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Research Article

QUALITY EVALUATION OF WHOLE WHEAT BREAD FORTIFIED WITH GERMINATED RAGI FLOUR

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A R T I C L E I N F O

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A B S T R A C T

The ragi (*Eleusine coracana*) flour is rich in protein, energy, vitamins and minerals. Ragi proteins are good source of essential amino acids, these are also rich source of phytochemicals and micronutrients. That is why they act as nutraceuticals. Therefore, efforts were made to prepare multigrain bread using these grain flours after germination. The bread was prepared by replacing whole wheat flour with millet flour at 1,2,3,4, 5% and prepared bread was evaluated for sensory properties using semi trained panel members by using 9-point hedonic scale. In the present investigation the bread at 1-3 per cent level of incorporation of germinated ragi rated almost equal to that of control sample. However, the bread at 5 per cent was not liked very much by most of the panel members. The bread was also evaluated for its physical characteristics, the physical characteristics at 3 per cent replacement level of ragi was as much as comparable to the control sample. The loaf volume, texture, taste, flavour, crust color, crumb color and overall acceptability was decreased with increased percentage of germinated ragi flour in bread.

INTRODUCTION

Cereals are used as staple food almost all over the world. Wheat is the mostly used for human consumption in many areas of the world. Common wheat or bread wheat (*Triticum aestivum)* is the most widely cultivated in the world. Large quantity of wheat is milled into atta (a high-extraction flour), which is used for the production of flat breads, especially chapattis and naans. A lot has, however, happened since the first bread was baked in Egypt approximately 12 000 years ago (Batifoulier F, *et al*.,2005). From the Egyptians random experimentation with flour, water and yeast, via the small, artisan bakeries established in almost every village supplying citizens with their daily rations of bread, to present were centralization and a high technological industrialization have taken toll on the production practice. The use of white flour derived from the processing of whole wheat grain, which is aimed at improving the aesthetic value of white bread, has also led to the drastic reduction in the nutritional density and fiber content when compared to bread made from whole grain cereals (Maneju *et al.,* 2011). Today, bread is produced in a large scale by a few production units and then distributed and re-distributed over large distances to wholesalers, supermarkets and in-store-bakeries (Cauvain S.and Young L. 2000). Wheat is highly nutritious crop which is rich in carbohydrates, vitamins and minerals.

Minerals play a vital role in the maintenance of human health. Cereals and legumes are rich in minerals but the bioavailability of these minerals is usually low due to the presence of ant nutritional factors such as phytate, trypsin inhibitor and polyphenols. Phytic acids is most important anti-nutrient because it is found in most of the cereals and have strong ability to complex multi-charged metal ions, especially Zn, Ca and Fe and make them unavailable for human body utilization. The simple traditional household technologies such as roasting, germination and fermentation, cooking and soaking have been used to process the cereal in order to improve the nutritional quality. To improve nutritional quality and organoleptic properties of cereal based foods genetic improvement, amino acid fortification, supplementation or complentation with protein rich sources and processing technologies are employed (milling, malting, fermentation and sprouting) (Chavan and Kadam, 1989a). During germination certain changes occur as the quantity and type of nutrients within the seed. These changes can vary depending on the type of vegetable, the variety of seed and the condition of germination (Bau *et al*., 1997; Dhaliwal and Aggarwal, 1999). An increase in bioavailability of minerals and weight has been observed due to germination. Germinated seeds are good source of ascorbic acid, riboflavin, choline, thiamine, tocopheroles and pantothenic acid (Sangronis and Machado, 2007). Millets are minor cereals of grass family Poacae. Finger Millets *Eleusine coracana*) have various nutritional qualities, and have rightly been called "nutri-cereals". Wheat is traditionally used in breads, and consumption of millet can be increased by replacing wheat by millet to a required extent.

