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Wheat Proteins: A Valuable Resources to Improve Nutritional Value of Bread

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Triticum aestivum, commonly known as bread wheat, is one of the most cultivated crops globally. Due to its increasing demand, wheat is the source of many nutritious products including bread, pasta, and noodles containing different types of seed storage proteins. Wheat seed storage proteins largely control the type and quality of any wheat product. Among various unique wheat products, bread is the most consumed product around the world due to its fast availability as compared to other traditional food commodities. The production of highly nutritious and superior quality bread is always a matter of concern because of its increasing industrial demand. Therefore, new and more advanced technologies are currently being applied to improve and enrich the bread, having increased fortified nutrients, gluten-free, highly stable with enhanced shelf-life, and long-lasting. This review focused on bread proteins with improving wheat qualities and nutritional properties using modern technologies. We also describe the recent innovations in processing technologies to improve various quality traits of wheat bread. We also highlight some modern forms of bread that are utilized in different industries for various purposes and future directions.

Keywords: wheat, seed storage proteins, baking, gluten, nutrition

INTRODUCTION

Cereals have achieved their well-deserved importance all around the globe owing to their good nutritional profile. People misinterpret cereals as starch-rich foods even though they have proteins, vitamins, antioxidants, and some essential fatty acids, too (McKevith, 2004). Wheat, as bread, contributes maximum nutrients to the global population than any other single food source. The end-product quality of wheat is mainly dependent on wheat proteins and their processing techniques involving harvesting of the grain to the production of flour, which further decrease the bioavailability of some of the nutrients (Rustgi et al., 2019). The product quality is determined by the balanced composition of biochemical components in a seed such as seed storage proteins, starch, minerals, fibers, and phenolic compounds (Žilić et al., 2011). In addition, besides interactions between wheat and companion, additives can also have effects on nutritional quality of end-products. There is a continuous increase in demand for improved wheat products by consumers and baking industries (Dewettinck et al., 2008). Wheat proteins are the responsible agents governing the production of bread and other related end-products. Biotechnological tools are also gaining importance in harnessing cereal proteins for better end-products (Verni et al., 2019; Shewry and Jones, 2020). Breeding *via* cross-hybridization in wheat crop have proved successful for the production of new superior end-use quality products (Kiszonas and Morris, 2018).

Wheat storage proteins are major determinants of wheat flour composed of gluten and non-gluten fractions out of which wheat end-product quality mainly depends on the gluten proteins. Gluten protein mainly provides the elasticity and extensibility of dough, which is unique for wheat, leading to diverse end-products. Gluten protein cysteine residues form disulfide bonds, which are basically the chemical bases for the physical properties of dough (Islam et al., 2019). Gluten was found to be degraded during germination (Michalcová et al., 2021). Worldwide studies are going on to assess various wheat varieties for producing enhanced quality bread (Lama et al., 2018). Various seed storage proteins alleles of wheat have also been explored to dissect their impact on end-product quality of wheat (Goel et al., 2018a,b; Altenbach et al., 2019). Additional work on enhancement of shelf-life was done to enhance its susceptibility to spoilage (Nionelli et al., 2020). Considering the wide acceptability of wheat bread and other related products, in the present review, we shall be discussing about wheat proteins impact on bread making, also other techniques that are revolutionizing the quality of today's bread, and the effect of interactions with other food components on the nutritional enhancement of bread.

BREAD MAKING

Bread is the product of baking of wheat flour mixed with water, salt, yeast, and flavor ingredients. The characteristic of wheat bread as physical attributes of texture, color, and volume are among the most important parameters taken into account by the consumers (Tebben et al., 2018). The mechanical properties of bread are often associated with the perception of freshness and elasticity that influence the consumption decision (Fagundes et al., 2018). The protein that is responsible for dough elasticity and formation of good bread is gluten produced by mixing gliadin and glutenin, which gives dough its elastic character (Peña, 2002). The gases produced during the rising of the dough and the ability of the dough to hold these gases makes a substantial difference in bread quality as illustrated in **Figure 1** (Janssen et al., 2021). The journey of bread making started during Neolithic times; history proves that the mixing of bread with other sources is not a recent tale. In the Second World War, it was called "National Loaf" in which the addition of calcium carbonate was done during that period to counter the expected deficiencies due to shortage of milk and cheese (Hayden et al., 2016).

