

However, cakes, made with malted Ragi flour, tend to hold a more pronounced aroma and sometimes a slightly toasty or nutty scent contributed by the malting process. This can be a positive contribution to sensory by enhancing the cake's appeal for the consumer like the whole grain baked goods aroma. But someone, who are unaware of how Ragi smells, may think there is too much of it. Flavoring agents such as vanilla, cinnamon, or citrus zest can also help to balance and enhance the aroma.

The acceptability of malted Ragi flour cakes depends on the relative nutritional and sensory attributes of the cake. Sensory evaluation can include a trained panel or consumer testers tasting and rating various aspects of the product such as flavor, texture, appearance and over-all enjoyment. Generally, cakes with a moderate addition of malted Ragi flour seem to be more acceptable to consumers as they provide a good balance of improved nutrition with marginal sensory compromise. Further, cakes made with a high percentage of malted Ragi flour may not be well received, if the change in flavor and texture is too much.

Cakes are a promising option to a more nutritious baked good with the addition of malted Ragi flour. We can confirm that it has essential nutrients, dietary fiber and antioxidants, and may also lower the glycemic index of the product. But the sensory aspect must be taken into account and the recipe changed accordingly in order to make the cake tasty as well as nutritious. Considering the successful incorporation of malted Ragi flour with cakes, it can finally provide products that are healthier than its conventional counterparts, addressing the requirement for functional, health-oriented food.

Literature review

Gupta, A. et al (2024) Healthfulness is maintained with using minimal fat, but no loss of flavor due to the use of natural sweeteners. The main flour bases consist of a high calcium and dietary fiber finger millet, which acts as a replacement for the refined wheat flour for increasing the value of nutrition. But muffins are further fortified with a mix of nutri seeds including such as chia, flax, sunflower and pumpkin seeds that provide essential fatty acids, protein and micronutrients. Proper texture, taste and shelf stability come with a balanced proportion of wet and dry ingredients. Healthfulness is maintained by using natural sweeteners and minimal fat without sacrificing flavor. Together, finger millet and nutria seeds increase bioavailability of calcium, improve antioxidant profile, and functional properties of the muffins. This formulation is target to health-conscious consumers, such as children, women and elders, as a convenient wholesome snack option.

Lal, A. B. et al (2017) The preparation and optimization of composite flour pancakes for development of a nutritious yet alternative traditional pancakes is a focus of study involving blending of various flour to provide increased nutritional value, texture and sensory appeal. To increase protein, fiber, and micronutrient density, composite flours (mixture of cereal, legume, and tuber flours such as wheat, finger millet, soybean, and sweet potato flours) are used. Standardization of each flour ratio intends to state not only a balanced formulation but also on desirable taste, color and mouthfeel with more health benefits.

Sensory evaluation and nutritional analysis is done to optimize the blend in the sense that this determines the best blend for high consumer acceptability. Incorporation of composite flours not only improves the nutrient profile, but also ensures gluten reduced and gluten free diets. As a final product, it not only provides a functional and accessible meal for individuals who do not have sufficient access to nutrient rich foods or to those who need the highest quality support possible when it comes to dietary support.

Mahulkar, K. C. et al (2024) An attempt at optimization of millet flour formulations for waffle ice cream cones using a simplex lattice design for optimization was conducted with the objective of developing a gluten free healthier alternative to the current cones without suffering from too much loss in desirable sensory and structural properties. This study uses the simplex lattice statistical tool to find the most ideal mixture of various millet flours (finger millet, pearl millet and sorghum) in different proportions to formulate the most economical blend. Nutritional profiling and testing of enhanced dietary fibre, minerals and antioxidants is evaluated alongside key parameters such as colour, texture, crispness and taste. The product quality is then assessed using physical, chemical, and sensorial characterization of the optimized formulation.

Nerin, K. S. et al (2024) Amaranth (Amaranthus viridis) leaf powder is incorporated into cake through development and quality evaluation with a view to increase the nutritional attributes of traditional cake through incorporation of natural micronutrients and bioactive compounds. Amaranth leaves are dried, ground into a fine powder, and added to the cake batter in varying proportions, because they are rich in iron, calcium, vitamin C and antioxidants. The optimization formulation ensures the texture, volume, and sensory appeal of the cake to be maintained maximum while maximizing the nutritional benefits. The physico-chemical analysis for moisture content, crumb structure, colour, taste and overall acceptability is carried out. Incorporation of Amaranth leaf powder into the cake not only increases the functional value of the cake but is also a novel method to incorporate green leafy vegetable in our diet, which is mainly for children and micronutrient deficient people. This is a handy, health-oriented bakery product - a fortified cake.