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The Millet kernel constitutes 15% of seed coat and is a good source of calcium, dietary fiber and polyphenols (Chetan and Malleshi, 2007). The major health benefits associated with regular intake of millet foods are hypocholesterolemic, hypoglycemic and antiulcerative which indicate the scope for its utilization by the non-traditional millet consumer also (Shobana and Malleshi, 2007).Health benefits of finger millets are attributed to its polyphenol and dietary fiber contents. It is an important staple food in India for people of low income groups. Nutritionally, its importance is well recognised because of its high content of calcium (0.38%), dietary fiber (18%) and phenolic compounds (0.3–3%). They are also recognized for their health beneficial effects, such as anti-diabetic, anti-tumerogenic, atherosclerogenic effects, antioxidant and antimicrobial properties.(Devi *et al* 2014). Lots of varieties of foods are prepared from ragi which varies from country to country and also from region to region within a country, such as thin or thick porridge , unleavened bread, , fermented porridge, making "ingera", etc. (Desai *et al.,* 2010). Awareness of the need to eat high quality and healthy foods – known as functional foods,is increasing among consumers. These foods contain ingredients that provide additional health benefits beyond the basic nutritional requirements (Ndife and Abbo, 2009). Germination improves the nutritive quality of cereals. Due to the high bulk density\ of products made from cereals, major efforts have been made to promote the use of sprouted millet. Sprouting has been reported to improve the nutritional quality of seeds by increasing the contents and availability of essential nutrients and lowering the levels of anti-nutrients.

Ragi was a major source of dietary carbohydrates for a large section of society. Ragi had various health benefits and is a good source of micro-nutrients. value added food products based on ragi, is the need for wellbeing of society as it enriches the nutritional value and is beneficial for good health . today the foods are not meant for taste and delight of eating but also for their high nutritional quality and health benefits. The development of new food products is a modern trend and it provides nutritional security as well. (Verma and Patel 2013).

The composite bread prepared by using ragi flour was found to have high calcium, soluble dietary fiber, tannin and phytic acid. Instead, the control bread contained significantly higher carbohydrate, physiological energy and starch. Studies showed that millets have good nutrition qualities ,and are known as "nutri-cereals". Wheat was traditionally used in breads, and millets consumption can be increased if it is being incorporated in wheat flour at certain acceptable levels in breads.

Aims and objective

1. To formulate and develop functional breads from whole wheat flours composited with germinated ragi flour.
2. To optimize the whole wheat bread with different levels of germinated ragi flour.
3. To access the acceptable levels of germinated ragi flour in bread formulations.
4. To fortify bread with germinated ragi protein to combat PEM in children.

MATERIALS AND METHODS

The present study on "Development & Quality evaluation of Wheat Bread formulated with germinated Ragi flour" was conducted and following material and method were used for the study.

Materials

Whole wheat flour: - whole wheat flour was procured from market under the brand name "ashirwad". germinated ragi flour: - ragi flour was prepared in lab.
Bakers yeast: - baker's yeast was procured from the local market.
Sugar: - normal sugar was purchased from the market and used for the preparation of bread.
Salt: - tata iodised salt was purchased from the market
Shortening: - oil was procured from the market under the brand name "fortune".
Improver:- improver was procured from market

Methods

A ***Ragi***

Finger Millet (*Eleusine coracana*) was purchased from a local grocery in Patiala ,India. A few seeds with defects were removed from samples.

Germination of Ragi

Ragi was cleaned and rinsed three times with tap water before being steeped at room temperature for 4 h. After steeping, samples were germinated at room temperature Approx. 25^0 C , 30^0C & 35^0C for 12, 24, 36 hours in a moist muslin cloth. Generally, it takes two to four days for ragi sprouts to mature. Germination (1.8 cm sprout) at room temperature (~25 °C) for about 24 h was selected as the optimum germination condition for germinated ragi flour production. Optimum germination time was selected, and ragi flour made from 24 h-germinated ragi under optimum germination conditions showed significantly good physichemical profile

Germinated ragi was placed in a hot air oven at 55℃ for 24 h for drying .The dried ragi was then, milled using a attrition mill. The obtained flour was sieved in a standard sieve which is used for chemical analysis.

Preparation of ragi flour

Grains were thoroughly cleaned and made free from dust and other foreign materials. Germinated grains were dried in a dryer at 55°C for 24 h. They were then milled in a mini flour mill and the germinated ragi flour was stored in deep freezer at -22^0C temperature for further to be incorporated in composite flour to prepare breads.