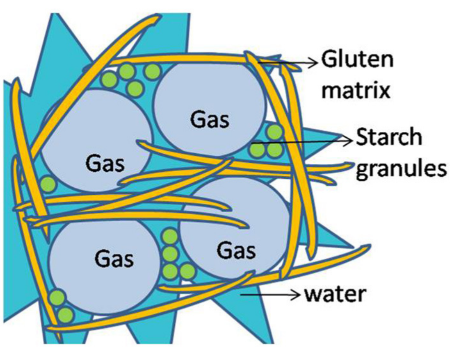

FIGURE 1 | Illustration of gas molecules entrapped in the gluten matrix of wheat dough.

The basic steps involved in bread making, including mixing, rising, kneading, baking, and cooling, have more or less remained constant since long. Mixing is simply a process causing the uniform distribution of ingredients and allows the formation of a gluten protein mesh-like network to give the product of bread (Guerrini et al., 2019). There is an optimum mixing time, which changes, depending on the flour and mixing method used, because too much mixing produces dough with reduced elastic properties. This results in the development of small unrisen and unmixed patches in the bread, giving the loaf a poor appearance from inside (Létang et al., 1999). Next to mixing, fermentation is done, during which dough slowly moves from a rough non-extensible dense mass into a dough with good gas holding and good extensibility properties. Besides this, breakdown of carbohydrates leads to the formation of alcohol and carbon dioxide that gives the bread its natural flavor and causes rising of the dough (Rosell, 2011). Kneading/molding is done to remove gas from a large hole formed during rising of the dough. The dough is then allowed to rise again and is kneaded if required by the particular production process being used. During the final rising (proving), the dough again fills with more bubbles of gas, and once this has proceeded far enough, the dough is transferred to the oven for baking (Cauvain, 2012).

The baking process transforms initial dough into a flavorful product, which is light and readily digestible. The penetration of intense heat increases the volume and size of the tiny gas cells (Ishwarya et al., 2018). At about 60°C, stabilization of the crumb begins, making the starch granules swell; as they get released in the presence of water, the outer wall of the starch granule cell bursts, making the inside starch form a thick gel-like paste that helps to generate the structure of the dough (Kumar and Sharma, 2018). As baking continues, the internal loaf temperature reaches ∼98–100°C. As the moisture is driven off, the crust heats up and eventually reaches the same temperature as the oven. During baking, crust temperature is over 200°C, and the internal temperature of crumb is about 98°C. The loaf is full of saturated steam, which must be evaporated. The whole loaf is cooled to about 35°C before slicing and wrapping can occur without damaging the loaf. In a bakery, special cooling areas are required to ensure efficient cooling before slicing and wrapping of the bread. This completes the process of bread making, which is then consumed by people all over the world (Pateras, 2007).

The rising demand in the food industry emphasized the intervention of research to enhance aspects of improved bread for large production and longer shelf-life. Food additives such as emulsifiers, which belong to a general class of compounds known as surfactants, are used to raise dough strength and as crumb softener in bread quality.

