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Review Article

Impact of Bread Wheat Milling Process on Wheat-Based Food Product Qualities

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Abstract: The grain physical, milling process, and technological characteristics of bread wheat are very crucial for the end-use quality of bread. Nowadays, there is an increasing demand among consumers for bread that contains not only traditional nutrients but also provides other compounds that are beneficial to health and well-being. This review was mainly focused on the impact of the wheat milling process on the quality of wheat-based food products. According to some literature reviews, it was indicated that wheat flour particle size is the major thing that can affect the sensory attributes, nutritional value, and functional properties of wheat-based food products. Four Particles size and wheat milling process steps such as cleaning, and tempering were indicated as factors affecting the color, texture, and acceptance of food products. In this review, there was also found a gap in considering the impact of the wheat milling process, and particle size. In the future research area, the researcher should include the effect of the milling process and particle size during new food product development, standardization of Ethiopian traditional food products, food process, and ingredients optimization, and blending of different proportions of cereals to attain better cereals based food products. Therefore, working on wheat milling process including other agronomic and disease resistance activities is very important.

Keywords: Wheat, Milling, Quality, Particle Size, Bread

1. Introduction

Wheat (*Triticum* species) is one of the major cereals grown covering most parts of the world. There are several species of wheat, but Triticum aestivum (bread wheat) and Triticum durum (durum wheat) is the most cultivated [33]. Wheat is fundamental to human civilization and has played an outstanding role in feeding a hungry world and improving global food security. The crop contributes about 20% of the total dietary calories and proteins worldwide [26]. (Different wheat varieties have different characteristics that are more or less suited to different types of food and processing. It is *consumed* worldwide after milling it into flour, primarily in the form of breads, and is a major source of nutrients [8].

It is one of the world's most important staple food crops and the most important crop among the cereals by area planted and is followed in importance by corn, barley and sorghum. The grains available for the production of flour, wheat is unique in its properties. It is the only cereal grain with sufficient gluten content to make a typical loaf of bread without being mixed with other grains. The wheat kernel parts, bran, germ and endosperm, were differ in relative toughness and friability, giving different breakage patterns on roller milling [29]. Wheat flour is the most important ingredient in home baking and is the framework for almost every commercially baked product and pasta. Most wheat is consumed in the form of baked goods, mainly bread.

Ethiopia is the largest wheat producer in sub-Saharan Africa [19]. It is also third in productivity (after maize and sorghum) among cereals [6]. It is one of the most important crops grown and consumed in Ethiopia both in terms of total production (2.85 million MT in 2010/11) [19] and the proportion of total calories consumed in the country (19.6% of calories consumed) [24].

The different wheat varieties are grown for special purposes

or end use products. The wheat varieties developed are general purpose and put to all uses i.e. bread, confectionery, noodles, and spaghetti, etc. Historical documents confirm that wheat is the earliest field crop used for human food processing. It also became the leading grain used for human consumption due to its nutritive profile and relative ease of harvesting, storing, transporting, and processing as compared to other cereals grains. Durum and hard wheat contain more protein (12–16%) than soft wheat (8–10%) (USDA/NASS, 2001). Wheat flour producing by a combination of roll milling and sieving processes. Many varieties of wheat and many processing procedures are necessary in order to produce commercial wheat flour for various uses [30]. These processes include cleaning, tempering, and milling Process (including preparation) makes food healthier, safer, for consumers, and more shelf-stable. While the benefits are numerous, processing can also be detrimental, affecting the nutritional quality of foods. Also, milling and extrusion can cause the physical removal of minerals during processing. The nutritional quality of minerals in food depends on their quantity as well as their bioavailability. Concentrations of these constituents mentioned above are altered by various processing methods including milling process, fermentation, germination (sprouting), extrusion, and thermal processing. Vitamins, especially ascorbic acid, thiamine, and folic acid, are highly sensitive to the same processing methods. The Current literature indicated that most of the wheat is end-use qualities are affected on the milling process of whole wheat. so, process improvemnts and baking quality of bread-making quality studies are very important.

