***Review Article***

**Nutritional Enhancement of Baked Goods Using Alternative Flours: A Review**

**Abstract:-**

Innovations for the bakery market are for healthier and functional foods (e.g., Peas, lentils and other fibers like psyllium) which are driven by taste and rethinks of the health of the product. Conventional baked goods are predominantly dependent on refined wheat flour, which is devoid of important nutrients including dietary fiber, high-quality protein and micronutrients. In addition, many alternative flours (ex: vegetable, legume and millets based flours) are being added to improve the nutritional profile. The review discusses the effect of alternative flours, particularly carrot, beetroot, sweet potato, millet and legume-based flours, on the nutrition profile, functional characteristics and sensory properties of baked products (bread, biscuits, cookies and cakes). Studies show that these alternative flours increase protein content, fiber levels, antioxidant capacity and overall availability of bioactive compounds. Furthermore, enriched bakery products can convey health benefits like favoured digestion, improved glycemic control and higher micronutrient intake. Research indicates that these nutritional Improvements can be achieved while maintaining desirable sensory qualities and texture. The review highlights the potential of flour fortification strategies to create bakery products that meet modern health expectations.

Keywords Bakery, Bread, Millets, Flour, Nutrition

**INTRODUCTION**

Urbanization, changing lifestyles and rising dietary health consciousness have all contributed to a sharp rise in the demand for wholesome, easily consumable foods. Bread, biscuits, cookies, cakes and crackers are among the baked products that are widely consumed around the world. However, refined wheat flour, which is primarily used in traditional baked goods, has fundamental nutritional limitations, such as low protein quality and insufficient amounts of important amino acids like lysine, methionine and threonine, despite its functional qualities. These goods become less nutritionally adequate as a result of the refinement process, which further depletes vital nutrients by lowering fiber, vitamins and minerals.Researchers and food engineers have looked into adding nonwheat flour to wheat flour in order to remedy these nutritional deficiencies. A viable way to improve the nutritional profile of baked goods is to use substitute flours made from legumes, oilseeds, other cereals, tubers and byproducts like rice bran and maize gluten (Bravo-Núñez & Gómez, 2023)​. While preserving or even enhancing the sensory and textural qualities of baked foods, these substitute flours offer more protein, better amino acid balance, more dietary fiber and vital micronutrients. Additionally, including nonwheat flours can improve food security because many of these alternatives come from locally accessible or neglected crops, which lessen reliance on wheat and encourage biodiversity in food production.The majority of the time, multigrain goods, such as baked goods, are made with or without wheat flour and a variety of cereal grains as well as oil seeds. The most often used cereals in multigrain baked goods to improve structure, flavor, texture, nutritional variety and consumer appeal include oats, corn, soy, barley, rye, rice, amaranth, triticale and buckwheat.Alternative flours affect the functional and textural qualities of baked foods in addition to improving their nutritional profile. The water absorption, gluten formation, and general baking properties of the dough can all be changed by adding vegetable and legume flours. Research indicates that adding quinoa and amaranth flours to baked goods enhances their antioxidant qualities while preserving their appealing sensory qualities (Alvarez-Jubete et al., 2010).

More often, legume flours are used to make baked goods that are high in protein. Legumes' proteins have a balanced amino acid composition and offer health advantages. Therefore, they are the best components to enhance the nutritional value of baked goods. The different flour is used for example chickpea flour, sorghum and buckwheat contributes different antioxidants (Sibian&Riar, 2020)​.The action of using different substitute flour on the nutrient quality. The desire to advance our understanding of the consequences of using substitute flours in bakery goods is the main driving force behind the creation of this study. In this regard, the literature of today provides a sizable body of research that not only supports the topic's applicability but also indicates the necessity for a more thorough examination.

So, the aim of this article is to examine how the incorporation of substitute flours impacts the nutritional profile of baked products. We will look at the levels of bioactive compounds, macronutrients and micronutrients in the end products. The baked goods are highly nutritious. Wheat proteins are being added into the premium products as well to further enhance them. Breads, biscuits, cookies, doughnuts and crackers are examples of products that can effectively deliver the extra proteins to the target population in an effort to combat protein malnutrition, which is a problem in many parts of the world. Melini et al., (2017) has used xantham gum and guar gum, to mimic gluten like properties and to enhance the dough properties. These raw materials also make it easier for many populations to use sources of animal and vegetable protein that are otherwise not commonly consumed. These are proteins derived from coarse cereals, legumes, oilseeds, single-cell proteins, whey proteins, fish protein products and even leaf proteins. In addition to protein enrichment, the products can be adapted to nutrition needs, like diabetes bread, low-calorie bread, high protein bread, high-fibre bread, gluten-free bread, etc. In order to enhance bakery products, efforts have been made to incorporate non-wheat sources of vegetable proteins and fiber. Here we find the latest advice regarding using dietary fibre and no wheat flours to fortify bread products.