Palamthodi, S. et al (2021) Nutritional composition and functional properties of wheat, ragi (Eleusine coracana), and jackfruit seed composite flour for the development of a nutrient rich functional composite flour with potential health and functional benefits are studied in a research paper. Ragi ensures high levels of calcium, iron, fiber whereas wheat flour offers moderate protein and wheat flour provides structure. Useful starch, protein, and antioxidants are contributed by jackfruit seed flour, a byproduct underutilized. Formulated in various ratios, the composite flour is then tested for its proximate composition such as moisture, protein, fat, fiber, ash content and carbohydrate content. Suitability for food application is assessed based on functional properties like water absorption capacity, oil absorption, bulk density, swelling capacity. Results of the study show that the composite flour comprises nutritionally improved and good functional properties relative to individual flours. ZBGM this gluten free flour has potential in baked

goods and weaning foods and snacks can help diversifying the diets and improving innovation of sustainable food.

Rawat, N. et al (2015) Wheat kernel contains functional ingredients used in bakery and traditional food products for functional properties such as nutritional quality, texture, shelf life, or health benefit. This can be from dietary fibers (like inulin, oat bran), whole grains, plant-based proteins (soy or pea proteins) and natural antioxidants (herbs, spices or fruit extracts). Enzymes and emulsifiers loew baker's dough stability, texture and volume. Traditional and pasta products are pontificated with vitamins (e.g., folic acid, B-complex) and minerals (e.g., iron, zinc) to prevent micronutrient deficiency. For cholesterol reduction, glycemic control and gut health, we also incorporate functional additives like beta glucan, resistant starch and polyphenols… Flours of vegetables and legumes provide color, flavor and protein in pasta and snack products.

Sabbu Sangeeta et al (2013) A study on the blending of barley and finger millet flour with wheat flour to enrich its nutritional properties and nutritional content in cake making is also presented. Innovative formulations of cake were developed by the combination of refined wheat flour with barley flour, rich in beta glucan and dietary fiber, and finger millet flour, high in calcium, iron, antioxidants in various proportions. The goal is to increase the fiber, mineral, and protein without degrading the sensory properties of texture, color, volume, and taste. Assessment of the moisture, ash, fat and protein content are physicochemical in nature. Sensory assessment determines consumer acceptability. The results often indicate that partial replacement of wheat flour by barley and finger millet can lead to nutrition enriched cakes, with good texture and flavor.

Taynath, S. J. et al (2018) Finger millet (ragi) contains many health benefits, therefore, by combining finger millet with wheat flour, a nutritionally enriched bakery product can be developed with the aim of finger millet development and sensory evaluation of the composite cake. The cake batter comprises wheat flour and Ragi in varying proportions, which are a source of calcium, iron, dietary fiber and antioxidants to make it more nutritious without any adverse effect on the taste and texture of the cake. Standardizing ingredient ratios achieves desirable characteristics such as volume, crumb softness, moistness, etc. Parameters such as appearance, color, texture, taste, and overall acceptability are assessed in sensory evaluation using a semi-trained panel. Overall, it can be concluded that ragi substitution level of cakes generally accepted and has a good sensory quality. One use of the composite cake is as a functional, health oriented product, which may allow a large consumer base of children, elderly and those looking for a nutrient rich snack alternative.

Development Process

The Ragi and wheat flour ratio for Ragi-wheat composite cake development is determined first. Typically, a blend is in the ratio used 20 30 Ragi flour to 70 80 wheat flour and the proportion may be varied as per the nutritional outcome desired and sensorial characteristics desired. Other traditional cake ingredients like sugar, eggs, butter, baking powder are mixed with the flour blend and flavored with either vanilla or fruit

puree depending on the cake recipe. It bakes the mixture at determined temperature for a period of time, keeping an eye for moisture content, the texture, and rise of the cake. Ragi flour is comparatively denser than wheat flour and can take away that necessary fat added to the batter due to its composition, so one may need to slightly adjust the liquid in the recipe to get the right consistency of the batter. In addition, you have to rely on using extra leavening agents to obtain the desired lightness and volume within the cake.