The sensory qualities of bread are affected by wheat variety composition, method of milling, storage conditions, rheological properties, kneading techniques, baking method and temperature [27]. Wheat flour milling is a grinding process which gives different fractions of wheat flour which affect the quality of bakery products [25]. During wheat milling a portion of the starch granules sustains mechanical damage, the level of which depends on wheat hardness and milling technique. Millers are of the opinion that granulation is very important in the production of quality flour.

1) General objectives

To review the impact of bread wheat milling process on quality of wheat based food products.

2) Specific objectives

a) To review the impact of wheat milling process and particles size on bread quality attributes.
b) To understand the all picture of the milling process impact on quality of wheat based food products and critical points to be emphasized in the future research ideas.
c) To find the research articles done so far on effect of wheat milling process and particles size on pasta and bread quality acceptance and appreciation for that work.
d) To recommend the gap related to impact of the milling process found during review paper to be done in the future research area.

2. Methodology

This review was done through reading and evaluating different research articles that have been published and have relevance to the seminar topic selected which were very related to the impact of the wheat milling process on end-use product qualities. This process was conducted by searching and reading different journals and Google oebsites.

3. Literature Review

3.1. Wheat Varieties

There are several different species of wheat, but *Triticum aestivum* (common or bread wheat) and *Triticum durum* (durum or macaroni wheat) are the most cultivated wheat varieties [33]. Different wheat varieties have different characteristics that are more or less suited to different types of foodfoodducts. The granulation properties for a large variety of wheat powders were obtained from different wheat grain species (durum wheat or common wheat) by different milling conditions [18].

Durum wheat has been found suitable for the manufacturing of pasta production [33]. Wheat belongs to the genus *Triticum*. The present-day bread wheat is a hexaploid wheat species called *Triticum aestivum* and they are a result of evolution (crossing and selection) from the original wwild-typecultivar which was a diploid species [2]. *Triticum aestivum* is known to be the most suitable species for bread-making. The quality of bread is normally defined on the basis of its volume, color, texture, and flavor of bread [23].

3.2. Bread Wheat

Bread wheat is described as ‘hard’ or ‘soft’ according to its protein content. Hard wheat has more protein, including more gluten, which makes it purposeful to bake bread, while soft wheat has a much lower protein content, which when milled produces ‘cake flour’ for sweet biscuits and cakes. Color, texture, and bread loaf volume, are the major quality parameters of bread produced from bread wheat. According to different articles in this seminar, these quality parameters were affected by wheat milling process including processing effects.

3.3. Durum Wheat

Durum wheat grains have a hard kernel and differ in appearance compared to common wheat by being larger and having a more elongated shape [33]. They also have higher protein content and larger flour particles and the large starch granules are smaller compared to common wheat [14]. The endosperm is hard and yellow which gives the durum pasta its yellowish color. Improvements in durum wheat quality and innovations in milling and the resulting impact on product quality [32].

It is suitable for pasta production due to its high content of yellow pigments and high content of proteins that are favorable when it comes to the cooking quality of pasta [1].

Upon milling of durum, the starchy endosperm is ground into a coarse yellow granular product known as semolina [33]. According to [10] Semolina should have a nice yellow color, enough gluten proteins, few black or brown spots, uniform granulation and a moisture content of 13.5 to 14.5% to obtain the best quality in pasta. Semolina particle size is a key factor in pasta making. Fine semolina gives a higher yield upon milling and is preferred by the pasta industry since it shows a high hydration rate and permits homogeneous hydration, thus facilitating the mixing process [33].