**Development**

The innovation of different bakery products with the substitution of different flour describes a new growth of food technology. Alternative flour are obtained from cereals, legumes, vegetable, fruits which not only increase the nutritional value as well as the sensory attributes.There is a noticeable increase in demand for bakery goods that satisfy higher nutritional standards in the modern world. Recent research showing a change in consumer eating habits supports this perspective. Concern over the nutritional value of the foods we eat, notably baked goods, is growing among modern consumers (Ramos, 2024).

**Categories of different flour**

Plants serve as a source of various flours that contribute to the expansion of baking goods. Using flour which has higher nutritive value such as wheat, amaranth, quinoa and buckwheat in baked products. The usage of beetroot flour, pea flour,banana, rice flour, barley will increase the essential minerals in body. They differ from conventionally used wheat flours in their nutritional profile due to the inclusion of bioactive chemicals and important amino acids.There is a significant chance for nutritional enrichment when alternate flours are used in the creation of baked goods. The protein and dietary fiber content in final goods rises noticeably with its incorporation of different sources (Ramos, 2024). Additionally, there is an increased concentration of minerals like calcium and iron as well as B-complex vitamins, which results in a more abundant supply of vital nutrients. Bravo-Núñez and Gómez (2023) reviewed the enrichment of cakes and cookies with pulse flours, highlighting their impact on nutritional and sensory properties. Research shows that varying the sources of flour, such as using flours from non-traditional cereals and legumes, can improve the end goods' nutritional profile.These findings are compelling evidence that the food sector should develop bread items using a more thorough and creative approach. It is a brave move to use less common components, like flours made from unconventional cereals and legumes.

**Commonly used indices to assess dietary fiber content:**

Dietary fiber is an essential component of human diet and is important for an adequately functioning digestive system, regulating body weight and prevention of diseases. The soluble and insoluble fibers also possess their own physiological health benefits (Dhingra et al.,2012). According to Guo et al. (2018), it has been observed that insoluble fiber, found in whole grains and vegetables, promotes gut health; soluble fiber is found in abundance in fruits, legumes, and oats, lowers cholesterol and balances blood sugar levels. Research shows that a diet high in fiber reduces the risk of obesity, type 2 diabetes and heart disease (Dahl & Stewart, 2015). European dietary guidelines emphasize the consumption of fiber from various sources to enhance metabolic processes and gut flora (Stephen et al.,2017). Fiber is known to have metabolic benefits like improved glycemic (carbohydrate) control and lipid profiles (Lattimer and Haub, 2010). On the whole, dietary fiber still remains vital for good health**.**

**Table 1 :Dietary fiber content in fortified bakery products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S.NO** | **Bakery type** | **Dietary fiber content** | **Fortified with** | **References** |
| **1.** | **Cookies** | 1.3-12.1 | Incorporation of fructo- oligosaccharide (FOS) as a sugar replacer increased fiber content up to 12.1% | (Handa et al., 2012) |
| **2.** | **Biscuit** | 2.77-3.44 | Use of cassava based composite flours enhanced fiber levels | (Jisha et al., 2010) |
| **3.** | **Bread** | 11.80 | Whole meal rye bread offers high fiber content | (Markiewicz-Żukowska et al., 2016) |
| **4.** | **Muffins** | 2.77-3.44 | Cassava – bran blends increased fiber content in muffins | (Jisha et al., 2010) |

**Enrichment of legume flour in bakery products**

The incorporation of bean flour in baked products has attracted a lot of attention as it can enhance nutritional characteristics due to the fact that they increase the level of protein, fiber and bioactive compounds. In bakery formulations, legume flours (chickpea and lentil as well as pigeon pea) can replace wheat flour in part, as they are rich in dietary fiber, antioxidants and essential amino acids (Imran et al., 2024).But according to some studies (Verma, Kumar, Das, & Dwivedi, 2013), some alternative flours especially legume based may pose allergen risk to sensitive individuals. The use of some legume based flour may impart a denser texture or a beany flavor which causes acceptability challenges for consumers.