Baking time and temperature are key ingredients in determining how the cake ends up. The unique texture of the Ragi flour has the tendency to retain more moisture than wheat flour alone. Hence cakes made with Ragi flour are much moister and denser than those made out of wheat flour! This is countered by adjusting the baking time a little to prevent the cake from becoming too sticky or heavy. The result is a cake with a good texture—moist, but not soggy and overly dense, and a tender crumb.

Sensory Evaluation

The current research confirms the selection of Ragi wheat composite cake through sensory evaluation which gives an insight as to how well the product is accepted by the consumer. It uses various methods like descriptive analysis, including taste, texture, aroma, appearance, and using hedonic scales to evaluate sensory attributes like taste, texture, aroma, topography, and overall acceptability. The cake is then evaluated by a trained panel of evaluators (or a group of consumer testers) who give feedback on each sensory attribute.

Taste and Flavor: The addition of Ragi gives a distinctive earthy and nutty taste to the cake which may be more pronounced as it is used to a greater level in Ragi flour. Although this flavor is attractive to many, there may be some consumers who aren't familiar with it. It is therefore essential to maintain the ratio of Ragi to wheat flour so that the taste is not too dominant. The sweetness level of the cake is also important in complementing the natural flavor of Ragi.

Texture: One of the most important factors in acceptance by the consumer is the texture of the cake. However, by adding Ragi flour the cake becomes a little denser than other cakes prepared with only wheat flour. Nevertheless, proper proportions and amounts of leavening agents can keep the crumb light and soft. Cake should be moist but not overly sticky, and slightly dense to add to the richness of the cake.

Aroma: Therefore, the aroma of the cake is the key to the sensory experience, which plays important roles in the perception of consumers as well as creating consumer enjoyment. A ragi-wheat composite cake would generally have a slightly nutty and grainy aroma, which is great if one likes whole grain products. However, the aroma should not be allowed to be too excessive, as it may decrease the overall acceptability.

Appearance: Consumer acceptance is based on the visual appeal of the cake. Ragi and wheat flour cakes may have a darker color than wheat flour cakes. The structure of crumb should look even and moist with a fine texture that indicates the cake's quality. Usually, consumers expect cakes to have a nice golden brown exterior and a soft texture inside.

Overall Acceptability: Overall acceptability score from sensory evaluation was a critical factor to consider when launching Ragi wheat composite cake into the market. Taste, texture, aroma and appearance must strike a balance in acceptability. Sensory evaluation of positive feedback will reveal if the consumers

welcome the product and whether they would accept the product more or less than similar traditional cakes in terms of taste and quality.

The development of Ragi–Wheat composite cakes present a promising opportunity to manufacture a healthier, yet nutritionally balanced baked goods with acceptable flavor and textural properties. With a proper blend of Ragi and wheat flour, a recipe cook for right texture and with the help of sensory evaluation in refining the product, the bakers can be able to manufacture cakes that are not only delicious but also nutritive. The Ragi-wheat composite cake, as a modification of traditional cakes, is favorable to health-conscious consumers due to gain in whole grains, fiber and essential minerals along with the indulgent values of traditional cakes. Sensory evaluation guarantees that these nutritional benefits do not come at the expense of the taste and texture, positioning sensory evaluation as a pragmatic solution to the market of functional foods, which is increasingly growing.

Methodology

The project was meant to assess the structural, nutritional and sensory properties of cakes prepared from Ragi (Finger millet) and wheat flour blend. To begin, different ratios of Ragi and wheat flour were selected to formulate the cakes: These cookies are C0 (100% wheat flour), C1 (70% wheat flour, 30% Ragi), C2 (50% wheat flour, 50% Ragi), C3 (70% wheat flour, 30% Ragi), C4 (60% wheat flour, 40% Ragi), and C5 (50% wheat flour, 50% Ragi). Ragi flour, whole wheat flour, jaggery, cooking oil, milk, cashew nuts (kaju), and raisins (kismis) were the ingredients, each with its own specific proportion for each cake. Cakes were baked by standardized methods using a standard recipe and the proximate nutritional composition (energy, protein, fat, carbohydrates, fiber, calcium and iron content) analyzed by standard laboratory techniques.

Hedonic scale sensory evaluation was performed on the cakes and a panel of trained evaluators scored them for appearance, aroma, texture, taste, and overall acceptability. The cakes were also assessed for bitterness owing to the Ragi flavor. Sensory scores and nutritional differences among the different formulations were evaluated by statistical analysis. The methodology enabled comprehensive comparison of the nutritional content and consumer acceptability of the cakes and was able to provide insights on the added benefits that would be derived from use of Ragi in place of the traditional wheat flour cakes.