3.4. Wheat Hardness

Wheat grain hardness is an important parameter that is considered while determining milling and baking properties [2] of wheat. Two distinct categories of wheat varieties are based on grain hardness; namely, "hard" grains and "soft" grains. The kernels of hard grains generally have a dark, shiny, vitreous appearance, whereas, soft grain kernels have a more opaque and floury look [22]. Wheat kernel hardness is a major quality characteristic used in classifying wheat cultivars. Differences in endosperm texture among cultivars profoundly affect their milling behavior, the properties of the obtained flour or semolina particles, as well as the quality of products [21].

During the milling process, starch damage is higher in hard wheat and this damage is favorable as it contributes to the soft texture and mouth-feel of the crumb of breads. The crushing of wheat kernels and its consequence on the grinding process can be depends on the wheat kernel hardness [7].

Hard grains are more suited for yeast-leavened bread-making due to their tolerance to fermentation [2]. Starch damage is also known to retard staling of bread [2]. Soft wheat on the other hand, does not undergo extensive starch damage and this property makes it suitable for making products like cakes, biscuits, wafers, etc. Hard wheat grains have higher protein content than soft wheat grains and hard kernels have more resistance to grinding than soft kernels [2]. The hardness of the cookies in terms of compression force showed an increasing trend as damaged starch of the flour fractions increased and wheat flour of particle size greater than 150 μm produced cookies with the best quality [11].

3.5. Nutritional Benefits of Wheat

Whole wheat breads have a higher nutritional value than refined breads. Dietary guidelines recommend the consumption of whole grains as a preventative measure to reduce risk of some common chronic diseases [28]. Whole-grain foods are a rich source of fiber whereas white breads have low fiber content due to processing of the wheat grain during milling. High-fiber diets have been associated with several possible health benefits like reducing risk of diabetes, coronary heart disease, improved insulin sensitivity, obesity, etc. [17]. Numerous epidemiological studies have investigated the potential health benefits of consuming more wholegrain foods. However, in Europe, most wheat-based food products are made with refined endosperm from which the germ and peripheral layers (bran) are excluded, although these tissues have considerable nutritional potential and contain most of the micronutrients, phytochemicals, and fiber of the grain [13].

3.6. Wheat Milling and Its Impact

Wheat Millers want uniformity and consistency in order to meet flour or semolina specifications demanded by their customers. The research findings reported by [4] indicated that particle size influences the functionality of the gluten network. Type of crushing and the size of the particles have an impact on the final concentration of some nutrients of the flours obtained [5]. The SRC test revealed that the water absorption increased from 77.43% to 85.76%, with decrease in particle size. The (protein weakening) values were correlated with the values for water absorption in the SRC and wet gluten test, respectively. Whole grain flours are produced by a variety of techniques and result in flours with widely different particle sizes and functionalities [16] Wheat Flour is produced by separating the endosperm from the other components of the wheat kernel and reducing it to a fine powder. Protein quantity and baking characteristics are important considerations in selecting wheat for bread flours milling. Milling is one of many food processes used for size reduction.

The influences of the durum wheat milling process (pre-cleaning, cleaning, hulling, different fineness milling steps) and its contamination distributed in the different products and byproducts (bran, shorts, flour, semolina, and pasta) have different physic-chemical contents [3].

According to Heshe. G et al 2015 study, the milling process indicated that at a low extraction rate (68%), the protein, fat, fiber, ash, iron, zinc, phosphorous, and antioxidant contents of the samples significantly decreased by milling process [15]. Some literature review indicated that, on whole wheat is scarce on the milling process of whole wheat, process improvements, and baking quality studies. However, some general work has been done around support areas of this reviewed topic. Three general areas of research have been identified: whole grain nutrition and its importance in today's dietary guidelines and baking quality. These areas support the general knowledge and understanding of milling, nutrition, and baking bread for better nutrition and consumers' acceptability. According to [25] report, wheat flour milling is a grinding process which gives different fractions of wheat flour which affect the quality of bakery products. Other study suggested that flour particle size, damaged starch and protein quality and quantity have adverse effects on the baked products [12]. The combination and sequence of operations determines the nature of the final product [9].