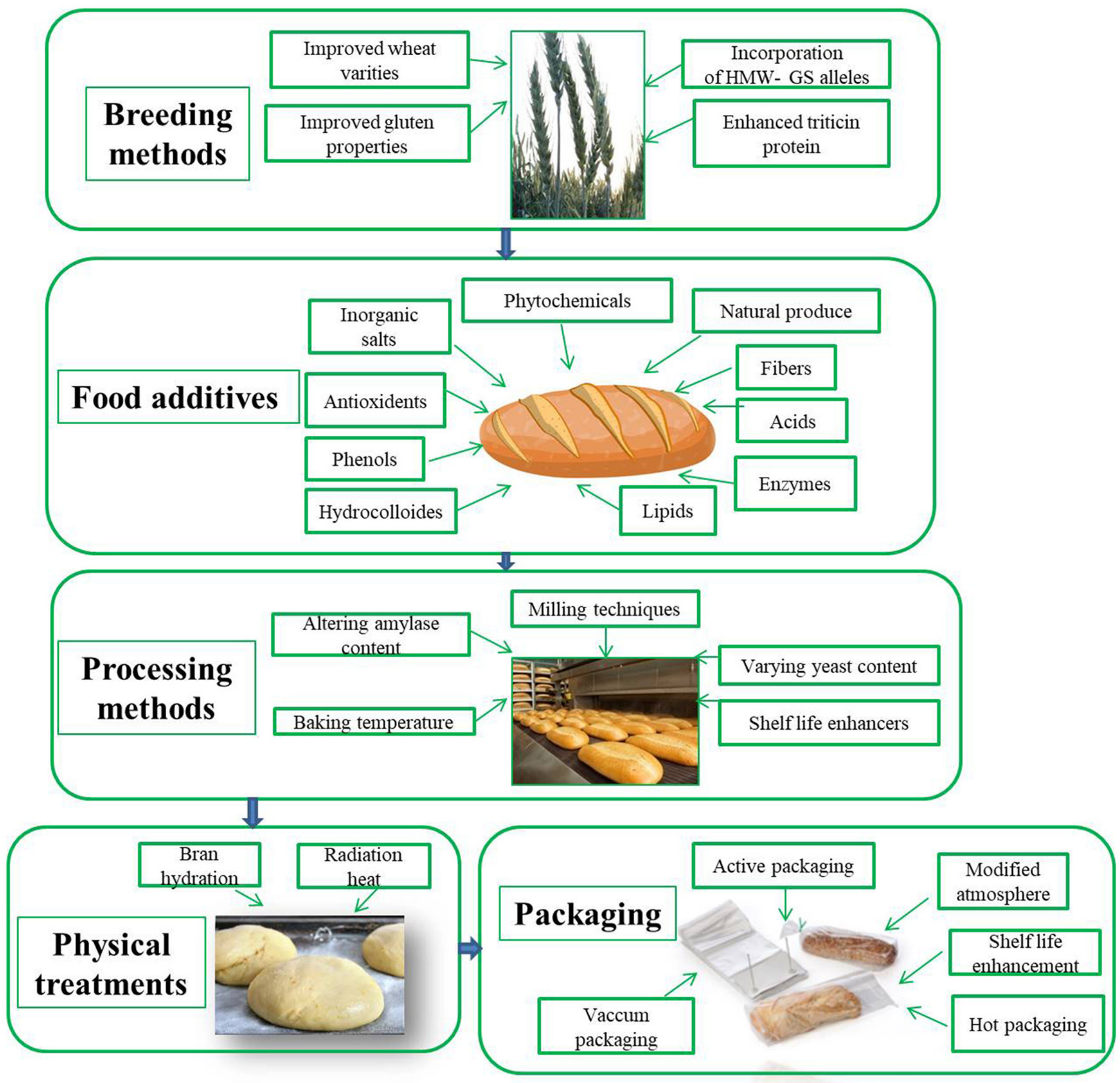

FIGURE 2 | Advancements in present day improving bread quality from breeding methods to processing techniques.

ROLE OF WHEAT PROTEINS IN BREAD MAKING

Bread making could be possible due to the viscoelastic properties of wheat doughs. These properties are a result of the structures and interactions of prolamins (a group of seed storage proteins) as observed in previous studies (Shewry et al., 1999). Seed storage proteins of wheat are comprised of the gluten proteins, comprising two prolamin groups, gliadin and glutenin, considered as the main creator of bread. Glutenin is comprised of polymers with subunits linked by disulfide bonds, which is significantly important for bread making (Shewry and Miflin, 1955). Qualitative or quantitative differences in the composition of seed storage proteins account for much of the variation in bread-making quality as observed in diverse wheat cultivars (Huebner and Wall, 1976; Payne, 1987; Goel et al., 2018a). A range of studies has been explored for the probable impact of wheat seed storage proteins and their role in bread making taking different allelic combinations (Gupta and Shepherd, 1989; Goel et al., 2015). A minute wheat seed storage protein, Triticin, was also thought to improve quality of bread product (Goel et al., 2015, 2018b). Extensive studies are also available on quantitative trait locus (QTL) analysis, depicting the role of the genetic loci on end-product bread quality and nutritional enhancement (Charmet et al., 2001; Li et al., 2009; Goel et al., 2019; Suliman et al., 2021). Owing to the huge genome size of the wheat, researchers focused on the synteny area of related cereal crops to study the responsible factors of wheat proteins further governing end-product quality (Quraishi et al., 2017). Furthermore, the biotechnological tools have been harnessed to dissect wheat proteins variable actions in improving bread quality (Goel et al., 2017, 2020).