**Nutritional and functional benefits:**

Legume-enriched bakery products have shown significant benefits due to their nutritional profile. For example, the protein content of biscuits made with legume flours ranged from 9.3% for control (wheat) biscuits to 23.7% for those supplemented with mung bean flour and 23.1% for those with chickpea flour (Imran et al.,2024). Similarly, the presence of bioactive chemicals in legumes caused a significant increase in total phenolic content and antioxidant activity.

Pasqualone et al (2019) conducted a study which focused on the effects of the integration of Apulian black chickpea flour in bread and focaccia made using durum wheat. According to the study, this had a negative effect on the rheological properties of the dough and led to thicker crumb and darker crust but there was an increase of the fiber content and the antioxidant property(Pasqualone et al.,2019).

**Effects on Sensory Properties and Dough Rheology**

Legume flours change the structure of dough by reducing the gluten mesh and create baked goods that are denser and lower in volume. The farinograph and alveograph studies revealed a decrease in dough stability with increasing amounts of chickpea flour. This suggests that in order to keep textural acceptability, the wheat to legume flour ratio must be optimized (Pasqualone et al., 2019).

A sensory analysis of baked goods made with legumes yielded mixed results. Biscuits that included 10–20% of bean flour were positively rated because of their higher nutritional value but higher substitution levels led to undesirable changes in texture and colour (Imran et al.,2024). Hence, approaches such as hydrocolloid addition and penetration of enzymes were needed to improve the functional characteristics of legume fortified doughs.

**Chickpea flour: Enrichment of legume flour in bakery products**

Studies have been extensively conducted on the inclusion of chickpea flour in various formulations with an aim to address nutritional profiles, alongside modifying the sensory and technological properties of baked goods. Chickpea flour, due to its high protein, dietary fiber and bioactive component content, is a valuable alternative to wheat-based formulations.

Pasqualone et al (2019) examined the effects of addition of the Apulian black chickpea flour on the nutritional properties of baked products based on Durum wheat. The study found that chickpea flour enrichment significantly increased the protein, lipid, ash and fiber contents of bread, focaccia, and pizza crust. However, this did bring with it a darker crumb colour and altered textural properties—these include potentially more chewy property and hardness that could affect consumer acceptability.

For instance, Hanafi et al. did a study in 2020 which focused on incorporating legume flours (including chickpea flour) into cereal items. Legume-enriched breads and cakes received higher sensory evaluation score than control items that indicates that regardless of whatever the adopted use of legumes might be, it imparts sensory benefits and when compared with control items, the legume-enriched products scored higher on sensory evaluations. The significant 24% increase in acceptability of cakes prepared using 50% chickpea flour replacement is primarily attributed to the colour of the crumb, which is darker and considered byconsumers as natural and healthy.

In 2013, De la Hera et al, studied the effect of chickpea flour on the rheology and quality of gluten free bread. The chickpea flour increased the nutritional profile by adding protein and fiber. But that also had implications on the texture and behavior of the dough leading to formulations that needed to find a balance between desired sensory properties and potential benefits.

**Enrichment of vegetable flour in bakery products**

Vegetable flours have attracted a lot of interest because of their potential to improve the functional qualities and nutritional worth of baked goods. Research has indicated that adding different vegetable powders to wheat flour can enhance the baked items mineral content, looked into the impact of adding pumpkin and carrot powders to wheat bread. According to their findings, the bread's antioxidant capacity was increased due to a significant increase in critical minerals including calcium and potassium as well as a noticeable rise in total phenolic and flavonoid content. Consuming 100 grams of such enriched bread could greatly contribute to daily mineral requirements, especially for potassium, according to the study's findings (Purkiewicz et al., 2024).as shown in table.

