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Review on the Effect of The Flour on The Quality of Bread

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Abstract

Originating from the Triticum aestivum plant, wheat flour is a basic component of diets worldwide and is the basis for bread, a food that is consumed by people everywhere. This study addresses the growing interest in composite flours and alternative grains as a result of health concerns and financial difficulties, while also examining the nutritional and economic value of wheat flour. Summary of the research results on the incorporation of several flours—potato, cassava, amaranth, chickpea, orange-fleshed sweet potato, pulse flours, and maize bran—into wheat-based bread. These substitute flours boost dietary fiber consumption, improve the nutritional profile of bread, and may lower the risk of conditions such as diabetes and cardiovascular disease. However, they cause difficulties in the rheology of the dough and the quality of the bread. Thus, it was stated that composite flours have a lot going for them nutritionally, and maintaining the quality of bread requires careful formulation. Understanding the interplay among diverse flours and their influence on dough and bread characteristics is vital for creating baked items with enhanced nutritional value that satisfy customer inclinations and health requirements.

Keywords: Composite flours, bread, alternative grains, Triticum aestivum plant, incorporation of flours

INTRODUCTION

Wheat flour is primarily composed of wheat grains which belong to the species Triticum aestivum. Its nutritional contributions to the human diet are very important and farmers are profiting from it. In the food production, wheat flour involves some mystical functional modesties [1].

There is no doubt that the bread has really made the major contributions to the progress and advancement of the humankind. However, its key positive aspects that are its easy preparation and the variety of options it offers make it more and more popular in different parts of the world. One of the dishes that is used most at the meal table is bread. It is also the easiest of foods to make.

Regardless of the types of bread, the bread made with these four basic ingredients: wheat, water, yeast, and salt (i.e. sodium chloride) is the same for all products. One of the ways to differentiate the bread from the dough is to combine these components, knead, ferment, and bake them. It is possible that cereal can be made from a variety of cereals, such as rice, wheat, barley, sorghum, millet, rye, oats, and maize. The use of bread—especially white wheat bread—has been drastically decreasing in western nations over the last few decades. They have advanced to the point where their excessive salt intake and low dietary fiber intake, which are linked to a number of health issues in these nations, have become issues, and they have shifted their focus to whole meal bread, which has a higher

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nutritional value. Recently, bran, vitamins, minerals, antioxidants, and other substances sufficient to be categorized as microelements present in whole-grain bread (WWB) have all contributed to the growing significance of whole grain flour (WWF) in the bakery industry. Dietary fiber has become an increasingly important component of a healthy diet. Consuming whole grains has been linked to a reduction in the risk of developing diabetes, obesity, cancer, and cardiovascular illnesses, among other health issues. In the coming years, as the bakeries develop more novel items, they may investigate bioactive compounds and unprocessed milk products due to their potential health benefits. A primary drawback of ancient grains, such as favorable nutritional concerns, is the technical and rheological deterioration of their properties in comparison to contemporary types, particularly when utilizing WWF to make bread [2,3].

And also, there are significant concerns regarding the long-term economic viability of some African countries' imports of wheat, particularly Zambia, due to inflation and fluctuations in exchange rates. As a result, there is a rising movement to support the partial substitution of locally produced staples for wheat flour in baking. In the Democratic Republic of the Congo, bread is a luxury food item that is out of reach for the majority of rural and resource-poor people. In truth, the main obstacle preventing wheat from being used in many areas, particularly those furthest from the metropolis, is its expensive cost. Therefore, it's important to support neighborhood bakeries in order to provide these communities with affordable, nutritionally sound, and high-protein food. It has been thought that providing nutrient-dense food products to resource-constrained and rural farmers is an effective way to reduce malnutrition, improve food security, and accelerate economic growth by maximizing human capital production. In the Democratic Republic of the Congo, cassava (Manihot esculenta Crantz) is the principal staple crop, making up over 70% of the country's agricultural output. Cassava is the most significant staple crop in Zambia after maize and is crucial for food security. If some cassava varieties were found to be suitable for baking bread, this would increase their market value and promote the cultivation of those types. Cassava can adapt to a variety of farming systems and agro-ecological circumstances. In addition, compared to cereals and legume crops, it has flexible harvesting dates, tolerance for low soil fertility, and high yields. The majority of the research on fortifying bakery products with legume grains, such as beans, soybeans, and sesame seeds, was conducted. These crops are more expensive in local markets because of their various uses. In addition, because they are reliant on meteorological factors like rainfall and temperature, their output is seasonal. In this sense, mushroom four is a useful substitute for the fortification of baked goods. Mushrooms are a good source of vitamins, vital minerals, proteins, and medicinal qualities. It can be manufactured year-round because it is inexpensive to produce using agricultural waste and unaffected by weather conditions. Eastern Democratic Republic is already familiar with oyster mushroom production methods, and it is more affordable than other fortification items utilized in other areas [4,5].