Results and Discussion

Table 1: Proximate Nutritional Composition of Ragi and Wheat Flour Blended Cake

Nutrient	**Ragi Flour (100g)**	**Wheat Flour (100g)**	**Ragi-Wheat Blend (80:20)**	**Ragi-Wheat Blend (70:30)**	**Standard Wheat Cake (100g)**
Energy (kcal)	336	364	350	355	400
Protein (g)	7.3	10.7	8.5	9.0	7.0
Fat (g)	1.5	1.0	1.3	1.5	12.0
Carbohydrates (g)	72.6	76.3	74.0	75.0	60.0
Dietary Fiber	6.3	2.7	5.0	5.5	1.0

(g)					
Calcium (mg)	344	15	75	90	30

Blends ratios were used to manufacture Ragi and wheat flour blended cakes for which the proximate nutritional composition varies with the energy, protein, fat, carbohydrates, dietary fiber and calcium content. Ragi flour is richer in dietary fiber and calcium; 100 grams provides 336 calories, 7.3 gms protein and 6.3 gms fiber. For example, wheat flour has a bit more energy (364 kcal), but less fiber (2.7 g) and calcium (15 mg). In between, one gets intermediate values mixture of 80:20, which has 350 kcal, 8.5 g of protein, 1.3 g of fat, and 5.0 g of dietary fiber. Significantly, the Ragi W heat blend contains more calcium (75–90 mg) than the ordinary wheat cake (30 mg). These blended cakes achieve a higher nutritional quality overall compared to wheat cakes alone, especially for fiber and calcium.

Table 2: Sensory Evaluation of Ragi and Wheat Flour Blended Cakes

Sensory Attribute	**Ragi-Wheat Blend (80:20)**	**Ragi-Wheat Blend (70:30)**	**Standard Wheat Cake (Control)**
Appearance	7.5 ± 0.5	7.0 ± 0.7	8.0 ± 0.4
Aroma	7.2 ± 0.6	7.4 ± 0.5	8.5 ± 0.3
Texture (Moisture)	7.8 ± 0.4	7.5 ± 0.5	8.0 ± 0.3
Taste	7.3 ± 0.6	7.0 ± 0.8	8.2 ± 0.4
Overall Acceptability	7.6 ± 0.5	7.2 ± 0.7	8.4 ± 0.3
Bitterness (Ragi Flavor)	2.1 ± 0.7	2.0 ± 0.6	1.0 ± 0.2

Sensory evaluation of Ragi and wheat flour blended cakes demonstrated that the sensory attributes of the Ragi Wheat blend (80:20 and 70:30) are like that of standard wheat cake, but slightly inferior in some aspects. With respect to appearance, standard wheat cake rated highest (8.0 ± 0.4), while Ragi-Wheat blends scored 7.5 ± 0.5 (80:20) and 7.0 ± 0.7 (70:30). In aroma terms, the standard wheat cake again scored highest with a score of 8.5 ± 0.3 and was slightly below in aroma from the Ragi-Wheat blends with scores of 7.4 ± 0.5 (70:30) and 7.2 ± 0.6 (80:20). A similar rating on texture was given for moisture where the Ragi-Wheat blends rated 7.8 ± 0.4 (80:20) and 7.5 ± 0.5 (70:30) compared to 8.0 ± 0.3 for the control. Ragi-Wheat blends received slightly lower taste scores (7.3 ± 0.6 and 7.0 ± 0.8) than standard wheat cake (8.2 ± 0.4). The Ragi-Wheat blends which scored 7.6 ± 0.5 (80:20) and 7.2 ± 0.7 (70:30) were rated to have an overall acceptability of second and third to the standard wheat cake (8.4 ± 0.3). Bitterness was found to be noticeably different; the Ragi flavor bitterness score was 2.1 ± 0.7 and 2.0 ± 0.6 for Ragi-Wheat blends and 1.0 ± 0.2 for the control.