Therefore, working on wheat particle size and impact on baking quality, and other wheat based food products viable solutions to improve wheat flour functionality. It is believed that this additional information would provide direction for the wheat milling industry, wheat breeding programs, and baking industry.

The milling process of wheat indicated as follow process flow chart.

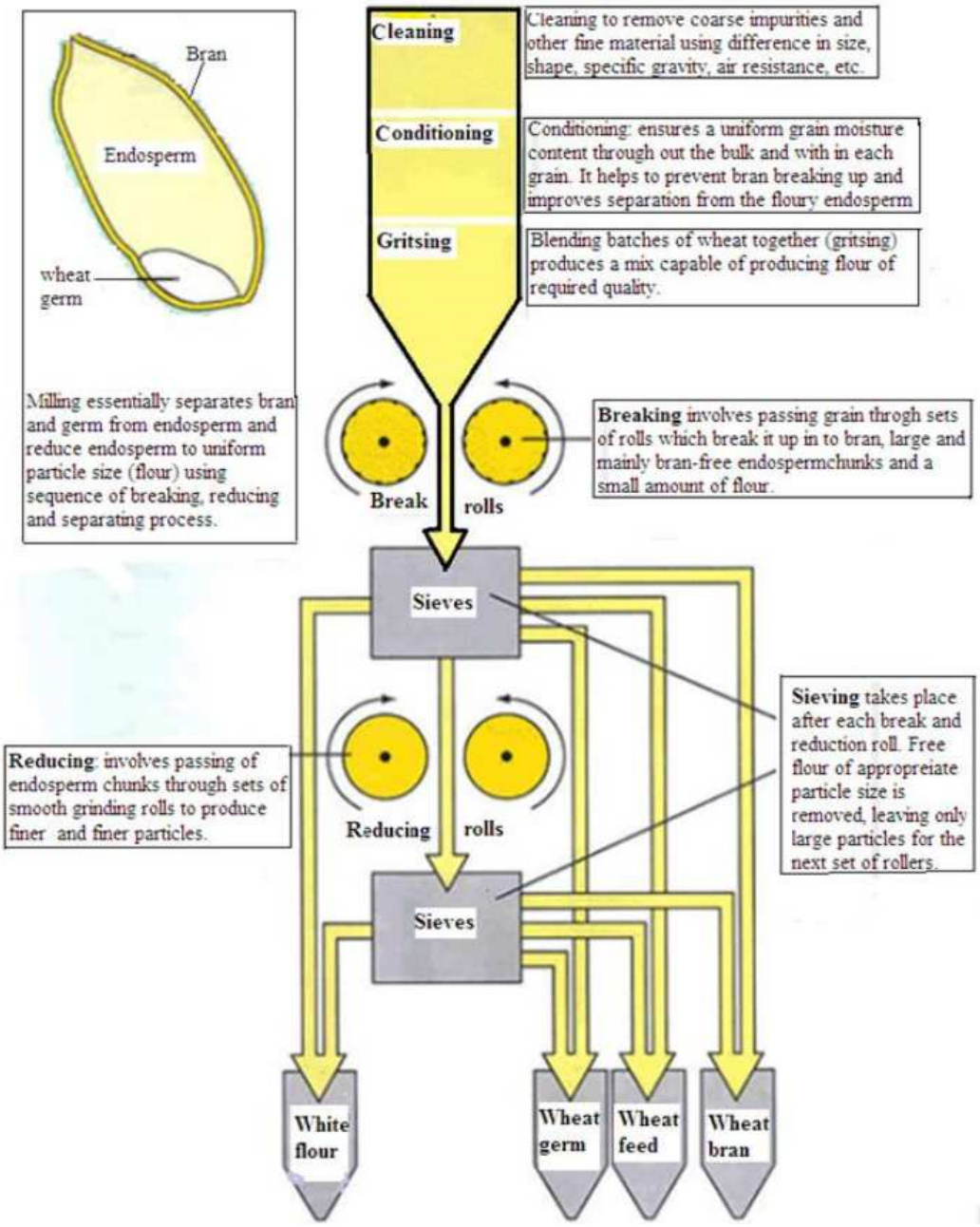

Figure 1. *Process steps in wheat milling. Source: School of Biological Sciences, University of Bristol, England (2007).*

The physicochemical and particles size indicated in the below table.