Composite flours are also made by mixing different flours with whole wheat flour. These are some of the several composite flours and variations that are used to enhance value and change the rheological properties of wheat flour. The different flour blends with cassava, amaranth, chick pea, orange-fleshed sweet potato, maize bran, pulse flour and potato flour have been discussed.

Bread compositions have included potatoes and potato derivatives to enhance texture and retain moisture better. Potato flour (PF) is easier to process than starch and has the potential to enhance dough fermentation, providing bread a variety of colors, tastes, and nutrition. The addition of PF to wheat-based diets may increase the potato's overall utilization efficiency and broaden its use. Additionally, it may lessen the amount of gluten consumed by people with special requirements, which lowers their chance of developing coeliac disease (CD) [6,7].

The biofortified orange-fleshed sweet potato (OFSP) cultivar of sweet potatoes is high in dietary fiber, minerals, and other health-promoting bioactive components such as vitamin C, flavonoids, polyphenols, and beta carotene, a precursor to vitamin A. In the bakery sector, premium OFSP flour offers a lot of potential. It may be used to substitute wheat flour and enhance the baked goods' nutritional value and eating quality [8].

A particularly convenient and affordable source of dietary fiber, protein, and phytochemicals are fortified staple foods like bread and maize bran, which also have a high insoluble dietary fiber content and antioxidants. When maize bran is mixed with flour, it improves a number of properties, including water absorption, lowering the tolerance for dough strength, mixing, fermentation, and dough stickiness [9].

The greater protein and polysaccharide content in pulse flour blends led to better water absorption than in regular wheat flour. According to a study on white flour/pea flour blends, the specific volume, density, and crumb texture of bread were positively correlated with dough rheological qualities, and the specific volume of bread reduced as the percentage of pea flour increased. Numerous studies showed that adding pulse flour considerably increased the nutritional content of wheat-based baked goods. The values of chickpea protein are greater for stability, thermal expansion, and foaming capacity. Additionally, the higher emulsion stability index of chickpea protein means that chickpea flour is ideal as a bread-making ingredient [10,11].

Pseudocereals are more often used to baked goods in an effort to increase their nutritious content. Adding amaranth flour to bread and bakery goods could enhance their nutritional value because amaranth is a high-protein, high-carb pseudocereal that meets the demands of wheat allergy sufferers, vegetarians, and those with coeliac disease. Amaranth seeds' protein content is distinguished by an amino acid composition that is well-balanced. In addition, dietary fiber, minerals (zinc, copper, and manganese), vitamins (thiamine, niacin, riboflavin, and folate), and bioactive substances (squalene, tocopherols, and phenolic compounds) are abundant in amaranth seeds. All of these nutrients have significant positive impacts on human health [12].

This study Synthesis and Integrates the effects of different types of flour on the final product's quality when baking bread. In order to determine which formulation has the most promising chemical and physical properties, a bread made with various flours is tested for its nutritional profile, rheological property, color, and texture of the crust. All of the samples are then compared to one another. This study is closely connected with consumer desire and provides a greater understanding of the variations between different types of flour in the overall physicochemical profiles of breads.