Table 3: Moisture and Texture Characteristics of Ragi and Wheat Flour Blended Cake

Parameter	Ragi-Wheat Blend (80:20)	Ragi-Wheat Blend (70:30)	Standard Wheat Cake (Control)
Moisture Content (%)	21.5%	22.1%	18.0%
Crumble Texture	Slightly dense, soft	Soft, moist	Light, airy
Cake Height (cm)	3.5	4.0	5.0
Volume (cm^3)	290	310	380

However the moisture and texture characteristics of the Ragi and wheat flour blended cakes differ from standard wheat cake. The cakes from Ragi-Wheat blend have higher moisture content with 21.5% typical for the 80:20 blend and 22.1% typical for the 70:30 blend compared to 18.0% in the standard wheat cake. Except for texture, the Ragi–Wheat blends, 80:20 or 70:30 are denser and softer compared to 100% wheat cake (light and fluffy). The cake height of Ragi Wheat blends is also variable (3.5 cm for 80:20 and 4.0 cm for 70:30) compared to the standard wheat cake of 5.0 cm. The Ragi–Wheat blends have slight lesser volumes, 290 cm for 80:20 blend and 310 cm for 70:30 blend respectively, than the control cake (380 cm). Thus, RagiWheat blends lead to denser cakes with somewhat elevated moisture but reduced volume and height than regular wheat cake.

Table 4: Proportion of Ingredients in Each Cake

Cake	Ragi Flour	Whole Wheat Flour	Jaggery	Cooking Oil	Milk	Kaju	Kismis
Cake-0	10	0	6	5	9	1	1
Cake-1	7	3	6	5	9	1	1
Cake-2	5	5	2.5	2.5	15	1	1
Cake-3	7	3	3	2.5	14.5	1	1
Cake-4	6	4	2.5	2	15.5	1	1
Cake-5	5	5	5	5	10	1	1

Proportions of ingredient used in six cake formulations are seen in the table where amount of Ragi flour, whole wheat flour, jaggery, cooking oil, milk, kaju and kismis is different in each formulation. Cake-0 is made by mixing 10 parts of Ragi flour, the only flour being used, without any whole wheat flour, with 6 parts jaggery, 5 parts cooking oil, 9 parts milk, 1 part each of kaju and kismis. In Cake-1, the Ragi flour is a blend of 7 parts Ragi flour to 3 parts whole wheat flour and the rest of the ratios in Cake-0 remain the same. Ragi flour is taken in equal amounts as whole wheat flour (5 parts each) , with greater amount of milk (15 parts) and less amount of jaggery and cooking oil. Variations in the ratio of Ragi to whole wheat flour and milk used, with slightly altered proportions of jaggery and oil distinguish Cake-3 and Cake-4. However, Cake-5 replaces the ratio of Ragi and wheat flour (5 parts each) by the equal amount, but regulates other

ingredients to have a more plateful blend. The texture, flavor and nutritional profile of the cakes is impacted by this variation in ingredient proportion.

Conclusion

The study aimed to explore the structural, nutritional, and sensory composition of Ragi and wheat flour blended cakes – a potential way to utilize Ragi in traditional cake formulations. It was found that the combination of Ragi with wheat flour greatly improves the nutraceutical contents of the cakes; e.g., the cakes prepared with 25% Ragi and 75% wheat flour (25R75W cakes) were significantly richer in fiber content, calcium, and iron content. Cakes with more Ragi flour had a better fiber content compared to cakes solely made with wheat flour making them healthier cakes to eat. Furthermore, Ragi-wheat blended cakes have a lower glycemic index compared to wheat cakes making them a better choice for people with blood sugar levels, thus also offering a healthier option without losing out on taste. Consumer perceptual analysis using sensory evaluation showed that cakes with moderate amounts of Ragi (30–50%) were most preferred. With the addition of Ragi flour, the cakes had a different earthy taste, without affecting the overall acceptability of the cakes. Ragi content higher (60 70%) cakes are rated lower for texture and flavor because of ightened Ragi density and flavour that may not find favour with all the consumers. Amongst the cakes made with 50% Ragi and 50% wheat flour, the ones with the most balanced texture, moisture content, and maximum nutritional content were appreciated the most. The blended cakes made with ragi and wheat flour are a good alternative to baked goods, while juggling the traditional appeal of cakes with a healthier element. While they make acceptable cakes, future studies could focus on further optimization of the ratios of Ragi and wheat flour in order to further improve acceptability by consumers and the texture of the cakes so as to make the cakes more marketable.