RECENT ADVANCES TO IMPROVE BREAD QUALITY

Production of Gluten-Free Bread

Improvement in the nutritional quality of wheat bread has always been on the priority list of bakers and wheat breeders because of its huge popularity throughout the world. When we look for the additives, one of the best option are legumes, as they are known as rich source of proteins, minerals, and bioactive health-promoting compounds, which may provide texture, structure, and baking quality to the end-products (**Figure 2**). They also have a low glycemic index, and therefore, their inclusion in bread has enhanced the food menu for people allergic to gluten. Furthermore, various laboratory experiments have proved that along with nutritional value, the viscoelastic properties of gluten-free bread can be improved with the addition of legumes like chickpea, soybean, and lupin (Melini et al., 2017). Industries have started adding barley to the wheat dough to enhance the fiber content without disturbing the glycemic index of traditional wheat bread and without negatively affecting its sensory characteristics (Cavallero et al., 2002). Major emphasis has been given these days toward the reformulation of bread and bakery products by altering the gluten content with the addition of functional compounds such as non-cereal flours, prebiotics, and additives (Elleuch et al., 2011). To improve sensory properties, shelf-life, and quality of gluten-free bread, flour from chestnut seeds, amaranth seeds, and psyllium seeds are added to the dough mix. It has been observed that the addition of prebiotics in dough prevents microbial growth and increases the shelf-life of bread (Rahaie et al., 2014). Production of gluten-free bread is an initiative over rising issues of celiac disorders; sorghum and potato starch were considered as potent options earlier for making bread gluten free. Further addition of hydroxypropyl methylcellulose and whey protein concentrate acts as a technological improver in bread dough, and it was stipulated from the observations that both can be efficiently used to obtain gluten-free protein-rich bread (Rustagi et al., 2018).

Improving Texture and Fiber Content

There are different classes of wheat flour that have been gown in different climatic zones around the globe. For example, five classes of wheat are grown in the United States, having their own properties in bread making, like soft white wheat is a special kind that has low moisture content and gives white product such as Asian-style noodles, pastries, and exquisite cakes. Another class is soft red winter wheat, which provides excellent baking and milling properties for making flat breads, cookies, and pretzels (Nebraska Wheat Board, 2020). In certain parts of North America, bread making is practiced by using white wheat flour in which other fibers, germ fractions, phytochemicals, and other important nutrients are generally concentrated. As compared to whole grain bread, white flour products have minimal dietary fibers and non-nutrient phenolics (Xu et al., 2019). On the other hand, hard white wheat is similar to red wheats in its characteristics but has sweet taste and is used in yeast breads, tortillas, and ramen noodles. Hard red winter wheat is mostly used for making pan bread, all-purpose flour, flat breads, and hard rolls, while hard red spring wheat, also called aristocrat of wheat, is used for making pizza crust, bagels, rolls, and hearth breads (Nebraska Wheat Board, 2020).

Therefore, in the direction of quality and texture improvements, several additions have been tried in different proportions such as the addition of course grains, dietary fibers, pectin extracts, and natural coloring and flavoring substances. These fortifications not only improved the nutritional properties of bread but also enhanced its texture and storage. In this light, Angelino et al. investigated the effect of dietary fibers and phenolic compounds on the properties of bread dough and finished bread (Angelino et al., 2017). The phenolic compounds in the form of apple pectin and fruit phenolic extracts showed enhanced antioxidant activity and storability of final bread as compared to the untreated bread (Sivam et al., 2011), although these changes in antioxidant properties entirely depend on the choice of pectin extract (kiwi, apple, and other fruits) (Rupasinghe et al., 2008). Research confirmed that the addition of pectin into bread dough enhances polymeric cross-linking with bread particles of high molecular weight (Sivam et al., 2012).

Increasing Nutritional Value

Providing healthy and safe fresh bakery products and fulfilling expectations of consumers are big challenges before organic farmers, millers, and bakers. The quality of raw organic produce depends upon various factors, *viz*., genotype, crop management, soil fertility, and crop rotation practices, which can be modulated as per market requirements, whereas the nutritional quality, taste, and flavor of bakery products varies with changes in the milling and baking process. Among crop management practices, nitrogen application plays an important role in achieving acceptable yield levels of good bread-making qualities. Canadian researchers have established the fact that the quality of bread can be affected by the cultivation practices of wheat to be used in bread making (Mason et al., 2007). The researchers found that organically cultivated wheat produces more nutritive bread (high in protein value indicating excellent grain quality for yeast leavened bread), whereas conventionally grown wheat results in stronger textured bread (Annett et al., 2007). Wheat bran proteins (WBPC) inclusion was observed in bread formulations and studied to determine the impact on nutritional properties without deleterious effects on quality (Alzuwaid et al., 2021). Manganese application through seed treatments (seed priming) is a cost-effective method for improving the productivity of bread wheat particularly in alkaline calcareous soil (Ullah et al., 2018). Additionally, the novel wheat varieties with pigmented grains (black, purple, and blue) with higher amounts of anthocyanins and other phenolics than the traditional wheat varieties can be effectively utilized to bake bread of some medicinal values as well, which may have preventive properties against cancer and chronic diseases (Sharma et al., 2018). The antimicrobial property was reported to improve with the addition of phenolic compounds in many baking products, improving health benefits and extending the shelf-life of bread (Xu et al., 2019).

