Physical, Nutritional, Textural and Sensory Properties of Wheat Bread Supplemented with Soybean, Finger Millet and Flax Seeds flour

Abstract

Two-third population of the world is under-nourished, and lack in required quantity of minerals and proteins. United Nations launched 17 Sustainable Development Goals (SDGs) of which SDG-3 is "health and well-being" to improve the position of malnutrition worldwide. Proteins are essential to human health and in post-covid-19 era, plant proteins production industry is booming to meet the demand of enhanced requirement of vegetative proteins by consumers. Proteins Digestibility-Corrected Amino Acid Score (PDCAAS) of soy protein is 1.00 which is closer to some of the proteins from animal sources. Soy proteins contain balanced amounts of essential amino acids except sulfuric-amino acids like methionine. With this viewpoint, this study was aimed to develop a multigrain wheat flour bread using a composite flour blend as a part of sustainable development goals (SDGs) of UNfor good health and well-being by increasing the nutritional profile of traditional wheat flour bread. The blended flourcontained equal quantities of soybeans, finger millet, and flax seeds andwas added at varying proportions (10%, 15%, 20%, and 25%) withrefined wheat flour for fortification purpose. The comprehensive evaluation encompassed nutritional, sensory, and physical attributes of the resulting multigrain bread whencomparedwith a control loaf made exclusively from wheat flour. Remarkably, the bread fortified with a 10% composite flour mixture exhibited properties equivalent to the control bread across parameters such as expansion, specific volume, color, and crumb hardness but with enhanced nutritional value. The data revealed that supplementation of bread with 10% composite flour blend led to a discernible increase in levels of dietary fiber and proteins. These augmented nutritional components may contribute to the overall health benefits of multigrain bread. We may safely conclude that the incorporation of a well-balanced composite flour blend, comprising soybeans, finger millet,and flax seeds, at 10% level offers a promising avenue to fortify wheat flour bread with enhanced nutritional content that may be helpful in improving the nutritional status of people as a part of Sustainable Development Goals of UN as the bread is a common food item of the poor also.

Objective: Bread is the common food of all people throughout the world and wheat flour the most abundant component that contain high quantity of gluten and is deficient in balanced nutrients. The purpose of this study was to develop highly nutritious multi-grain bread to fight with malnutrition as a part of Sustainable Development Goal-3 of UN.

Methodology: Composite flour containing equal amounts of soybean, finger millet and flax seed was prepared. The bread was prepared using different combinations of wheat flour with 10, 15, 20 and 25% composite flour. Physio-chemical and sensory properties of wheat flour (control) and different combinations with composite flour were measured using standard parameters and protocol.

Results: The nutritional, sensory, and physical attributes of the multigrain bread when compared with a control wheat flour loaf, revealed that the bread fortified with a 10% composite flour mixture possessed similar expansion, specific volume, color, and crumb hardness with that of control wheat flour bread but showed enhanced nutritional value. The data further revealed that the supplementation of bread with 10% composite flour blend led to a discernible increase in levels of dietary fiber and proteins. These augmented nutritional components may contribute to the overall health benefits of multigrain bread.

Keywords: Soyabean, Flax seed, Finger millet, Bread, Functional characteristics, Nutrient composition, Physical characteristics, Sustainable Development Goal

INTRODUCTION

Nutrition plays a pivotal role in maintaining overall human health and promote a sustained and healthy lifestyle. Bread, consumed globally by both the affluent and the economically disadvantaged, is crafted primarily from wheat flour. It serves as a convenient source of essential nutrients and energy for people across all socioeconomic classes. Despite its widespread popularity, traditional breads often fall short in terms of nutritional content and bio-availability. **(1).** Bread is a fast-moving consumer good (FMCG). It is a soft meal that consists of two phases: a solid (cell wall material) and a fluid (air) **(2).** Wheat flour is commonly used for bread preparation, its high gluten content allows it to expand to give a good texture, however, gluten has several complications in digestion and is also not friendly for gut microbiome**(3).**Even then, it is the staple of our daily diet as a meal that has incredible range of tastes, colours, texture and nutrients. In western countries, a large variety of bread is available at Food halls. We noticed more than 200 types of wheat-based bread in Germany alone, but glutenis considered a factor in weight growth and other things as it gets stick on internal walls of the intestine and cause leaky gut especially in those who have sensitivity for celiac**(4-5).**In post-covid-19 era, the demand for healthy bread has motivated food technologists to develop breads that combine health benefits with good sensory properties. Fortified food is enriched with other healthy flours to increase nutritive value and consumer acceptability. Grains have been a part of human diet for about 10,000 years and are the most important food source for the Indian population, accounting for 60-70% of total food intake. Different varieties of grains are available in India, and whole grains are now recognized as essential sources of fiber, trace minerals, and vitamins **(6)**.