**Table2 :Severalmainly used vegetable flours**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Vegetable flour** | **Enriched with** | **References** |
| **1.** | **Carrot Flour** | Rich in βcarotene content | (Purkiewicz, GulandPietrzak-Fiećko, 2024) |
| **2.** | **Pumpkin flour** | Vitamin A, It helps to reduce oxidative stress | (Zavalishina, KuznetsovaandKorneeva, 2021) |
| **3.** | **Spinach Flour** | Iron fortified products, Essential for red blood cell formation | (Shatat, Khaliland El-Gammal, 2023) |
| **4.** | **Beetroot Flour** | Bioactive compounds, Supports digestion and improves gut health and helps to boost immune function and enhances collagen production. | (Guldiken et al., 2023) |
| **5.** | **Sweet potato Flour** | Rich in fiber, Aids digestion and promotes gut health, Provides anti-inflammatory properties. | (Meng, Xu, Wuand Feng, 2022) |
| **6.** | **Broccoli flour** | Contains glucoinolates, supports detoxification and liver health. | Fanesi et al. (2023) |
| **7.** | **Pea flour** | High in protein and fiber, improves muscle and digestive health. | Saeed et al. (2020) |
| **8.** | **Cauliflower flour** | High in phytosterols and vitamin C, aids in immune function | Nartea et al. (2023) |

1. **Bread:-**

It has been studied to increase the nutritional value of bread compositions by including cauliflower by-products. According to some studies the use of cauliflower leaves and stalk flour in the substitution with some flour leads to increase in vitamin A and phytosterols, contributing to enhanced health benefits.

**(B)Biscuit:-**

The studies done by Kuhalskaya et al. (2023) have shown that the addition of components obtained from broccoli to biscuits in order to enrich them with beneficial substances. 10% broccoli flour raised the amount of glucosinolates, carotenoids and phenolic compounds.

**(C) Pizza:-**

According to the Nartea et al. (2023) it has been mentioned that cauliflower leaves and stalks can be converted into very effective bioactive flours, which are useful components for pizza. The aerial portion and the type of cauliflower violet or orange had an impact on the profile of bioactive components in the special flours.The different bakery products enriched with vegetable flours leads to some changes in sensory attributes.

**Table3 :Enriched vegetable flour bakery products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bakery product** | **Vegetable flour used** | **Nutrient benefits** | **Sensory attributes** | **References** |
| **Bread** | Cauliflower, carrot, Pumpkin | Potassium and calcium levels increase | Improves texture and softness | Nartea et al. (2023), (Bas-Bellver et al., 2024) |
| **Biscuit** | Buckwheat, Sorghum | Improved protein and fiber content | Crispness depends upon flour used | (Yadav et al., 2014) |
| **Pizza** | Cauliflower | Rich in glucosinolates | Crust colour and taste slightly changed. | Nartea et al. (2023) |
| **Crackers** | Amaranth Flour | Rich in protein, fiber, and minerals | Improves texture and crispiness | Kuhalskaya et al. (2023) |
| **Cookies** | Pea Flour | Increases protein content, provides essential amino acids | Texture improves with | (Ikade et al., 2024) |
| **Muffins** | Sweet Potato Flour | High in vitamins A and C, fiber | They are fluffy, softness | (Ikade et al., 2024) |

**Enrichment of Millet flour in bakery products**

Due to their affordability, varied taste and texture profiles, appealing packagingand long durability, which make marketing easier, bakery products, are consumed globally and their production has increased dramatically.

The different millets has came in light to enrich the mineral levels in bakery products. Before most of the bakery products are made from different varieties of wheat but now the use of millets is in trends. (SirohaandBangar, 2024) has mentioned millets as “Nutri cereals “because of their good protein and amino acid content. It shows good nutritional profile that fulfils the basic human nutritional needs. It is well known that millet flour contains a lot of proteins, dietary fiber and vital micronutrients like phosphoruszinc and iron. Ikade et al. (2024) have out that adding millet flour to baked goods greatly enhances their nutritional profiles, particularly by raising the amount of fiber, protein and minerals. The increasing demand from consumers for nutritious foods that provide health advantages beyond basic nourishment is met by this improvement

To create healthier versions of bread and cookies, Multi Millets Flour was gradually substituted for refined wheat flour. The addition of millet flours greatly increased the amounts of protein, fiberand vital micronutrients like calcium, zinc and iron. (Chaudhary et al., 2024) has mentioned that the major millets, including Finger Millet (Eleusine coracana), Pearl Millet (Pennisetum glaucum)and Sorghum (Sorghum bicolor), have been widely utilized for the preparation of various baked products due to their superior nutritional benefits.