INNOVATIONS IN BREAD PROCESSING APPROACHES

Bread Milling

The damage to flour starch, amylase activity, particle size, and ash content of dough largely affects the baking performance of bread. These qualities are modified with milling techniques that in return modifies baking performance and nutritional properties of bread. The mineral bioavailability in bread can be increased using sourdough techniques (acidification process) in the baking method. The responses of bread quality parameters to milling and baking techniques have allowed identifying positive and negative characters of wheat bread, as baking has a multidisciplinary approach (Abecassis et al., 2008).

Addition of Different Yeast Concentrations

Birch et al. (2014) stipulated that the level and strain of yeast along with temperature and duration of fermentation have a significant effect on the aroma of bread crumb. The strain and amount of yeast added to the flour mix control fermentation activities, and modifications in temperature along with time during the fermentation process may alter oxidation of lipids present in flours. The fortification for improving the quality and protein content of homemade bread had also been tried using nutritional yeast. Such fortified bread boosts the nutritional status of poor people and reduces the incidence of protein deficiency diseases. Variable concentrations of yeast (1–15%) is known to increase protein percent in homemade bread; however, fortification with only lower concentrations (1–3.5%) of yeast is acceptable in the market, as higher quantities of yeast alter the taste of bread to an unacceptable level by its consumers (Harusekwi et al., 2014). The impact of addition of organic acids in improving bread quality was studied in China. They analyzed the yeast activity, proteolysis, and amylolysis by adding acetic acid, malic acid, fumaric acid, lactic acid, and citric acid to bread dough ingredients. The organic acids increased specific volume of the bread, whereas they lowered moisture content, pH value, and hardness of bread, which resulted from high yeast activity (Su et al., 2019). Since organic acids improve bread quality, the effects of addition of lactic acid bacteria in dough mix on bread texture and quality have been studied by food technologists. Out of many strains of *Lactobacillus plantarum*, LAB strains (LB-1, F-3, and F-50) exhibited antifungal activity and found useful for making bread to extend shelf-life. In fact, among these three strains, LB-1 significantly improved water holding capacity, viscosity, elasticity, and extensibility of sourdough (Sun et al., 2020).

The baking interventions include sourdough, which is prepared through natural fermentation using lactobacilli and yeast. The lactic acid produced by the action of lactobacilli adds taste and good keeping qualities to sourdough. It reproduces nutritionally superior, fiber-rich, gluten-free bread with improved mineral bioavailability, making it unsuitable for celiac persons. Poutanen et al. (2009) stated that the inclusion of natural yeast and bacteria in bread dough results in the solubilization of proteins and polysaccharides present in cell wall, which change the texture of baked bread and absorption of nutritional and non-nutritional compounds. The process of natural fermentation may also lead to the synthesis of novel bioactive compounds and metabolites such as prebiotic oligosaccharides.

Loaf Volume and Sensory Qualities

The researchers working on the qualities of loaf stated that the consumers are attracted to higher loaf volume and weight, which is a positive economic character for retail marketing. The buyers often believe that bread with higher loaf volumes offers more substance for similar prices. Shittu et al. (2007) explained that the varying rates of gaseous output and starch gelatinization capacity are responsible for variable loaf volumes, which result from differences in time and temperature of baking. Industries keep these factors in mind to attract the consumers by making little changes in the bread-making process. The crumb moisture content and loaf volume of bread are significantly affected by baking temperatures (Shittu et al., 2007), while dried crumb hardness, bread loaf weight, and density levels can be altered with differential baking durations at variable temperatures. Ghorbani et al. (2019) observed that bread baked at 320°C for 3 min were liked more by the judges of the sensory panel, taking their texture and chewiness, whereas the samples baked at 370°C for 2.5 min did not score well in comparison to other evaluated samples. The research shows that baking at higher temperatures results in hard bread with reduced consumer acceptability. Thus, even a slight degree of change in temperature and time has substantial effect on the overall quality and acceptance of bread.

Reducing Microbial Activity

The shelf-life of bread is a big constraint for the whole bread industry, as the bread is prone to mold contamination due to its moisture content. Within a matter of days, the microbial contamination spoils the product. There have been various studies done focusing on extending the shelf-life, and it was found that replacement or reduction in NaCl in bread making could affect the growth of *Penicillium roqueforti* and *Aspergillus niger*. The salt added to the bread mix not only improved the flavor but also increased the water activity (a_w), making the bread more susceptible to mold infections. The infection can be prevented by reducing the amount of NaCl or simply replacing NaCl at least partially with other acceptable salts such as calcium chloride, potassium chloride, magnesium chloride, and magnesium sulfate. The growth of *P. roqueforti* and *A. niger* was found to be reduced in the bread dough with 30% less NaCl or with suitable replacers. Mixing wheat flour with other flours (cassava, soybean, etc.) was tried by many bakers to improve the quality of existing bread (Samapundo et al., 2010).