Raw Material Analysis

Moisture analysis (air oven method)

Sample of (5g) was taken in a weighed petriplate and was placed in oven at 130^0C for one hour. After this the sample was placed in dessicator and then weighed again. Difference in both gives the moisture content of wheat flour (AOAC approved).
Moisture content (%) = weight of fresh sample- weight of dry sample * 100

Weight of fresh sample

1. ***SDS sedimentation volume: -*** Sample (5g) and 50ml of water is taken in 100ml stoppered volumetric cylinder. For hydration it was shaken three times for 15 sec at interval of 2 min. 20ml of SDS lactic acid stock solution was added to the cylinder (1 part of lactic acid in 8 parts of water with 50ml of SDS dissolved in water). The sample is inverted four times for 15 sec at interval of 2 minutes. Then the sample was allowed to rest for 40 minutes and sediment reading of sample was noted. (AOAC approved)
2. ***Gluten estimation: -*** Wheat flour 20g and water (10ml) is mixed so as to make stiff dough. This is allowed to stand in a beaker of water for 30 minutes. The dough was then squeezed with fingers gently kneaded under a stream of running water until all the starch is washed out and wash water is clear. The residue of moist gluten is squeezed dry in the finger and weighed. After this the gluten was dried in air oven at 105^0 for 6 hours and that gives dry gluten weight and gives the amount of water a dry gluten can take, that is its hydration capacity (AOAC approved).

Wet gluten= $\frac{\text{weight of wet gluten} * 100}{\text{Weight of sample}}$

Protein content: - In kjeldahl method of nitrogen estimation, sample is digested in concentrated sulphuric acid act as dehydrating and oxidizing agent carbon in sample is oxidized

Micro- kjeldahl method: -AOAC Method followed
Protein content = amount of nitrogen* 6.75

Fat content: - Sample of (2g) was taken in thimbles. Round bottom flask was filled with ether up to 3/4th of its volume. It was refluxed for 5 hours at the rate of 5-6 drops /sec. after 5 hours take out thimble and dry in oven for 20-30 minutes at 80^0 C. cool in dessicator and thimble is weighed along with dried sample (AOAC approved).
Fat content = $\frac{\text{fat content (g)}}{\text{Sample wt (g)}} * 100$

Ash estimation: - Ignite 3-5g of Sample in a silica dish at 600^0 C to constant weight. In this method, sample are weighed and charred before ashing on direct flame. Then crucible having charred is placed in muffle furnace at 565^0 C temperature. Ashing is done for 5-6 hours. Then these crucibles are taken out and placed in dessicator and these are weighed again. The white residue left behind is ash (AOAC approved)

Ash % = $\frac{\text{weight of ash} * 100}{\text{Weight of sample}}$

Falling No.:- (25ml) was exactly heated to 100^0 C in falling number apparatus .7 gm of Whole Wheat Flour was dispersed in 25 ml of distilled water.It was mixed for 60 seconds in boiling water tank. The mixing probe was then left to check the falling rate of probe in seconds.

Dough raising capacity: - Water (45ml) was exactly heated to 40^0 C and it was dispersed in 2.5g of yeast. 35g of flour was taken in a beaker. 1g of sugar was added and mixed in yeast suspension. Mass was made into smooth batter and added to 250 ml graduated cylinder and base level was noted. The rise in level of dough was 15minute intervals for 1 hour. Plot the graph between time and rise in dough volume.

Final Product Testing: For the final product testing parameters to be tested are moisture, protein, fat, ash and loaf volume. The loaf volume was measured by rape seed displacement method. The other parameters that are moisture, protein, ash and fat are tested by methods approved by AOAC and followed under the topic raw material testing given above.

Test Baking Procedure*:* For the past 20 year, remix baking test has been employed as principle method in the evaluation of baking quality of wheat by the grain research laboratory USA.

The baking method requires high speed dough mixing at both the initial mixing stage and the remix stage which follows a medium long fermentation period. Dough is made from flour water compressed yeast salt and sugar under specified condition of dough temperature, mixing speed and mixing time. Dough are fermented for 2 hours remixed sheeted molded and assessed for absorption and handling properties. It is placed in baking pan, proofed for 40 minutes and baked for 15 minutes. Loaf volume is measured after 25 minutes of cooling and loaves are evaluated the following day for appearance crust color crumb color flavor grain softness and overall acceptance.

Ingredients	Quantity
Flour	100
Compressed yeast	4
Sugar	4
Bakery shortening	3
Salt/NaCl	2
Improver	0.15
Water	Optimum (ml)

Standardized Recipe of Bread Making

Mixing: Pour all ingredients in a beaker except yeast. Four minutes before schedule mixing time yeast suspension that is 6g of yeast in little amount of water was added for standard recipe. Add this directly to flour in mixing bowl. Start the mixture continuously and mix for atleast 2 minutes. During mixing period, measure ingredient for next test sample. Remove the dough immediately after mixing, round it lightly with hands and place it in a greased fermentation bowl. Place the bowl to fermentation cabinet at 500 C for 30 minutes at 90% relative humidity. Continue other mixing operation as above maintaining time schedule for remaining samples. Place wet cloth over bowls containing dough.