METHODOLOGIES

This section will cover the different methodologies used by various authors to study the effect of flour on bread quality. The different methodologies used in general are chemical analysis, physical analysis and technological analysis.

Chemical Analysis

The High-gluten wheat flour and commercial potato flour were sourced and prepared. The potato flour was milled and passed through a sieve to achieve the desired particle size. And the specific formulations for bread preparation, varying the levels of potato flour (20%, 30%, 40%, and 50%) in the wheat flour mixtures were prepared. The pasting behaviors of the flour mixtures were analyzed using a Rapid Visco-Analyzer (RVA). This included measuring parameters such as peak viscosity, trough, breakdown, final viscosity and X-ray Diffraction (XRD) was done to identify the degree of crystallinity of the bread samples which helps to understand the structural changes during storage. Moisture Content Measurement: Bread samples were stored under controlled conditions (20 ± 2°C, RH of 35%) for different time intervals (1, 3, 5, and 7 days). The moisture content of both crust and crumb was measured to evaluate the staling process [6] The blending of wheat flour with varying percentages of potato flour (0%, 5%, 10%, 15%). Dough Quality Assessment was done by Farinograph analysis, gel texture measurement was taken and the pasting property was measured using Rapid Visco Analyzer (RVA) was performed [7].

The nutritional composition of maize bran-enriched flour was analyzed for parameters such as moisture content, crude protein, crude fat, crude fiber, nitrogen-free extract (NFE), and ash content [9].

The preparation of dough samples with varying levels of germinated chickpea flour (GCF) (0%, 5%, 10%, 15%, and 20%). There is a Use of specific fluorescent dyes to differentiate between dough components: Rhodamine B: Used to stain proteins, resulting in red fluorescence and Fluorescein: Used to stain starch granules, resulting in green fluorescence. Also, the images of the dough samples under the microscope were taken to analyze the spatial distribution of proteins and starch. valuation of the images to observe the microstructural changes in the dough, focusing on the relative amounts and distribution of proteins and starch. Analyzing differences in microstructure based on varying levels of GCF addition [11].

Physical Analysis

As said in introduction, the concept of using cassava flour in wheat bread production to improve its quality and nutritional value. To achieve a 90:10 (wheat: cassava) ratio, 225 g of wheat flour and 25 g of cassava flour were combined. 100% wheat flour served as the control. The straight- dough bread-making method was followed. The study measured the qualities of dough using a variety of tests, such as the mixing tolerance index (MTI), dough stability time (DST), and dough development time (DDT). Additionally, it assessed variables related to bread quality, including bread density (BD), specific volume (SV), and volume (BV). [4] Harvesting fresh cassava, peeling, washing, cutting, pressing, drying, and molding were all steps in the production process. Picked mature mushrooms were dried in an oven before being crushed to a flour consistency. They created six composite four formulations by varying the proportions of wheat, cassava, and mushrooms. Here the concepts of food fortification and the use of alternative ingredients to enhance food security is the theoretical basis [5].

It shows the comprehensive approach to addressing food security challenges in the DRC through innovative bakery product formulations. It combines practical experimentation with theoretical insights into nutrition and food systems, ultimately contributing to the discourse on sustainable food practices in developing regions.

Bread was prepared using the maize bran-enriched flour along with other ingredients (milk powder, yeast, sugar, salt, etc.) following a straight dough method. The rheological properties of the flour blends (wheat flour with different levels of maize bran) were assessed using a farinograph to evaluate water absorption and dough characteristics and by using Mixograph for mixing time and peak height, were analyzed to understand the dough behavior with the addition of maize bran [9].

Different types of pulse flours (yellow pea, green pea, red lentil, and chickpea) were selected for the study. Whole wheat flour served as the control and substitution levels of the pulse flours were used to partially replace whole wheat flour at varying substitution levels (0%, 5%, 15%, and 25%) to assess their effects on dough and bread quality. The Mixolab analysis is done to know the mixing and pasting properties of the dough. This analysis provided insights into dough stability, viscosity, and thermal behavior during mixing and heating [10].