The digestibility of protein is expressed in terms of Proteins Digestibility-Corrected Amino Acid Score (PDCAAS) which is 1.00 for soybean (*Glycine max*). It suggests that soybean has high quality of proteins comparable to other animal sources **(7).** It contains balanced amounts of essential amino acids except sulfuric-amino acids like methionine. The animal proteins, though, are good source of proteins but have raised serious environmental issues of greenhouse gas emissions in recent years during meat production and long term use of red meat increases the health risk of various chronic diseases **(8)** because it contains saturated fatty acids that are related to certain lifestyle diseases like cardiovascular. The European Prospective Investigation showed that non-meat eaters ranked higher scores than those meat eaters **(9).** Replacement of animal meat proteins with plant-based proteins to maintain balanced nutritional demand is the current topic of research of food industry. The food industry is searching for alternate solutions to fulfil increased demand of plant-based proteins and the soybean is one of the good substitute for red meat protein **(10),**a good source of all essential amino acids, it provides between 30 and 45 percent protein. A soybean's digestible protein content is around double that of other pulses, four times that of wheat, six times that of rice grains, four times that of eggs, and twelve times that of milk **(11-12).** Lecithin, which aids in brain development, is present in soybeans at 3%. Reduced cost, longer shelf life, and higher yield are achieved when soy flour, in modest amounts, is added to bread to improve moisture content and water absorption.

Millets are important cereal crops that are cultivated in various parts of the world and are consumed by more than one-third population. Millets are highly nutritious and contain 60-70% carbohydrates, 12-20% dietary fibers, 6-19% proteins and 2-4% minerals while fat is limited to 1.5 to 5% only. Millets contain several other beneficial phytochemicals that include phenolic acids and flavonoid **(13).**Finger millet (*Eleusinecoracana*) is a staple food in India and other developing countries (Nepal, Sri Lanka, Bhutan, Africa), ranking third in cereal production in semi-arid regions. Major ragi cultivating Statesof India, are Maharashtra and Uttaranchal, however,ragi is uncommonly used in north India, particularly Punjab and Haryana. Its higher calcium, iron, and dietary fiber content has made it a significant food source. Ragi also contains good quality proteins, essential amino acids, vitamin B, and phosphorus **(14).** Finger millet is a nutritious dietary source for growing children, pregnant women, elderly people, and patients. It is commonly used in flour, pudding, porridge, and roti. In post Covid-19 era, increased awareness of health benefits has been noticed throughout the world **(5)**and the use of processed products with finger millet has gained importance due to its functional components like slowly digestible and resistant starch. The combination of ragi and wheat flour improves nutritional quality and promotes several health benefits **(15, 16).**UN declared the year 2023 as "*International Millet Year*" to fight malnutrition of 2/3rd population of world and to encourage the cultivation of Millets as alternate strategic crops under present climate change scenario **(17).** Millets are also called as "future crops" because of their ability to resist most of the pests and grown well under tough and the changing climate conditions. Millet derived foods have the potential to function as prebiotics and probiotics that provide numerous health benefits including the alleviation of symptoms of gluten related disorders **(3).**

Though, the health advantages of soybeans have long been acknowledged, but the potential health benefits of other functional foods, like flax seed, have just lately been recognized.Flax seed (*Linumusitatissimum*), also known as linseed, is a world-old, cultivated crop with a healthy fatty-acid profile containing 42 to 46% fat, 28% dietary fiber, 21% protein, 4% ash, 6% carbohydrates and is consumed by people for a long time due to its high nutritional value and several medicinal properties. Flax seed is a blue-flowering Rabi crop and a member of the familyLinaceae. It is rich in alpha-linolenic acid (C18:3) having 45% of total fats and has low saturated fatty acids, moderate monounsaturated fat, and a high concentration of polyunsaturated fatty acids (PUFAs). Flax seed protein (28-30%) has demonstrated effectiveness in reducing plasma cholesterol and triglyceride levels when compared to soy and casein proteins. Flax seed also contain abundant plant lignans, such as secoisolariciresinol Di glucoside (SDG), which exhibits antioxidant properties and possess anti-cancer activity **(18).**The fibre content of flax seed range from 30-35% which is good for gut microbiome. Nutritional profile of flax seed exhibits numerous health benefits like cardiac health, brain development, skin shine, gut health, maintain blood sugar level and reduce risk of kidney diseases and several cancers **(19).**An infinite number of proteins could be synthesized from the twenty odd natural amino acids present in flax seed. The proteins form a wide variety of biological molecules to carry out various biological activities in all living organisms such as cell repairing, transportation, enzyme production, biosensors including cell signaling *etc.* (**20, 21**).The health benefits of extruding germinated multi-millet grains blends (sorghum millet, finger millet, foxtail millet, pearl millet, and rice) in various ratios to produce nutritionally important expanded snack products have earlier been reported from our laboratories **(22).** Theeffects of germination on the physio-chemical and anti-nutritional properties of finger millet (*Eleusinecoracana)*, pearl millet (*Pennisetumglaucum*), and sorghum (*Sorghum bicolor)*have been explored by our group**(23)**and their nutritional benefits have been discussed earlier. Thus, the goal of the current study is to prepare functional wheat bread withragi, flax seed, and soy flour and to assess their sensory, nutritional, and physical aspects to find out their acceptability and health benefits.