Remixing: Remove the dough from fermentation bowl and remix it for 15 seconds and again place it in fermentation bowl for 25 minutes.

Intermediate Proof: Allow a recovery period for 25 minutes.

Remixing: Remix the dough again for 15 seconds.

Fermentation: Keep the dough in fermentation cabinet for 15 minutes

Sheeting And Molding: Remove the dough from fermentation bowl without tearing it and wipe it back and forth on a lightly flour dusted bench top. Spread dough on a clean table by a roller and then and then start molding the spread dough. Turn the end inside and seam the seal. Remove the dough and place it in a baking pan containing numbered slip of paper identifying the sample. The seam of the dough is placed and ends are pushed downward with tips of finger producing pillow-shaped appearance. Place baking pan in proper sequence.

Proofing: Proof for 40 minutes at 30^0 C at 90% relative humidity.

Baking: transfer the proofed dough from fermentation cabinet to oven (oven temperature maintained at 250^0 C. Remove baked dough from oven after 15 minutes.

Similarly different breads were prepared by incorporation of germinated soya flour at different concentration

METHODOLOGY

Experimental: This study was be carried out by supplementing wheat flour with germinated soyaflour at 0, 1, 2, 3, 4 and 5%.

Bread sample	Wheat Flour	Level of germinated Rgai flour	Replication
Control	100	0	
RG1	99	1	
RG2	98	2	
RG3	97	3	3
RG4	96	4	
RG5	95	5	

A Micro-Farinograph (Brabender instruments) was used to determine the amount of water that each flour required to get a consistency of 500 BU, which is the standard consistency to test quality of wheat flour, and to establish the mixing time required to reach the peak consistency (dough development time). The water absorption required by flours is determined. The dough was allowed to relax in a plastic container within an incubator for 20 minutes at 30^0C and a constant relative humidity of 85%. After relaxation the dough was punched by hand .

Bread quality: The loaves was be analysed for volume, weight, specific volume and height. Sensory panel evaluation for appearance, crust color, crumb color, aroma, taste and overall acceptability was done by a panel semi trained judges on nine point hedonic scale.

Sensory Evaluation: Sensory evaluation is one of the method used in identifying market acceptability especially in bakery based products it is used for product development and improvement since the most important factor for a particular can e identified and improved. Influential factors are essential for consumer to get the best product and manufacturers to develop and sell best products. Sensory evaluation is also necessary to ensure that their product will be succeeding in market place (Dhillon and Amarjeet Kaur, 2013). Without appropriate sensory analysis there is a high risk of market failure. Sensory analysis is too commonly often overcooked as a requirement before product is launched. The implication again back to the successfulness of product to survive in market. Today's consumerare discerning demanding and more knowledgeable about food and expert which are safe, good quality and high sensory quality. Therefore knowing consumers preferences and perception of sensory characteristics of the food and drink products is very important for food manufacturers. Sensory evaluation may be seen as specific discipline which looks at how measurement evoked and interpret characteristic of food and material as they are perceived by senses. It involves measurement and evaluation of food and other material. Human judges are used to measure the flavor or sensory properties of food. Sensory data such as taste, color flavor smell, mouth feel are obtained through subjective evaluation. This type of evaluation data are normally analysed statistically, but it is not possible to find out from such analysis the strength and weakness of specific sensory attributes which is responsible for acceptance and rejection of the product, in the statistical analysis of sensory evaluation data, average score of attributes are generally calculated and compared with certain significant level among sample (Lazim and Suriani, 2009).

Whole wheat bread substituted with ragi flour blends were prepared as described in procedure and kept for storage before subjecting them to organoleptic evaluation. A panel of semi trained and untrained panelist from industry tested and rated the product according to the hedonic scale.

RESULT AND DISCUSSION

Chemical analysis of germinated Ragi flour

The whole wheat flour was procured from the local market & was analysed for different parameters and the result for the same is summed up in the table below. The results indicated that the whole wheat flour used for the preparation of composite bread is suitable from the values obtained by parameters such as SDS sedimentation, protein, moisture, ash, fat and gluten content given in the table below. The results show that the germinated ragi flour used for bread preparation was very rich in protein than the whole wheat flour used.