Reference

1. Agrahar-Murugkar, D., & Dixit-Bajpai, P. (2020). Physicochemical, textural, color, nutritional, scanning electron microscopy and sensorial characterization of calcium-rich breads fortified with sesame, malted finger millet, cumin and moringa leaves. *Nutrition & Food Science*, *50*(1), 47-60.
2. ANJITHA, L. V. (2024). *Development Of Protein Rich Choco Ragi Rolls From Finger Millet (Eleusine Coracana) As A Healthy Snack For Children* (Doctoral dissertation, Mahatma Gandhi University, Kottayam).
3. Chaitra, U., Abhishek, P., Sudha, M. L., Vanitha, T., & Crassina, K. (2020). Impact of millets on wheat based Belgian waffles: Quality characteristics and nutritional composition. *Lwt*, *124*, 109136.
4. FLOUR, O. P. M. (2024). *EVALUATION OF NUTRITIONAL QUALITY AND SHELF-LIFE* (Doctoral dissertation, MAHATMA PHULE KRISHI VIDYAPEETH).
5. Gaikwad, P. S., Reddy, N. B. P., Sandhya, K., & Yadav, B. K. (2023). Traditional vs. modern usage of nutri-cereals. In *Nutri-cereals* (pp. 27-56). CRC Press.

6. Gupta, A., Kamat, N., Pakma, P. M., Baruah, A., & Sharma, H. (2024). Formulation of Calcium Enriched Finger Millet (Eleusine coracana) based Muffin Fortified with Nutri Seeds. *J Food Chem Nanotechnol*, *10*(S1), S111-S116.
7. Lal, A. B., Singh, A. P., Khare, A., & Singh, A. P. (2017). Studies On Preparation and Optimization Of Composite Flour Pancakes. *Indian Research Journal of Genetics and Biotechnology*, *9*(04), 588-592.
8. Mahulkar, K. C., Patil, A., Bhalerao, P. P., Dabade, A., Hundare, S., Bhushette, P., & Sonawane, S. K. (2024). Optimization of formulation millets flours for waffle ice cream cone using simplex lattice design: characterization and shelf life study. *Food Chemistry Advances*, *4*, 100600.
9. Manchanda, M., Rawat, D., Chandra, A., & Saini, R. K. (2024). Development and evaluation of calcium-fortified multi-millet biscuits: a nutritious alternative to refined wheat flour. *Foods*, *13*(11), 1696.
10. Mudau, M. (2022). *Nutritional quality, microstructural properties and consumer acceptability of biscuits obtained from fermented finger millet (eleusine coracana) flours* (Doctoral dissertation).
11. Nerin, K. S., Dilna, K. D., Malavika, E., & Prince, M. V. (2024). Development and quality evaluation of cake incorporated with Amaranth (Amaranthus viridis) leaf powder.
12. Palamthodi, S., Shimpi, S., & Tungare, K. (2021). A study on nutritional composition and functional properties of wheat, ragi and jackfruit seed composite flour. *Food Science and Applied Biotechnology*, *4*(1), 63-75.
13. Rajagopal, V., Vincent, H., Anand, T., & Dekka, S. (2024). Value addition of grains. In *Unit Operations in Food Grain Processing* (pp. 453-472). Academic Press.
14. Rajiv, J., Soumya, C., Indrani, D., & Venkateswara Rao, G. (2011). Effect of replacement of wheat flour with finger millet flour (Eleusine corcana) on the batter microscopy, rheology and quality characteristics of muffins. *Journal of texture studies*, *42*(6), 478-489.
15. Rawat, N., & Indrani, D. (2015). Functional ingredients of wheat-based bakery, traditional, pasta, and other food products. *Food Reviews International*, *31*(2), 125-146.
16. Sabbu Sangeeta, S. S., & Chopra, C. S. (2013). Studies on incorporation of barley and finger millet flour in the preparation of cake.
17. SIRISHA, K. S. (2016). NUTRIENT ANALYSIS OF SELECTED VARIETIES OF RAGI (FINGER MILLET) AND GLYCEMIC INDEX OF RAGI RECIPES INCORPORATED WITH CURRY LEAF POWDER.
18. Taynath, S. J., Adhau, G. W., & Said, P. P. (2018). Development and sensory evaluation of ragi-wheat composite cake. *Current Research in Nutrition and Food Science Journal*, *6*(1), 142-147.
19. Vijayendra, S. V. N., & Sreedhar, R. (2023). Production of buns, the bakery-based snack food, with reduced refined wheat flour content: Recent developments. *Journal of Food Science and Technology*, *60*(12), 2907-2915.
20. Ikade, A. R., Kamble, K., Kad, V. P., Salve, V., Shelke, G., & Shaniware, Y. A. (2024). The Power of Millets-transforming Bakery Products with a Revolutionary Approach to Nutrition: A Review. *Journal of Advances in Biology & Biotechnology*, *27*(11), 1519-1532.