**Table 4: Enriched millet flour products**

|  |  |  |  |
| --- | --- | --- | --- |
| **Bakery product** | **Millet flour used** | **Health benefits** | **References** |
| **Bread** | Pearl millet, Finger millet | Rich in Dietary fiber content, improves gut health | (Ikade et al., 2024) |
| **Biscuit** | Sorghum, Foxtail millet | Gluten-free alternative for celiac patients | (Yadav et al., 2014) |
| **Cookies** | Buckwheat , Pearl millet | Supports digestion and improves bone health | (Aggarwal and Sharma, 2020) |
| **Cake** | Foxtail millet | Reduces the risk of diabetes | (SirohaandBangar, 2024) |
| **Muffins** | Pearl Millet | Increases iron content and provides essential amino acids | (Ikade et al., 2024) |
| **Crackers** | Pearl Millet | Boosts fiber and micronutrient content | (Ikade et al., 2024) |

**Bakery Products with Beneficial Nutritional Features**

Refined wheat flour lacks most of the vital proteins, vitamins, and minerals which gives it an inferior nutritional profile that raises concerns about baked goods' nutritional quality (Chavan et al., 1993). In an effort to boost the nutritional value of baked goods, it has become voguish to put efforts to explore alternative flours.

The use of non-wheat flours derived from oilseeds, legumes and exotic cereals have been considered to be an effective strategy for improving the protein, fiber and micronutrient composition of baked products (Chavan et al.,1993). These alternative flours contain more lysine, threonine and methionine — most of which are low in wheat-based products. Additionally, incorporating alternative grain flours such as quinoa and amaranth significantly boosts the protein and mineral content of baked products and enhances their nutritional quality (Ramos, 2024). In addition, the use of these alternative flours in baked products increases the content of dietary fiber that is beneficial to bowel health and avoids chronic diseases such as diabetes and heart disease. Bioactive constituents, including micronutrients such as flavonoids and ascorbic acid, enhance the functional traits of these products and offer health benefits beyond basic nutrition. However, these alternatives can affect the sensory and structural properties of baked products, requiring reformulation in order to maintain consumer acceptability (Ramos,2024).

**Various baked goods enriched with various types of flour**

**Cookies:-**

A widely consumed snack globally, Cookies one of the type of bakery product that is consumed by the individuals of every generation. The fat level of these goods is high. A little butter cookie may have about 65 and 70 % fat (Chavan et al., 1993). A normal cookie contains Cake flour, eggs, sugar and fat as their primary ingredients. Krajewska and Dziki (2023) examinedthat Because of cookies many benefits, including their affordability, availability in a variety of forms and ease of storage, wheat cookies have grown in popularity as a snack. Adding fruit additives to food has been more popular, particularly in recent years and thus enhances the products' health-promoting qualities. To address the global problem of protein energy deficiency, protein supplements are the most effective means of substituting kidney bean protein for a portion of wheat flour. For the undernourished population, the fortified baked goods are therefore quite important (Hayat et al., 2022).

1. **Incorporation of Fruit By-Products**

It has been demonstrated that adding fruit by-products to cookie recipes greatly increases their nutritious content. When powdered fruits and fruit by-products were added to cookies, Krajewska et al. (2023) found that the cookies had higher amounts of fiber and minerals, as well as phenolic compounds with strong antioxidant properties. However, the kind and quantity of fruit additive affected the overall acceptability of the product by influencing sensory qualities as color, texture, and flavor andtaste. The use of pulp of the juicy fruit has been got a major importance in making cookies, the powdered pomace of strawberry, raspberry is used in bakery industries, as they are the natural sources of the vitamins and minerals, anthocyanins and iron .The fortification of cookies with the orange feel act as a good source of vitamin c.

1. **Supplementation with** **Legume Protein Isolates**

Adding even in small quantities legume protein isolates to cookies improves their overall nutritional profile and protein quality. Hayat et al. (2020a) added 10% protein isolate derived from red kidney beans in cookies. (2022), leading to a great increase in content of protein (7.87% in control cookies to 16.92% in cookies enriched with 20% of protein isolate). But Cookies isolated protein has low but low range of energy level. Plant-based gluten-free protein blend: Soy, lentil, pea and chickpea flour protein isolate increases the amount of protein and improves gut health, resolves digestive issues and acts as an alternative to gluten-containing food.