Table: chemical analysis of Germinated ragi flour and Non Germinated ragi flour

Parameter	Non Germinated ragi flour	Germinated ragi flour
MOISTURE%	6	8
SDS %	-	-
GLUTEN%	-	-
PROTEIN%	10.5	11.5
FAT%	1.7	1.5
ASH%	2.0	1.8

Fig: Germination of Ragi for 28 h

Fig: Germinated ragi flour

Dough Raising Capacity of Yeast

In order to produce uniform quality bread, it is important to add the optimum quantity of yeast. Therefore, it becomes necessary to check dough raising capacity of flour for its optimum performance. The graph obtained for DRC is shown in Fig below

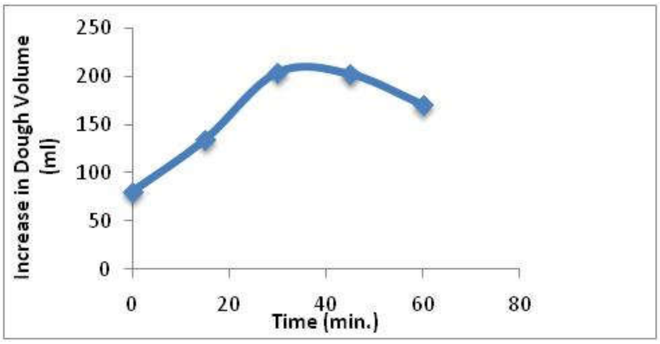

Fig: Dough raising Capacity of Yeast

It was reported by Ramachandra *et al*. (2009) that minimum DRC value of yeast should be 80% of initial value. Therefore yeast being used, having DRC value 112.5, had desirable activity of rise in volume more than three times over a period of 60 min. Based on the DRC value, yeast was found suitable for use

Bread Characterstics: It is noticed that the addition of germinated ragi flour to the whole wheat flour adversely affects the characteristics of bread. It affects the physiochemical properties and dough volume of bread (Dhingra and jood,2004). The increase in concentration of germinated ragi flour is inversely proportional to the dough as ragi concentration increases the dough volume decreases. The dough handling also varies with the increase in concentration of ragi flour. The result in the difference in dough handling is summed up in the table given below

Table Effect of Different Conc. of Germinated Ragi Flour on Dough Handling

Bread sample	C	RG1	RG2	RG3	RG4	RG5
Level of germinated ragi flour	0%	1%	2%	3%	4%	5%
Dough handling	smooth	smooth	Slightly sticky	Sticky	Sticky	Sticky

The increased concentration of germinated Ragi flour blends affects the physiochemical properties like ash, fat, moisture proteins etc. the proximate values of these parameters were lowest in the control bread and increases as the concentration of germinated ragi flour increases. However, the substitution of germinated ragi flour reduced the gluten content of the dough and it's extensibility with increasing substitution levels of germinated ragi flour. The water absorption levels of the mixed flour reduced with increasing levels of germinated ragi flour. The substitution of ragi flour into whole wheat flour yielded a dough of higher protein content ranging from 9.59 at 1% substitution level, 11.03 % at 2% substitution level 11.20 at 3% substitution level, 11.40 at 4% substitution level and 11.70 at 5% substitution level compared to whole wheat dough (control) at 8.36 %. There was also increase in the fat contents with an increase of 4.52%, 4.79% 5.59% 6.20 and 6.45% compared to whole wheat dough (control) at 4.03%. respectively. Moisture percentage of bread was increased with increase in finger millet flour.RG1 contained lowest moisture that was 36.10 and RG5 contained 39.95 per cent moisture which was highest than any other. This might be due the fact that ragiflour contained higher amount of solid matters compared to wheat flour. An increase in the ragi flour increases the moisture percentage.The analysed data for increased parameters are given in the table given below.

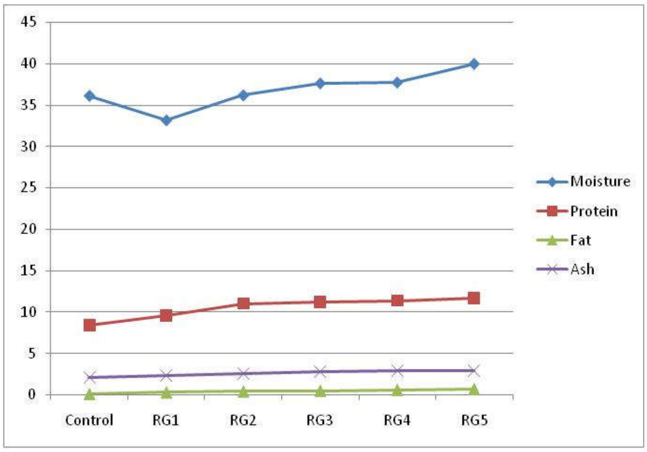

Table: Proximate Result of Chemical Composition of Composite Bread With Increasing Germinated ragi Flour

The addition of germinated ragi flour to whole wheat flour depresses the loaf volume of the bread. However the percentage decrease in loaf volume was much greater in case of germinated ragi fortified with 5% ragi flour and this can be identified in fig below.