Technological Processes

The bread formula consisted of composite flour (a mixture of wheat flour and orange-fleshed sweet potato (OFSP) flour), water (calculated based on the farinograph optimal water absorption) baker's yeast, sugar, margarine, and salt. The proportions of wheat and OFSP flour. Various response variables were measured, including, Dough farinograph parameters, Unfermented dough pH, baking loss, Loaf volume, Specific volume, CIE-LAB color of bread crust and crumb, Crumb moisture content, Water activity, Textural properties and Staling rate [8].

The moisture content of the freshly baked bread was determined using a hot air oven. The hardness of the bread was evaluated through a compression test, and fracturability was assessed using a cylindrical ball die. The volume of the bread loaf was estimated using the rapeseed replacement method for the bread prepared with maize bran [9].

Amaranth flour was milled to obtain different particle sizes (large, medium, and small) and then blended with refined wheat flour at varying substitution levels (0%, 5%, 10%, 15%, and 20%). The rheological behavior of the dough during mixing and heating-cooling cycles was evaluated using Mixolab equipment to measure parameters such as water absorption, dough development time, stability, and viscosity. The dough's extensibility and tenacity were assessed using an alveograph, which provided insights into the dough's strength and behavior during baking. After baking, the bread samples were evaluated for volume and firmness using specific methods, including the seed displacement method for volume and texture analysis using a texture analyzer [12].

Synthesis and Integration

Synthesis of findings

Potato flour with high-gluten wheat: Using RVA and XRD, it was discovered that adding more potato flour to wheat flour mixes had a major impact on crystallinity and pasting behaviors increased quantities of potato flour typically resulted in increased final and peak viscosities, which are markers of starch retrogradation and gelatinization.

Maize bran-enriched flour: According to nutritional study, maize bran improves the nutritional profile of bread by adding more protein and crude fiber.

Germinated chickpea flour (GCF): GCF levels are directly correlated with observable changes in the microstructure of the dough, as demonstrated by fluorescent microscopy, which also revealed the distribution and interaction of proteins and starch in the dough.

Cassava flour: By substituting 10% of the flour with cassava flour, bread's nutritional value was increased without noticeably altering its physical characteristics. DST, DDT, and MTI studies showed that dough stability is improved by cassava flour.

Mushroom and cassava flour: By combining the two flours, a thorough fortification strategy was created that enhanced both the nutritional value and food security. Specific volume, volume, and bread density all improved with this blend.

Pulse flours: Mixolab research showed that the stability and viscosity of dough are greatly impacted by pulse flours, particularly chickpea and lentil flours. The structural integrity of the bread was generally impacted by higher replacement levels (15% and 25%), which increased dough viscosity and lowered stability.

Orange-fleshed sweet potato (OFSP) flour: Dough rheology and bread quality were altered when OFSP flour was substituted for wheat flour. The amount of OFSP flour greatly affected parameters including the pH of the unfermented dough, baking loss, and staling rate; higher amounts produced softer bread with improved moisture retention.

Maize bran bread: Texture investigation and technological evaluations with the rapeseed replacement method revealed that maize bran reduces loaf volume and boosts bread toughness. The gluten network is probably disrupted by the coarse particles in the bran.

Amaranth flour: Dough rheology was impacted by amaranth flour's varying particle sizes in diverse ways. While bigger particles had a detrimental effect on loaf volume and dough elasticity, smaller particles enhanced dough stability and water absorption.

Integration

Chemical qualities: Dough qualities and the quality of the finished bread are greatly influenced by the nutritional makeup and pasting behaviors of flour. Although higher protein and fiber contents typically enhance nutritional value, they can also complicate the handling of dough and the structure of bread.

Physical properties: For bread to be produced of a high Caliber, the dough's elasticity, viscosity, and stability are essential. While using non-wheat flours might increase nutritional content, maintaining dough and bread quality frequently necessitates striking a balance with the right processing methods.

Technological procedures: To obtain the desired bread qualities, the mixing, fermentation, and baking procedures must be tailored for each type of flour. For the integration of different flours to be successful, factors including dough development time, stability, and textural features are essential.