MATERIALS AND METHODS

Soybeans, finger millet, and flax seed were procured from the local market in Meerut, a part of National Capital Region, Delhi, India. These were thoroughly washed, dried and pulverized using a laboratory hammer mill. The yeast, sugar, all-purpose wheat flour (commonly referred to as refined wheat flour or "*Maida*" in Hindi) and shortening (fat) were also obtained from the nearby local market but by ensuring the use of the latest and highest quality supplies.

Preparation of composite flour

To prepare composite flour, equal proportions of soybean, finger millet (ragi), and flax seed flour were meticulously blended. The composite flour mixtures, in ration of 10%, 15%, 20%, and 25% (w/w), were then incorporated with refined wheat flour to formulate four distinct bread variations and wheat flour alone served as control without addition of composite flour (Table 1). To achieve uniform distribution, the composite flour mixture was sieved through a mesh size of 60 μm which ensureduniform mixing.

Table 1: Process parameters for composite flour bread

Independent variables	Dependent variables
Composite flour included equal quantities of soybean, finger millet and flax seed flour, which was finally mixed in ratio of 10, 15, 20, and 25% with refined wheat flour. Control - 100% wheat flour B1 – 10% Composite flour + 90% wheat flour B2 – 15% Composite flour+ 85% wheat flour B3 – 20% Composite flour + 80% wheat flour B4 – 25% Composite flour+ 75% wheat flour	❖ Physical characteristics of bread - Loaf volume, Specific Volume, Crust Color, Crumb firmness ❖ Nutritional composition of bread - Moisture, Crude protein, Crude fat, Crude fiber, Carbohydrate and Ash content ❖ Sensory quality attributes -Color and appearance, Texture and grain, Flavor, Crispiness, Taste and Overall acceptability

Formulation and preparation of bread

The breads were prepared in the Research laboratory of the Department of Food Safety and Drugs Administration, Regional Public Food Laboratory Meerut, India using straight dough method **(24)**of whichthe protocol is outlined in Fig 1.

Raw Materials (Composite Flour in different ratio + refined wheat flour)

⇩

Addition of water containing yeast

⇩

Kneading (20 min)

⇩

Proofing (1hr)

⇩

Knock back

⇩

Proofing (30 min)

⇩

Filling in greased pan

↓

Proofing (35 min)

↓

Baking (225 ^{0}Cfor 30-35 min)

↓

Cooling (1 hr)

↓

Slicing

↓

Packaging, Storage, and testing for various parameters

Fig.1: Flow chart for the preparation of bread

Physical characteristics of bread

Analysis of Loaf and Specific Volume:

The length, width, and height of bread were measured using caliper and for measurement of volume the bread was placed into a container and filled with rapeseed and bread volume was defined as the number of seed that the bread displaced. The formula below, [Eq-1],was used to get the precise volume of bread.

Loaf specific volume = Loaf volume (cc) / Loaf weight (g) in cc /g [Eq-1]

Measurement of Crumb and Crust:

Crust and crumb of each bread slice were separated carefully and were weighed. The breadth and length of each slice were measured. Total weight of the slice was calculated by adding the weights of crust and crumb and the ration was calculated as follows:

Crumb to Crust Ratio = Crumb Weight / Crust Weight.

Moisture Content

Moisture content was determined by placing 5g of bread in preheated oven at 105°C (212°F and 221°F) for 2-4 hours until constant weight was achieved, cooled down in desiccator and weighted. The percentage of moisture content in the resulting weight loss was calculated.

$$\text{Moisture Content (\%)} = \frac{\text{Initial weight - Final weight *100}}{\text{Initial weight}} \quad \text{[Eq 2]}$$

Analysis of Crude Fat

Sample of 5 g bread was placed in a thimble, defatted with n-hexane (boiling point 68–72°C) in a Soxhlet apparatus for 8 hand the extract was allowed to evaporate and the crude fat was calculated**(24).**