**Biscuits:-**

Biscuits are one of the items that are preferred in breakfast by most of the people . In an effort to satisfy consumer demand for healthier snack options, food scientists have focused a lot of attention on improving the nutritional value of biscuits. The impact of several biscuit enrichment techniques, such as adding functional fibers, bioactive chemicals, or alternative flours, on the finished goods' physicochemical characteristics, nutritional profile and sensory qualities is examined in this research.Lazou (2024) examined the properties, structure and consumer acceptability of legume-based biscuits with alternative sweeteners he has said that dicoccum wheat flour was combined with chickpea and lentil flours to create three distinct legume-to-flour ratios: 0%, 10%and 30%.Although biscuits are a common baked good, traditional recipes frequently lack important nutrients. Alternative flours including millet, legume and fruit by-product flours can be added to biscuits to improve their functional and nutritional qualities while also encouraging sustainability. The several flour substitutes used in biscuit-making are highlighted in this review along with their effects on microbiological stability, physical characteristics and nutritional quality.

1. **Enhancement of Nutrition by Substituting Flour**

The nutritional profiles of the Biscuits are improved by the incorporation of the pearl millet and orange peel in biscuits. Biscuits enhanced with pearl millet and orange peel in flour had greater levels of crude protein (11.70%-13.41%), crude fiber (11.44%-16.24%) and ash content (4.50%-5.59%), per Ramashia et al. (2024). The nutrient intake in the enriched biscuit has increased with the addition of antioxidant. When banana pseudostem flour (BPF) was used in place of wheat flour, the biscuits' nutritional value and antioxidant capacity were greatly enhanced. Compared to conventional wheat biscuits, studies showed that BPF-substituted biscuits have greater levels of protein, fiber, phenolic compounds, flavonoids and antioxidant activity Chakraborty et al. (2021).​

1. **Nutrient and textual enrichment:-**

When black gram flour (BGF) was added to biscuits, the amount of fat decreased and the amount of protein and fiber increased. According to the study, biscuits enhanced with BGF had better spread ratio, moisture retention and a more palatable texture (Ali et al., 2020). Furthermore, rice-based composite flour including orange pomace and soy protein isolate was used to manufacture gluten-free biscuits. This flour demonstrated improved protein content and fiber enrichment, making it more suited for people with gluten intolerance (Cayres et al., 2021).

**BREAD**

Bread is a primitive food that everyone, of every colour and culture consumes. Its essential ingredients are wheat flour, water and all kinds of leavening agents. Bread's importance in human nutrition comes from its carbohydrate content and its potential to be fortified with helpful materials. The health effects of bread are varied, depending on its constituents and the manner in which it is made.

Given the low cost of bread and its fairly ubiquitous availability, it is a staple food as well. It has turned into a stable food in many countries. That's why it may take on so many different forms, given its adaptability to satisfy various dietary needs which may be its characteristic of being gluten-free or fortified (Muñoz-Bernal et al., 2024)

**Nutritious Content in the Bakery Products of Bread**

As a bakery product, the nutritional value of bread could vary based on its composition and the technique of production. Bread contains simple nutrients, vitamins, and minerals as micronutrients and proteins, fats, and carbohydrates as macronutrients. The health benefits related to whole wheat bread are due to its content of fibers, iron, magnesiumand zinc (Dapčević-Hadnaђev et al., 2022). Breads are also fortified using strategies that takes into use various functional ingredients, including seeds, legumes, or enriched flours, which increases the nutritional profile of bread due to protein, antioxidant, or healthy fat supplementation (Subaşı& Ercan, 2024)

However, refined white bread is very low in fiber and has lower contents of micronutrients due to the bran and germ being stripped away in the processing and fortification processes. (Cetiner&Koksel, 2024). Alternative bread formulations, such as gluten free, make use of rice, corn, and oat flours. Wheat-based bread nutrients also may need to be fortified additionally (Martins et al., 2022).

**Methods of Improving the Quality of Bread in Food Processing**

In food processing, quality enrichment of bread is one of the fields of interest that is committed to improve sensory taste, nutrition and shelf life of bread. The quality and properties of bread can be enhanced in terms of more methods and ingredients varied, and there are numerous techniques that could be introduced to enhance the quality and functionality of bread. Few of them are:-

1. Use of Whole Grains and Alternative Flours: The use of whole grains and alternate grains such as buckwheat, amaranth, quinoa in bread enhances dietary fiber, protein and mineral content. Gluten-free versions can be more advantageous for diet type, replacing oats, rice and legumes with flours (Subaşı& Ercan,2024).

2. Fortification with Functional Ingredients: The inclusion of bioactive compounds such as polyphenols and plant-based antioxidants into bread has been shown to result in bread variant that are packed with health benefits. Thus, acorn or wine byproducts can be included in formulation of bread to enhance their phenolic content, thereby increasing their antioxidant capacity (Muñoz-Bernal et al.,2024).