Improving Bread Quality *via* Value Additions

Non-cereal Items

The addition of non-cereal flours in bread dough is very popular these days. It not only improves the texture of bread but also increases mineral nutrition. According to recent studies, cassava flour (unfermented) is added to bread making due to its high nutritional values. Various combinations of cassava flour with wheat flour have been tried to develop a wide range of food products, *viz*., pies, rolls, cakes, biscuits, doughnuts, and breads. Due to low setback viscosity and high peak viscosity, yellow cassava flour is considered good for bread dough, as it imparts low tendency to undergo retro gradation, making it suitable for products that require high elasticity and gel strength (Ayeh, 2013). In addition to the improvement in the quality of bread, the addition of cassava flour reduces the time for dough development as compared to all wheat flour dough. Later, Pasqualone et al. (2010) also reported that cassava-enriched bread is suitable for celiac patients, as it is gluten-free, nutritious, and palatable. The desirable loaf volume and crumb firmness of cassava bread can be achieved by using olive oil (extra virgin) and egg white, even if the hydrocolloids and industrial improvers are not added during dough preparation. The Indian bakeries transformed wheat into an Indian bread, known as *chapatti*. On an average, *chapatti* is consumed in every home on a daily basis in India including consumers from weaker economic sections. The recent studies suggested incorporation of 20–50% amaranth seed flour to wheat bread mixture to improve rolling properties, protein content, and mineral availability in the final bread (Mutahi, 2012). The addition of amaranth also increases stickiness, softness, rollability, and elasticity of dough (Banerji et al., 2019). Other non-cereal grains have also been tried to develop multigrain bread, such as buckwheat and quinoa (Gawlik-Dziki et al., 2009), for enhanced protein content, energy, mineral, phytate, and condensed tannin contents; however, when the percentage of wheat was decreased below 70%, the bread quality was found inferior as compared to regular bread (Ayele et al., 2017). The cereal legumes (chickpea, lupin, and soya) are a rich sources of digestible proteins and blend well with wheat dough or other cereals (oat, barley, and rye) for baking purposes. The combination of legume cereals and oats/barley/rye mixed in equal proportions was also found to improve sensory properties and texture of multigrain bread. However, an adverse effect of mixed flours on the technological properties of bread dough was observed that could be corrected by using industrial additives such as ascorbic acid, fungal alpha-amylase, glucose oxidase, xylanase, and vital gluten, alone or in combination (Yaver and Bilgiçli, 2019). Dairy products were also assessed for impact on bread quality (Graça et al., 2019).

Non-plant Ingredients

Monteiro et al. (2018) mixed tilapia-waste flour to bread dough in different proportions (0–20%) and observed that the amount of carbohydrates and total dietary fibers in bread increased with increased levels of tilapia-waste flour, whereas, in sensory evaluation, tilapia-waste flour bread scored low as compared to the traditional bread due to its disagreeable texture, flavor, and aroma. Despite that, the overall acceptance for mixed bread was unaffected as the stickiness in teeth, loaf volume, and cream color of bread did not vary significantly from wheat-based breads. Calcium is another main component that should be adequate in the diet especially for women and children for the health of bones. Recently, to increase the level of calcium in bread, new materials in trend has been used in powder form like skim milk (10%), oyster shell (2%), and eggshell (2%). This also increases set back viscosity, dough stability, percentage of water absorption, the heat of transition, and mixing time. The bread fortified with oyster shell powder showed higher amounts of fiber and ash contents. This bread is also rich in carbohydrates and proteins. It is evident from the latest results that technological properties and nutritional values in bread could be positively increased with the addition of calcium from natural resources. However, the bread fortified with eggshell and oyster shell scored badly in terms of aroma and general acceptability as compared with the bread supplemented with milk powder (Alsuhaibani, 2018). In further continuation with the addition of uncommon substances, seaweed extracts were also tried for improving quality bread for baking purposes. In Indonesia, brown seaweed from coastal areas of Yogyakarta was used to extract alginate, which was proved to be a non-toxic compound with hypo-cholesterolemic effects. Its addition in wheat bread mixture tends to improve proximate values of bread making and is useful for daily consumption (Supartini and Mushollaeni, 2017). However, higher cholesterol levels in alginate added to bread mixture can lead to adverse consequences, which may result in cardiovascular diseases as well. The fortification of wheat bread with plant-based or uncommon additives certainly enhanced the nutritional value, qualities, and texture of the final product. Conte et al. evaluated the effect of bee pollen addition to the flour used for gluten-free bread. They observed that such flour has a higher percentage of total proteins, carotenoids, and minerals, and showed anti-free radical activity (Conte et al., 2020).