Analysis of Crude Fiber

Bread was cut into small pieces and was thoroughly blended in a food processer, the blended bread was transferred into a pre-weighed crucible, and treated with 1.25% (v/v) sulfuric acid to completely dip the sample. It was allowed to digest in boiling water bath at 100°C for 30 minutes with occasional shakings. The digested sample was filtered and washed with hot water until neutrality and was placed in crucible. Sodium hydroxide (1.25% w/v) was added to the residue and boiled for 30 min with occasional shakings, filtered, washed thoroughly with hot water, dried in oven at 100-105°C until constant weight, cooled down in desiccator and weighed followed by incineration in muffle furnace at 500-550°C until ash is obtained, cooled down in desiccator and weighed. The crude fiber was calculated:

$$\text{Crude Fiber (\%)} = \frac{\text{Weight of Residue after Incineration*100}}{\text{Weight of Bread Sample}} \quad \text{[Eq 3]}$$

Crude protein

The protein content was determined using Micro Kjeldahl method **(17)**where a sample of 0.5 g moisture-free, defatted bread was treated with concentrated sulfuric acid and digested at 130–140˚C in presence of a catalyst copper sulfate until a clear solution was obtained. The digestion flask was cooled down and distilled water was added to it and connected to distillation unit after addition of sodium hydroxide (40% w/v) to liberate ammonia. The gas was collected in boric acid solution (4% w/v) and titrated with hydrochloric acid (01. N HCl) using methyl red:bromo cresol green (1:5 ratio) as indicator. The proportion content was calculated by multiplying percent nitrogen by a factor 6.25 using following equation:

$$\text{Crude Protein (\%)} = \frac{\text{(Volume of HCl (standard or sample) * × Factor of Nitrogen × Conversion Factor}}{\text{Volume of HCl (blank)}} \quad \text{[Eq 4]}$$

Total ash

Sample (5g) was weighed into crucible and burned entirely at low flame until no more smoke was visible, maintained at 600°C for 6 h in a muffle furnace, and was cooled in desiccators and weighed, was again placed in the muffle furnace at 550°C for two consecutive constant weights.Percent ash was determined as follows:

$$\text{Total Ash (\%)} = \frac{\text{(Weight of Ash)} \times 100}{\text{Weight of Bread Sample}} \quad \text{[Eq 5]}$$

Total carbohydrate

Phenol and sulfuric acid was followed to analyze the total carbohydrate content of bread. A sample of 500 mg of bread was treated with 2 mL of 72% (w/v) $H_2SO_4$and 23 mL of distilled water was added. It was refluxed on a water bath at 90 ± 5°C for 3 h. The total sugar concentration was computed using the standard curveprepared at 480 nm with 0.2, 0.4, 0.6, 0.8, and 1 g concentration of glucose.

Texture Profile Analysis (TPA)

Textural Profile Analysis (TPA) was made using Texture Analyzer (Model TA-XT2, Make Stable Micro System, UK) as per instructions of the manufacturer for firmness, hardness, springiness, cohesiveness, gumminess, chewiness, and resilience test**(26)**.

Sensory evaluations

A panel of 13 common individuals was chosen at random from the Universityand local community for sensory evaluation of the bread samples. The panelists were given a 9-point hedonic scale, with 9 representing "extremely liked" and 1 representing "disliked extremely," to use when rating the samples' scent, texture, taste, color, appearance, and general acceptability. The assessment scores were averaged and compiled.

Statistical analysis

Using Fully Randomized Design for various treatments, the data were subjected to an analysis of variance **(27)** and was expressed at P<0.05 level of significance, S.E., and C.D. at the 5% level.

RESULTS AND DISCUSSION

The goal of the current study was to examine the effect of incorporation of ragi, flax seed, and soy flour with respect to the chemical, nutritional, textural, and sensory qualities of bread. Standardization of the amount of composite flour in multigrain wheat bread to a level of acceptable quality was the main focus of the study.

Physical characteristics of multigrain bread

Table 2 shows the impact of varying the amount of composite flour used during preparation of multigrain bread on the physical properties of the bread.

Loaf volume of multigrain bread

The use of bread improver greatly boosted physical attributes [Table 2], scoring nearly equivalent to the control sample. The difference in loaf volume was between B4 (590±1.40 mL) and control (680±1.50 mL). Adding soft B-60 bread improver to multigrain bread often resulted in a significant increase in loaf volume. Loaf volume of B1(665±0.95 mL) was like the control (680±1.50 mL). When compared to beads without an improved, the loaf volumes of B2, B3, and B4 were similarly improved, measuring 640±1.11 mL, 615±1.26 mL, and 590±1.40 mL, respectively. In finger millet, flax seed, and soy flour bread, **(28)** also saw a drop in volume. Hard wheat flour replacement resulted in a considerable decrease in pan bread loaf volume **(29).** Because of the weaker cell wall structure, the dough's capacity to rise is reduced, which may be ascribed to a decreased amount of gluten network in the dough.