3. Enhancement of leavening Method: The method of leavening, which varies according to the type of leavening agent used, can greatly influence the bread’s texture, digestibility, and shelf life; one example which can be taken here is of sourdough fermentation. Such bread, fermented with sourdough, offers several positive effects such as flavour enhancement and the enhanced availability of minerals due to reduced concentration of phytic acid, which binds the mineral species in the bread (Venturi et al.,2021).

4. LoweringGlycaemic Index: Whole grains, fibre enrichment, and enzyme treatment lowers the glycaemic index of bread, which is beneficial to people suffering from diabetes (Cetiner& Koksel, 2024).

5. Dietaryfibre and prebiotics incorporation: When dietary fibre is added in a bread made from natural sources such as flaxseed, psyllium and inulin which are healthy food, it results in increasing the satiety (Dapčević-Hadnađev et al., 2022).

**Enhancement of cake fortified with different flour**

Fortification of cakes with alternative flours has been extensively studied to enhance their nutritional value and cater to diverse dietary preferences. Researches indicate that incorporating flours such as buckwheat, chickpea, and composite blends can significantly improve the protein, fiber, and mineral content of cakes. For instance, Farzana et al.(2021) demonstrated that substituting wheat flour with up to 30% buckwheat flour resulted in cakes with higher protein, fat, fiber, and micronutrient content compared to control samples. Similarly, Fakhri-Aldeen et al.(2017) explored the partial replacement of wheat flour with a mix of legume flours, including beans, chickpeas, and lentils, in cake formulations. Their study found that adding legume flours increased the protein and mineral content of the cakes. However, higher concentrations of legume flours resulted in changes to the sensory properties, such as color and texture of the cake. Sensory analysis indicated that cakes with a 10% substitution of legume flours maintained acceptable sensory qualities, suggesting that moderate substitution levels can enhance nutritional value without compromising consumer acceptance. Additionally, Ramos (2024) assessed the nutritional quality of bakery products enriched with alternative flours derived from unconventional cereals or legumes. The study found that the inclusion of alternative flours, such as amaranth and quinoa, resulted in a significant increase in protein, fiber, and mineral content in bakery products. However, variations in sensory and textural characteristics were observed, suggesting the need for adjustments in formulations to optimize consumer acceptance. These findings underscore the potential of alternative flours in cake fortification, though careful formulation is necessary to balance nutritional benefits with desirable sensory attributes.

Incorporating fruit-derived flours into cake formulations offers a sustainable approach to fortification, particularly for enhancing fiber content. A study by de Oliveira Paz et al.(2020) reviewed the use of alternative flours in bakery products, including those derived from fruits like banana. The review highlighted that banana flour could enhance the nutritional profile of bakery products by increasing their fiber content. However, the inclusion of such flours may affect the sensory and textural properties of the final products, necessitating careful formulation adjustments. Similarly, Fakhri-Aldeen et al.(2017) found that incorporating legume flours into cake formulations increased protein and mineral content, with a 10% substitution maintaining acceptable sensory qualities. These studies highlight the feasibility of utilizing alternative flours to improve the nutritional profile of cakes, aligning with sustainable food production practices.

**Conclusion**

Notably, adding addition flours to bakery products leads to a more nutrition-rich profile maintained with good sensory and functional properties. By replacing the refined wheat flour with flour rich in vegetables, legumes and millet, it causes a massive net gain of protein, dietary fiber, essential micronutrients and bioactive compounds. The resulting products are enriched with the beneficial effects promoting improved digestion, enhanced glycemiccontrol and increased antioxidant capacity from 18 to 19. Studies have shown that by adding flours of carrot, beetroot, sweet potato and spinach, the mineral composition and bioactive value of bakery products (bread, biscuit, cookie and cake) can be improved. Flours based on millet, such as pearly millet, jowar (sorghum) and petite millet, are important amino acids for individuals with celiac disease. Legume-based protein isolates also provide higher protein content and help fight malnutrition. Although the fortification of bakery products with alternative flours possesses various benefits, optimizing flour formulations and substitution levels is imperative to product sensory acceptance. Further studies may direct to progressive processing techniques and consideration of combined usage of alternative flours to promote their health benefits while ensuring the wider market viability in bakery circumstances.

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Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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