Enhanced Aroma Properties

The aroma is among the first few parameters that a consumer is inclined to for bread quality. To date, more than 150 volatile compounds have been characterized in bread loaf, which evolves because of fermentation activities of yeast. Among these, many volatile compounds contribute to the aroma of bread crumb, which is sensed by consumers while eating (Pico et al., 2016). These compounds impart a characteristic odor and flavor to the final baking product. Sensory perception has a major play in the choice of bread by the consumers. The addition of legume flour in gluten-free bread can improve its nutritional value but could harm its sensory properties. Sourdough is often used to improve the sensory properties of bread. Moreover, the addition of sugars and amino acids as precursors of aroma compounds or enzymes that produce them can positively affect bread aroma. In a study, it was established that the addition of pea flour in combination with improvers (fructose, proline, arginine, and protease) helps to enhance sensory properties of bread. The relative amount of pleasant volatiles (key aroma compound 2-acetyl-1-pyrroline) has been found to increase with the addition of quinoa flour (15%) and teff flour (5%) along with wheat and corn starch (40% each). The combination also resulted in lower levels in rancid volatile compounds that originate because of fatty acid oxidation (Pico et al., 2019).

Dough Strength

The starch, which is composed of amylopectin and amylose, is abundantly present in wheat flour and maintains bread stability. However, there are varieties of wheat that are deficient in endosperm amylose. Such wheat is known as "waxy wheat," which can be utilized in the baking industry to alter amylose levels in wheat-based bakery products. The more waxy wheat is added to the dough mix, the lesser is the amylose content in it, and the better is the quality of bread. The quality of Chinese steamed bread was found to be improved with the addition of waxy flour into the bread mixture, although the addition did not improve the bread quality because the firmness of bread was decreased during storage. In experimental trials, flours of waxy wheat and Canadian spring wheat were mixed in varying amounts (0–20%), where 15% addition of waxy flour improved bread stability without affecting the quality (Rustagi et al., 2018). Wheat varieties with different allelic combinations of seed storage proteins were found to be responsible for a better bread loaf and used for production of better end-product variants of wheat bread (Goel et al., 2015, 2017).

Increasing Shelf-Life

The fatty acid salts, when used as surface acting agents and food additives, show antibacterial activity. The mold-proofing activity and improved baking property with fatty acid salts have been studied by many food scientists (Hamaishi et al., 2018). The results have proven that the addition of >5% potassium myristate to dough inhibited fungal growth on bread during storage. The length of the carbon chain of fatty acids contributed to the antifungal activity and antimicrobial effects of fatty acids; it was observed that the activity reduces with an increase in the chain length; also, medium-chain fatty acids showed stronger antimicrobial activity than longer chain fatty acids (Pareyt et al., 2011). Efforts have also been made in the direction of increasing the shelf-life of bread, which is largely affected by molds. As the bread is packed and distributed to several destinations in the world, technological interventions are needed to minimize mold infection bread. Liu et al. (2011) studied the impact of radiofrequency energy in addition to the usual hot air treatment for the control of mold in bread packaging. It was found that the radiofrequency treatments decrease moisture content and water activities in bread, which ultimately reduces formation of *Penicillium citrinum* spores. This method also enhances the storage time by 28 ± 2 days for treated white bread. Some researchers also studied the effect of incorporation of non-plant-based material into bread dough on the final product. Moreover, the addition of marine food products (Kadam and Prabhasankar, 2010), plant extracts such as green tea (Wang and Zhou, 2004), natural antioxidants (Lim et al., 2011), grape seed extracts (Peng et al., 2010), and prebiotics (Korus et al., 2006) to bakery products have been widely proposed to enhance quality and functionality of the bread. Currently, studies are revolutionizing the baking industries and serving in the development of more novel products that are low in calories and cholesterol and suitable for people with celiac disease. There are a lot more opportunities to be tested for ensuring food and nutritional security for the ever-growing population in the world.