Specific Loaf volume of multigrain bread

Specific bread loaf volume for B4 (2.95±0.05 mL/g) was quite less when compared with control (3.25±0.04 mL/g). As the amounts of each composite flour level in wheat flour increased, the specific loaf volume of loaves reduced regularly and considerably. The control bread showed a maximum specific loaf volume of 3.25±0.04 mL/g, however, after multigrain flour was supplemented in B1, B2, B3, and B4, the maximum specific loaf volume dramatically dropped to 3.13, 3.05, 3.00, and 2.95 mg/g, respectively.The specific volume of bread decreased with increased amounts of finger millet and foxtail millet **(30),**however,it was found **(2)**that adding 10% millet sorghum flour to conventional baking mix increased loaf volume and crumb grain. Comparing breads with up to 5% soy flour, flax seed flour, and finger millet flour, the study found improved grain structure, loaf volume, and specific volume. We suggest that addition of 10% composite flour with refined wheat flour provide an acceptable loaf volume of 3.13 in comparison to 3.25 in control (Table 2).

Crust to Crumb ratioof multigrain bread

The present study revealed that the crust to crumb ratio declined gradually by addition of composite flour as compared with the control group exhibiting the greatest crust to crumb ratio (0.260±0.01), followed by B1 (0.258±0.02), and was least in B4(0.245±0.01). It suggests that the crust to crumb ratio is not negatively impacted by the inclusion of multigrain flour up to a 15% level and is under acceptable limits. More than 15% addition, however, had a negative impact on the crust to crumb ratio (Table 2). The current study's findings are in close accord with those of **(31),** who found that adding flax seed to wheat flour at levels of 15% and 20% produced bread with a lower crust to crumb ratio than bread made with 100% wheat flour.

Crumb Firmness of multigrain bread

Additionally, it is evident from **Table 2** that the crumb hardness of composite bread gradually increased as the percentage of multigrain flour increased. The control sample had the lowest force (1.25 g) at control, that increased to 1.35 g at B1 and the highest force at B4 (2.25 g). The results of this study are consistent with those of **(2),** who found that the concentration of soy and flax seed in bread increased crumb firmness. The increased level of crumb firmness may be attributed to decreased aeration and compact texture of multigrain composite bread.

Sample bread	Loaf volume (mL)	Specific loaf volume (mL/g)	Crust to Crumb ratio	Crumb Firmness (g force)

Control	680±1.50	3.25±0.04	0.260±0.01	1.25±0.02
B1	665±0.95	3.13±0.11	0.258±0.01	1.35±0.03
B2	640±1.11	3.05±0.21	0.255±0.02	1.50±0.01
B3	615±1.26	3.00±0.08	0.250±0.01	2.10±0.01
B4	590±1.40	2.95±0.05	0.245±0.01	2.25±0.02

Table 2: Physical characteristics of breads prepared from wheat and composite multigrain flour**(**Values are means ± standard error of three independent replicates. Different superscript in the same row indicates significant differences at *P*< 0.05) (Control- 100% wheat flour; B1 – 90%Wheat + 10% composite flour; B2– 85%Wheat + 15% composite flour; B3 - 80%Wheat + 20% composite flour; B4 - 75%Wheat + 25% composite flour).

Control(100% Wheat flour)**B1**(90%Wheat flour + 10% composite flour)

SampleB2 (85%Wheat flour + 15% composite flour)

SampleB3 (80%Wheat flour + 20% composite flour)

Sample B4 (75%Wheat flour + 25% composite flour)

Fig 2. The physical appearance of bread prepared from control wheat four and supplemented with composite flour containing soybean, finger millet and flax seeds bread**.**

Texture Profile Analysis of Multigrain Bread

Table 3 provides information about the bread's texture characteristics. One of the most crucial factors in determining the freshness and quality of bread is its texture. All of the bread samples' hardness, springiness, cohesiveness, gumminess, chewiness, and resilience were examined using the Texture Analyzer TA-XT. PLUS, which mechanically compresses food and creates a deformation curve representing the food's reaction.

Table-3 Texture Profile of Bread prepared with different incorporation level of multigrain flour

Samples	Hardness (kg)	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
Control	1.634	2.11	0.562	155.01	0.659	0.55
B1	2.158	2.10	0.551	156.08	1.287	0.56

B2	2.529	1.67	0.390	183.11	1.195	0.47
B3	3.028	1.13	0.367	197.55	1.394	0.44
B4	3.256	1.12	0.355	208.91	1.511	0.41

Values are means ± standard error of three replicates. Different superscript in the same row indicates significant differences at $P < 0.05$. (Control- 100% wheat flour; B1 – 90%Wheat flour + 10% composite flour; B2– 85%Wheat flour + 15% composite flour; B3 - 80%Wheat flour + 20% composite flour; B4 - 75%Wheat flour + 25% composite flour)

The increased amount of multigrain flour (composite flour) in the bread formulations enhanced the hardness of the samples considerably (P<0.05) and proportionately with per cent content of the composite flour [Table-3] and revealed an increase from the control (1.634 kg) to multigrain bread B4 (3.256 kg). **(32)**have explainedthat the interaction between water and hydroxyl groups of polysaccharides through hydrogen bonding may account for the increased hardness, which might also be attributed to greater water absorption of fiber-rich integrated dough. Our findings support those of **(2),** who also found a considerable rise in baked goods' hardness as soya and flax seed content increased**(10)**also found the increased hardness with increasing concentration of soy flour in the fortified biscuits.