Table 1. *Physico-chemical analysis of flour fractions of wheat varieties.*

Flour fractions	Moisture (%)	Wet gluten (%)	Dry gluten (%)	Damaged starch (%)	Falling No.(s)
Wheat variety 'WH542'					
Control	11.3 ± 0.05	24.7 ± 0.22	7.9 ± 0.05	11.1 ± 0.08	572.1 ± 4.01
>150µm	11.2 ± 0.05	24.7 ± 0.42	7.9 ± 0.05	5.4 ± 0.04	590.3 ± 3.51
100-150µm	11.4 ± 0.06	24.9 ± 0.19	7.9 ± 0.07	10.5 ± 0.11	606.3 ± 4.04
<100µm	11.6 ± 0.05	25.1 ± 0.22	8 ± 0.05	14.8 ± 0.11	525.6 ± 3.07
Wheat variety'C 306'					
Control	11.1 ± 0.03	28.5 ± 0.07	9.1± 0.04	9.3 ±0.06	654.1 ± 4.38
>150µm	11.7 ± 0.02	28.1± 0.08	9.1± 0.08	5.1 ± 0.09	648.4 ± 2.64
100-150µm	11.1 ± 0.03	28.3± 0.09	9.2± 0.07	9.1 ± 0.03	658.7 ± 3.54
<100µm	11.1 ±0.04	28.7 ± 0.08	9.2± 0.05	12.6 ± 0.03	600.3 ± 3.03

Source (Food Sci Techno (July 2014) 51 (7): 1342–1348).

According to this report, milling is the critical process that affects the concentrations of nutrients in wheat-derived food products. White flour with an extraction rate 68% meaning up to 32% of the original grain is not in the flour. Whole grain flour includes all parts of the seed and is 100% extracted. As [31] report indicated starch is the major component in most cereal grains, milling process inevitably affects starch component and it simplified the complex structure of starch in grains by grouping them in six stratified levels. The damage to the starch granules extends further to disruption of starch crystalline structure (level 3 structure) and degradation of starch molecules (levels 1 and 2) [17]. The effect of the wheat pearling prior to milling was investigated and the results showed that pearling affects flour quality characteristics [20].

4. Conclusion

The objective of this review was to examine how milling process and particle sizes of wheat flour in bread and pasta or what based food products influenced the quality of end-use. In this review, the milling process indicated the influence of milling steps particle size, damaged starch content on the quality of both bread and durum wheat flour, and also the relationships of the particle size with damaged starch, functional properties, nutritional contentsand sensory qualities attributes. It was found that the damaged starch level was increased as the flour particle size decreased. From this review, it was concluded that the wheat milling process, particles size of flour have greater impact on end-use quality of wheat based products including nutrients contents. This review highly suggests that milling process have an impact on the sensory quality attributes and functional properties, nutrient composition of wheat based food products.

5. Recommendation

The milling process is a critical process which can affect the end –use quality of cereals grain based food products and particle size also the main thing to maintain the quality attributes of wheat-based products. From this review, it recommended that during wheat-based food products milling process effect quality and the gap is also found because some grain hard to mill. In the future research area, the researcher should include the impact of the milling process during:

1) New food product development.
2) Standardization of Ethiopian traditional food processing.
3) Food process optimization and ingredient optimization.
4) Blending of cereals for food product development.
5) Fortification and supplementation wheat flour or any other cereals based food products.

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