MODERN FORMS OF BREAD

Bee Bread

Bee bread is a specialized fermented product comprised of combination of pollens, bee saliva, and nectar that bees pack in the honeycomb to ferment them with the help of many kinds of yeasts and bacteria (Khalifa et al., 2020). It is very important and considered as a key protein source for bee adults and larvae. Apart from this, bee bread is an excellent source of energy and nutrition for humans due to the higher protein concentration of pollens. The biochemical components of bee bread include vitamins, fatty acids, proteins, enzymes, hormones, antioxidants, carbohydrates, and minerals (Kieliszek et al., 2018). Nowadays, bee bread is very popular in the commercial market due to its high nutritional properties. This bread has high antioxidant activity and phenolic content that contribute to its biological and nutritional properties that can be used as beneficial food supplements (Mutsaers et al., 2005). The bee bread is a product with a long history used mainly in folk medicine due to its therapeutic properties. For example, in recent years, numerous studies have been carried out to study the effectiveness of bee bread to treat different illnesses. Bee bread has been exhibited anti-inflammatory, anticancer, antiradical, and antimicrobial activities (Khalifa et al., 2020).

Steamed Bread

Steaming instead of baking is done in some areas for preparation of bread, which is actually a staple food in China. Bread is consumed after steaming in many countries of the East and Southeast Asian regions (Peng and Cheng, 2007). The People's Republic of China grows large quantities of wheat and is a major wheat importer. The wheats that it produce are both hard red (winter and spring) and soft wheat, which are commonly blended to produce basic flours. Hard red spring wheat is used in northern China to produce steamed breads, which are distinctly different in texture from breads produced in southern China from lower protein hard and soft red winter wheat flours (Rubenthaler et al., 1990).

Multigrain Bread

Multigrain bread is made by mixing wheat flour with flours of some legumes, cereals like oats, and some seeds like flaxseeds and sesame seeds. This bread is more nutritious and flavorful than the normal bread. The study conducted found a positive effect of this multigrain on the dough properties and the quality of bread. Multigrain bread with a 15% multigrain mix proved to be effective in increasing protein, fat, and dietary fiber contents of bread (Indrani et al., 2010). There are enough products in the market that can be claimed as gluten-free and can be safely digested by patients affected by celiac disease. Sourdough is a type of foremost fermentation that is commercially used for baking purposes of gluten-free bread. It has also been proven to be ideal for improving the texture, aroma, palatability, shelf-life, and nutritional enhancement in the case of wheat and rye bread. The concept of sourdough in gluten-free baking industry is a new zone of the experimental area to improve the quality and acceptability of gluten-free bread (Moroni et al., 2009). In addition, the health risk to various celiac diseases has emphasized the focus on gluten-free bread prepared by mixing chestnut, bean flour, and chickpea, with rice flour at different ratios using straight dough bread-making process (Yildrim and Nadeem, 2019). There are challenges even today for optimal formulation when we deal with texture, flavor, and nutrition (Wang et al., 2017). Rye bread is again a variant of ancient bread using rye as a component. A study conducted on rats found that the addition of green tea to rye might help in preventing obesity in rats (Bajerska et al., 2013). High-fiber rye bread was also experimented in menopausal-stage women for insulin secretion and appears to enhance insulin secretion by improving b-cell function (Juntunen et al., 2003). The addition of saffron powder in rye bread showed antidiabetic properties (Bajerska et al., 2013).

CONCLUSION AND FUTURE PERSPECTIVES

After rigorous efforts and interventions by researchers and global food industries, we still have a significant proportion of the chronically undernourished populations in developing countries. Surprisingly, even today, around 80% of the world's growing population is devoid of basic balance diet. The research in food sciences should be directed to focus on the quality of food in addition to the quantity of food that is available to humankind. The application of scientific approaches for the improvement of the baking industry provides the potential solution for resolving the challenges of global food and nutritional security. The fortification of bread dough with more nutritive grains and supplements enhances the quality and digestibility of bread. The recent advancement in bread-making process, namely, addition of enzymes, flours of non-plant origin, antimicrobial supplements, improved yeast strains, tools used in baking, and enhancement of dough rheological properties, have helped to bridge the gap between the nutritional demands and fulfillment to some extent. However, the face of ancient bread changed positively with recent research; there are endless possibilities to explore further. Exploration of novel genotypes with varying wheat proteins suitable for bread making, identification of more stable yeast strains, shelf-life enhancement, attractive color, fiber and flavor enhancement in bread, and development of celiac patient-friendly products are the issues that should be considered in future research. It will undoubtedly give rise to new avenues for food and nutrition research, and such advances will allow the development of better end-products from wheat, which can be utilized to reduce global hunger.

AUTHOR CONTRIBUTIONS

SGr, MS, and SGo: literature survey. SGo, AR, and SW: first draft. SGr, MS, and SW: review and editing. All authors finalized the manuscript before submission.

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