In terms of the springiness characteristic, there were no discernible changes (P>0.05) between the control and bread samples containing 10% composite flour while the higher concentrations of 15, 20, and 25% showed lesser figures than the control group. **(33)**looked at similar data and found no change in springiness. The cohesiveness of the bread samples from the control, B1, B2, B3, and B4 groups showed a substantial reduction (2.11, 2.10, 1.67, 1.13, and 1.12, respectively).

The findings additionally demonstrated that, in comparison to the control (0.562 kg-sec and 0.55), cohesiveness and resilience were found to be significantly reduced with an increase in multigrain flour level in the composite bread. Specifically, with an increase in multigrain, cohesiveness and resilience decreased from B1 (0.551 kg-sec and 0.56) to B4 (0.355 kg-sec and 0.41). This might be explained by the higher percentage of other flours diluting the wheat gluten and facilitating the preparation of gluten less bread which is the requirement of the present-day food industry. Gluten free foods are considered healthy and improve gut health which is necessary for immunity and good digestion.

Proximate composition of Multigrain Bread

Moisture content

Table 4 exhibits the findings for the moisture content of loaves made with varying amounts of multigrain flour. The results reveal that the moisture content increased as the amount of multigrain flour was enhanced from 10 to 25% in wheat flour. The control bread sample had the lowest moisture content (31.40%), while thesample B4 (with 25% of composite flour) had the greatest moisture content (36.81%), with B3 (35.11%), B2 (34.78%), and B1 (32.34%) following closely behind. **(34)**also demonstrated that the higher moisture content of the final product is a result of the dough's enhanced ability to absorb more water due to the soy flour addition. Soy flour has the ability to hold onto large amounts of water during baking; thus, every 1% addition increases the final product's moisture content by 0.3 to 0.5%. This leads to higher yields, lower costs, and longer shelf lives. Increased dietary fiber levels can help retain water by limiting evaporation during baking, contributing to an increase in moisture content **(35).**Our study suggest that multigrain bread has higher shelf life than pure wheat flour bread.

Crude Fat content

As the amount of multigrain flour increased, the fat content gradually rose from 3.18 % for the control group to 8.93 % for the B4 group. Increased levels of fat in the multigrain bread may be because of the addition offlax seeds as a part of composite flour. Comparable outcomes have been shown in the manufacture of bread using soybean by **(2)** and in the preparation of bread using flax seed at varying quantities by **(34).**

Table-4 Proximate composition of Multigrain Bread

Samples	Moisture (%)	Crude Fat (%)	Crude Protein (%)	Ash (%)	Dietary Fiber (%)	Carbohydrate
Control	31.40	3.18	7.78	1.85	1.15	55.64
B1	32.34	4.55	10.27	2.35	1.85	48.64
B2	34.78	5.34	12.69	2.99	2.67	41.53
B3	35.11	7.28	14.03	3.78	3. 89	35.91
B4	36.81	8.93	15.89	4.58	4.76	29.03

Values are means ± standard error of three replicates. Different superscript in the same row indicates significant differences at *P*< 0.05. (Control- 100% wheat flour; B1 – 90%Wheat flour + 10% composite flour; B2–

85%Wheat flour + 15% composite flour; B3 - 80%Wheat flour + 20% composite flour; B4 - 75%Wheat flour + 25% composite flour)

Crude Protein content

With increasing amount of composite flour showed a corresponding increase of protein content from B1 (10.27%), B2 (12.69%), B3 (14.03%), and B4 (15.89%)than the control (7.78%) as shown in Table 4. This increase in protein content is because of the high concentration of protein in soybean.**(33)**have documented comparable results with respect to the increase in protein content with the integration of soybean.**(2)**have reported similar results for flax seed; and researchers have looked into similar outcomes regarding the manufacture of bread by including ragi at different levels.

Ash content

Ash content also increased gradually from 1.85% in the control group to 4.58% for the B4 group having 25% of additional composite flour. The greater ash level of the multigrain bread is based on the additional part of composite flour. **(36)**reported higher ash content in bread supplemented withsoybean flour.