The Pasting behavior, crystallinity, moisture content, dough quality, and nutritional makeup were the main areas of concentration. Using substitute flours including cassava and pulse flours, the dough's stability, viscosity, density, specific volume, and bread quality were evaluated. Taking into account rheological behavior and textural characteristics, the effects of composite flours (OFSP, amaranth) on dough and bread properties were assessed. Combined, these approaches offer a thorough grasp of the ways that various flours impact bread quality, taking into account technological procedures in addition to chemical and physical characteristics.

RESULTS AND DISCUSSION

The results differ from author to author because of the variations in the composite flour and flour blends. The results are provided according to the blending of flour used.

Dough stability time increases with reduced particle size of cassava flour, which enhances gluten development. Mixing tolerance index (MTI) values were satisfactory across all cassava flour substitution levels, indicating good dough mixing quality. The bread density increased with higher levels of cassava flour substitution, implying that increased cassava flour favored starch interactions but weakened the gluten structure. It is concluded that incorporating cassava flour into wheat bread can be beneficial for improving dough mixing quality and maintaining satisfactory bread quality, although high levels of cassava flour might weaken the gluten structure.[4] For improved bakery outcomes, good uniformity, and high protein and calorie contents, use the 5–15– 80% and 10–10–80% mushroom–cassava–wheat composite four. This will improve the nutritional status of communities in tropical non-wheat producing regions like the DRC [5].

While adding potato flour to bread recipes has a negative effect on loaf volume, it improves texture, moisture retention, and nutritional content for a better finished product. These modifications may result in a product that is more appealing to bakers and customers alike because it is softer, holds moisture better, and has a more favorable glycemic response. However, to offset the drop in loaf volume, careful formulation modifications might be required. Although bread quality can be enhanced by moderate quantities of PF, high levels of PF can cause unfavorable alterations, which emphasizes the significance of formulating for optimal overall quality [6,7].

The substitution of wheat flour with OFSP flour and the optimization of baking conditions significantly influenced the end quality of the bread, affecting its volume, texture, moisture content, color, and staling rate as it affects moisture retention, browning reaction, higher incorporation cause changes in crumb moisture, increased hardness and chewiness of the bread and decreased loaf volume [8].

The incorporation of maize bran improved the nutritional profile of the bread, it improved the water absorption capacity of the dough, there is reduction in height and it was attributed to the water-binding ability of the bran, which affected gas retention during fermentation, the volume of the bread loaves also decreased with increasing levels of maize bran and there is increased moisture content and hardness of the bread [9].

The specific volume of the bread generally decreased with increasing levels of pulse flour substitution. Breads made with higher levels of pulse flour tended to be denser and firmer. The presence of pulse flour contributed to a denser crumb with a different cell structure compared to traditional wheat bread. The moisture content of the bread was also affected by the addition of pulse flours but some pulse flour blends could help maintain moisture better than others. While the nutritional benefits of incorporating pulse flours were evident, sensory attributes such as taste and aroma were also impacted based on pulse flavor [10].

The optimal level of GCF addition for improving the quality of bread was found to be around 15%. This level enhanced physical characteristics, sensory properties, and overall consumer acceptability, while higher levels (above 15%) led to negative effects on bread quality, including reduced volume, porosity, and sensory appeal [11].

The incorporation of amaranth flour generally led to a decrease in loaf volume, the firmness of the bread increased due to small particle size, it affected the bread's texture, with changes in parameters such as chewiness and elasticity but it improved nutritional profiles, offering higher protein, fiber, and essential nutrients [12].

The difference in the composition of the flour and the level of incorporation of different types of flour to the wheat flour showed different rheological effects on the end quality of the bread.

Table 1. Summary of the studies which focused on the effect of flour on the end quality of the bread.