CONTROL **RG1** **RG2** **RG3** **RG4** **RG5**

Bread dough expansion and bread volume decreased as level of substitution of germinated ragi flour increased. The effect of germinated ragi flour substitution on loaf volume of whole wheat bread is given below.

Parameters	Control	RG1	RG2	RG3	RG4	RG5
Levels of germinated ragi flour	0%	1%	2%	3%	4%	5%
BREAD VOLUME	310	300	295	290	285	280

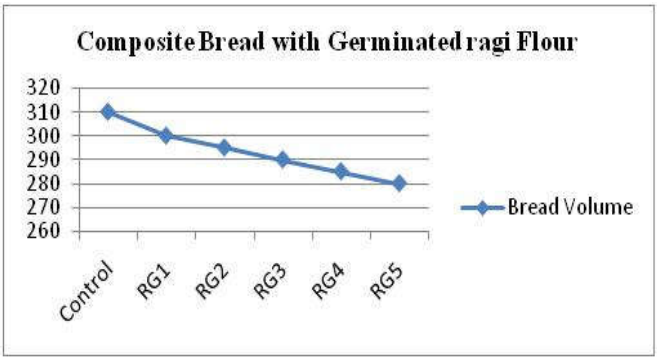

Fig: Effect of Germinated Soya Flour on Loaf Volume of Bread

Sensory Evaluation

The breads supplemented with different levels of soybean flour were evaluated by panelists for sensory characteristics.Texture is a sensory characteristicwhich varies among people & can not be measured.Apart from texture others are flavour & appearance. Results of sensory evaluation of bread samples containing different level of germinated ragi flour substitution as compared to the control is shown in table below

Table: Sensory mean scores of germinated Ragi bread samples

Parameters	Colour & Appearance	Flavour	Texture	Crust	Crumb	Overall acceptability
Control	7	6	6	6	6	7
RG1	7	6	6	6	6	7
RG2	6	6	6	5	5	6
RG3	6	6	6	5	4	6
RG4	5	5	4	4	4	4
RG5	5	4	4	4	3	3
SEM^2	±0.31	±0.28	±0.29	±0.28	±0.29	±0.30

The incorporation of ragi flour into whole-wheat bread resulted in poor flavour scores. Most of the panelist complained of off flavour and aroma from the germinated ragi flour in the composite breads. The scores for texture of the germinated ragi bread samples, decreased with increase in ragi flour substitution, when compared to the whole wheat bread.

CONCLUSION

From the results of present study, it can be concluded that acceptable high protein bread can be prepared by substituting whole wheat flour with germinated ragi flour upto 3% substitution level without adversely affecting the consumer acceptability of bread. Composite breads with germinated ragi flour substitutions were found to be nutritionally superior as they have higher values of protein. Higher protein breads show high nutritional value as the level of lysine content was increased. However the scores for organoleptic attributes like taste, aroma and texture (mouth feel) were generally inferior to that of whole wheat bread. Higher germinated ragi flour substitution showed higher moisture content which can lead to spoilage and hence can effect its storage stability. Therefore, the whole wheat bread had better overall acceptability scores than the germinated ragi composite breads.

The composite breads would serve as functional food because of the high protein content. Germinated ragi blended bakery products with the general advantages of ready availability and consumability may serve the purposes of better nourishment without changing the food habits on incurring excessive expenditure. However further research work should be focused on the phytochemical (isoflavone) content and how to improve the organoleptic qualities and acceptability of germinated ragi fortified breads. Public enlightenment on the nutritional benefits of the soya-supplemented functional foods would help to improve the sensory acceptability of the germinated ragi supplemented bread. There is also the need to adjust the mixing ingredients and baking techniques in order to improve the composite bread qualities. Therefore the need to develop a different approach to offer the weary consumers the opportunity to feed on improved formulations with substantive health benefits from wheat-soybean combinations.

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