Crude Fiber

Similarly, crude fibercontent increased from 1.15 % for the control group to 4.76% for B4 that was in proportion to the percentage of composite flour (Table 4). It quite evident that the amount of fiber in the composite bread increased gradually as the amount of multigrain flour increased. The increased dietary fiber content of multigrain bread supports its appropriateness for use as a nourishing bread. This may be the result of a higher percentage of fiber in the original ingredient used to make multigrain bread. **(27)**havecorrelated the higher fiber content of multigrain bread with the per cent amount of soybean flour in the bread.

Carbohydrate content

Table 4 revealed that the bread made with 100% wheat flour (control) had the greatest amount carbohydrate content at 55.64% which reduced to 29.03%. in B4 sample containing 25% of the composite flour, a desirable parameter for consumer. Logically, the addition of composite flour will reduce the carbohydrate content. Similar results have been reported by other food technologists.

Sensory Quality of multigrain bread

The inclusion of soy flour, flax seed, and finger millet decreased the score for nearly all metrics when compared to the control (Table5). With an increasing amount of multigrain flour, the product's color gradually faded. The B4 sample showed a decrease in color from the (8.01) control to (7.00). The drop of color score is the result of addition of multigrain flours that was directly proportional to the amount of composite flour added. But when compared to the control sample, adding up to 10% multigrain flour was satisfactory **(Fig.3).** Due to the reducing sugars in the flour caramelizing and giving the bread's surface a brown hue, the fading color may be explained on the basis of the composite flour's reduced reducing sugar content. The results of the current study closely correspond with those of **(31),** who noted a decrease in color features in baked loaves made using soy flour.

As the amount of multigrain flour increased, the product's flavor and taste gradually declined. The B4 therapy received the lowest scores for flavor and taste (7.55) and 7.25, respectively, whereas the control group had the highest scores (8.6 and 8.55). The presence of nutty and unpleasant tastes in flax seed and soybean flour, respectively, may be the cause of the decline in flavor and taste at greater multigrain flour levels. Similar findings on flavor and taste were also reported by **(29),** who reported that there was no significant difference in the flavor of breads supplemented with soybeans up to a ten percent threshold.

Table 5. Sensory Evaluation of breads prepared from wheat and composite flour

Samples	Color	Flavor	Taste	Texture	Overall acceptability
Control	8.01	8.6	8.55	8.85	8.05
B1	7.92	8.35	8.35	8.5	8.00
B2	7.55	8.05	8.15	8.1	7.55
B3	7.25	7.9	7.65	7.35	7.25
B4	7	7.55	7.25	6.8	7

Values are means ± standard error of three replicates. Different superscript in the same row indicates significant differences at *P*< 0.05. (Control- 100% wheat flour; B1 – 90%Wheat flour + 10% composite flour; B2– 85%Wheat flour + 15% composite flour; B3 - 80%Wheat flour + 20% composite flour; B4 - 75%Wheat flour + 25% composite flour)

There were notable differences in the texture qualities of each treatment, and as the amount of composite bread made with multigrain flours increased, each treatment's textural qualities gradually declined. Control had the highest textural score (8.85), while B4 received the lowest (6.80). As shown in **Fig 3**, the B1 sample's score of 8.50 was quite similar to that of the control sample which suggests that addition of 10% composite flour in the refined flour is a balanced bread having reduced carbohydrate, high protein, moderate fiber content and acceptable fat. The increased fiber content of the composite flour may be the cause of the multigrain flour's lower textural quality score since fiber prevents the normal formation of gluten during the fermentation process. Similar findings on the texture characteristics of bread were also published by **(13),** who discovered that an increase in soy flour addition reduces the bread's textural attributes.

As the quantity of composite flour in the bread increased, the overall acceptability of the multigrain bread declined gradually. Control had the greatest overall acceptability (8.05), followed by B1 (8.00), B2 (7.55), B3 (7.25), and B4 (7.00) at the lowest. On comparison of all parameters, it is evident B1's acceptability for the sample was nearly identical to the control for the other treatments.