Author	**Method**	**Flour**	**Obtained data**
(Ju et al.,2020)	Chemical Analysis.	Potato flour	Lowers bread volume but increases texture and moisture retention
(Chisenga et al.,2020).	Physical Analysis.	Cassava flour	At lower level, it improves nutritional value without appreciably changing the quality of bread.
(Zhang et al.,2021)	Physical Analysis.	Pulse flours	Boost protein and fiber content, but at larger amounts, they may have an impact on bread structure and dough stability.
(Irakizaet et al.,2021).	Physical Analysis.	Mushroom flour	It enhanced the quality of bread with cassava and is a cost-effective, year-round source of nutrition.
(Coțovanu et al.,2022).	Technological Processes.	Amaranth Flour	Improves dough stability and nutritional value, especially for smaller particlesizes.
(Hussai et al.,2021).	ChemicalAnalysis, Physical analysis and Technological process.	Maize bran	Increases the amount of protein and fiber in maize bran, but it also lowers loaf volume and makes bread harder.
(Chikpah et al.,2021)	Technological Processes.	Orange-Fleshed Sweet Potato (OFSP) Flour	Boosts the nutritional profile but has effect on the quality under optimal formulations.
(Atudorei et al.,2022).	Chemical Analysis.	Chick pea flour	15% of incorporation is optimal for better quality end product. Greater than 15% is led to negativeeffect.

Table 2. Formulation of composite flours used in bread making.

Formulations	Mushroom flour (%)	Cassava flour (%)	Wheat flour (%)
F1	2.5	17.5	80.0
F2	5.0	15.0	80.0
F3	7.5	12.5	80.0
F4	10.0	10.0	80.0
F5	2.5	22.5	75.0
F6	5.0	25.0	70.0
Relative control (IITA) (F7)	0.0	20.0	80.0
Absolute control (local bread) (F8)	0.0	0.0	100.0

Source: Formulation of composite fours used in bread-making used by (Irakiza, et al,2021)

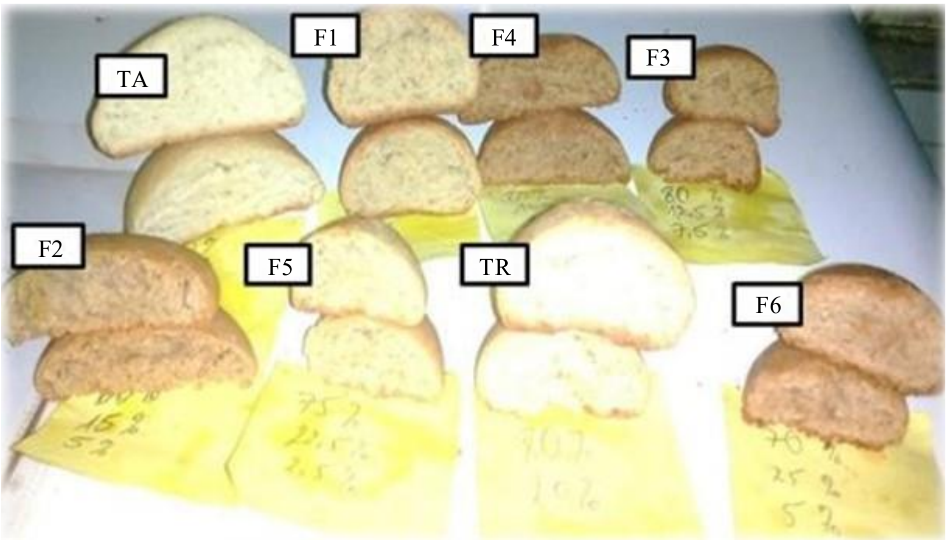

Figure 3. Appearances of the breads produced F flour formulations as in Table 2, TA absolute control (100% Wheat bread) TR relative control (20-80%) cassava wheat bread).

CONCLUSION

Triticum aestivum, the primary source of wheat flour, is essential to human nutrition and international agriculture. The usual ingredients for bread, a staple food, are wheat flour, water, yeast, and salt. To improve nutritional content and address food security, alternative flours such as potato, cassava, pulse, amaranth, and composite flours have been investigated. Important conclusions consist of:

All things considered, these composite and alternative flours can raise the nutritional value of bread, possibly improving health and promoting food security. However, to preserve the desired qualities of the dough and bread quality, careful formulation and processing changes are required.

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