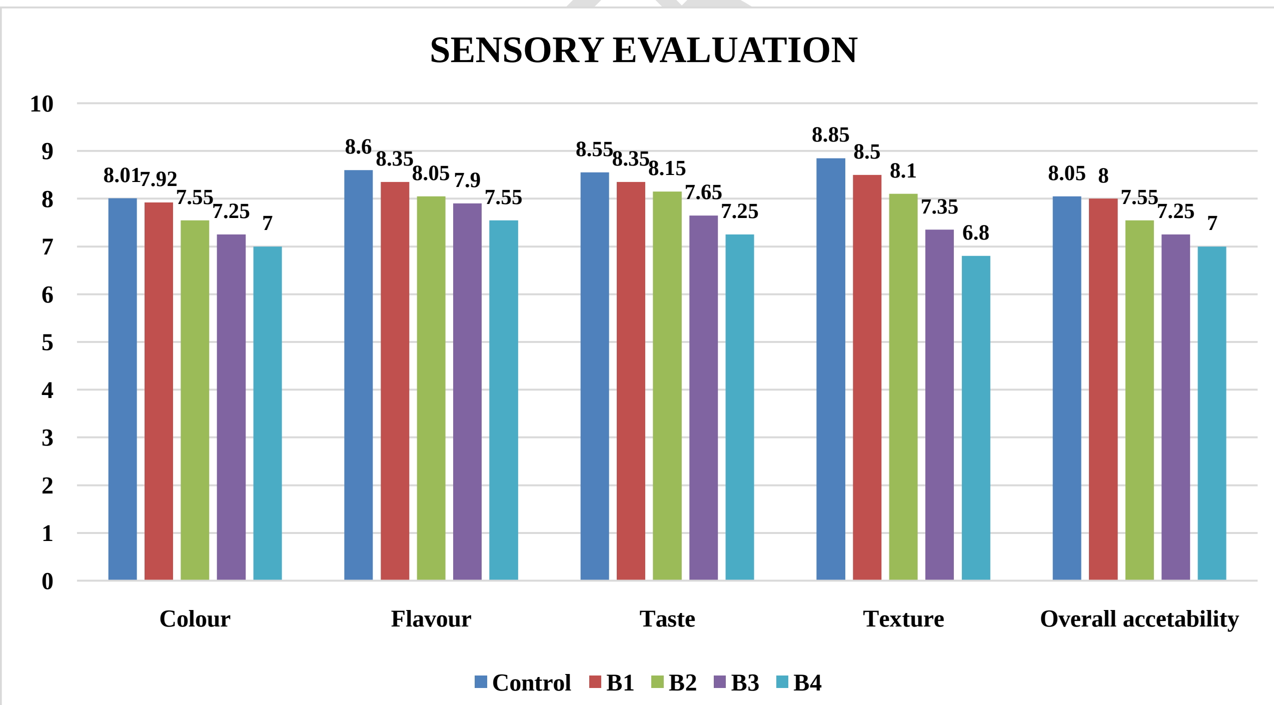

Fig 3: Sensory Evaluation of Multigrain Bread (Values are means ± standard error of three independent replicates. (Different superscript in the same row indicates significant differences at $P < 0.05$)

The health benefits of soybean flour, flax seed and finger millet have been recognized scientifically by several chemists, nutritionists and food technologists in various publications as enumerated in introduction **(3, 5, 7, 10, 11, and 12).** Soybean is one of the most acceptable plant-based protein that contain almost all essential amino acids required for muscle formation and repair of body parts while flax seed besides the high content of alpha linolenic acid, contain several minerals and high protein content and as well recognized healthy grain **(7, 37).** Finger millet being rich in minerals contains phenolic acids and flavonoids and is well recognized with health benefits. The multigrain bread has thus various components that have anti-cancer, anti-diabetic, anti-inflammatory properties including antioxidant and anti-oxidative which makes this fortified bread as ideal nutritive for good health and well-being. The addition of multi-grains in wheat flour will improve the nutritional quality of bread and will help in achieving 3rd Sustainable Development Goal on UN. The cost of multigrain bread in market is only 10-15% higher than the pure wheat flour bread which can easily be afforded by all classes of people, but it has numerous health benefits and can reduce multi-fold cost on health issues. Multigrain bread also supports the gut microbiome and having lower gluten content possess numerous digestive benefits. The nutritional value of soybean, flax seed and finger millet has been supported in more recent publications also **(3, 5, 7, 10, 11, and 12).**Garg and Sharma **(37)** have reported that the composite flour prepared from blends of germinated finger millet and pearl millet contained better nutritive properties and the cookies prepared from such blends were healthy and possessed good sensory properties. It, is, therefore suggested that multigrain bread should be supported and facilitated in poor countries also to enhance the nutritional levels of marginal people.

CONCLUSIONS

Multigrain bread is made by the addition of finger millet flour, flax seed, and soybeans. The physical, nutritional, and sensory qualities of the bread made with varying amounts of mixed flour—10, 15, 20, and 25% of three distinct flours blended equally—instead of whole wheat flour were evaluated. The findings demonstrated that bread enriched with 10% multigrain flour had good physical characteristics, including specific volume, crumb to crisp ratio, textural quality, and loaf volume. The reduced carbohydrate content, increased protein, fiber, fat and ash content increased its nutritional value in terms of health. The bread that was 25% enriched with multigrain flour had high levels of protein, crude fat, fiber and ash, and nutritional benefits but its acceptability was lower. It may be concluded that the preparation of fortified bread with 10% composite flour with a blend of soy, flax seed, and ragi flour has comparable physical and textural qualities as well as a similar scores for taste and acceptability as that of control, but with huge health benefits.

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