HEALTH BENEFIT OF ANCIENT WHEAT BASED BAKERY PRODUCTS COMPARED TO MODERN WHEAT BASED ONES

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Abstract: *The development of bakery industry and the increased demands of consumers for products with anti-inflammatory effects transform ancient grains into valuable alternatives to modern wheat species. The aim of the study was to emphasis the differences in terms of nutritional benefits and technological properties between ancient and modern wheat and their influence on quality caharacteristics of bakery product. Ancient, and modern wheat varieties have a similar gluten content, but with different physiological responses. Ancient wheat varieties present different anti-inflammatory and antioxidant proprieties with respect to modern ones. Modern wheat are much more frequently subjected to strong industrial processes, while ancient species are often processed by using more traditional methods. The bakery products from ancient wheat are leavened using traditional yeasts or the sourdough, very rich in lactobacilli capable of degrading the inflammatory components of the wheat proteins.*

Key words*: ancient wheat, modern wheat, bakery product, health benefit*

INTRODUCTION

Wheat, one of the most important source of food along history, and have started to be cultivated 10.000 years ago [6]. The term "ancient wheat" lacks a precise definition in the literature but generally encompasses grain types such as einkorn, emmer, spelt, and khorasan wheat [12]. Notably, all these varieties belong to the wheat family and are not gluten-free [20]. The oldest known form is the diploid species einkorn (AA), existing in both wild and cultivated forms. Natural crossbreeding with a related wild grass led to the creation of the single tetraploid, emmer, with four sets of chromosomes (AABB). This encompasses three major forms: wild emmer, cultivated emmer, and modern durum wheat. Khorasan wheat, a minor form, also resulted from crossing wild emmer with a related grass species. The hexaploid, consisting of six sets of chromosomes (AABBDD), originated from the crossing of cultivated emmer with a known wild grass species. Hexaploid wheats have two main forms: spelt-like hulled wheat and bread wheat. Einkorn, emmer, and khorasan wheat, including the variety known as Kamut™, grown today are believed to be descended from wheat types cultivated during the earliest human agriculture [12,13]. The primary wheat of the Roman Empire was emmer, and its modern cultivars are commonly used for biscuits and pasta [9].

Hexaploid wheats lack wild equivalents and resulted from the hybridization of cultivated emmer with a known wild grass species. While these hexaploid wheats are typically free-threshing, spelt wheat, with tightly adhering glumes, likely emerged a few thousand years after the initial wheat domestication. Durum wheats, mainly used for pasta, can also be employed in bread-making, a practice that remains common in the southern regions of Italy [12].

Notable differences exist between ancient and modern wheat species (common wheat and durum wheat), particularly in protein and starch content. Ancient species typically boast higher protein contents [3]. It is probable that, post-domestication, the protein content of wheats decreased due to an increase in starch content [6]. The paper

aims to explore available evidence regarding the potential health benefits of products derived from ancient and modern wheat. This involves considering the genetic and nutritional profiles of wheat species and examining the impact of different fermentation processes used in bakery products.

MATERIALS AND METHODS

The paper is a review on ancient wheat species. In order to carry out the study 30 references have been studied. The bibliographic study conducted in this paper considered scientific aspects related to the composition and benefits of primitive wheat species published in scientific journals and books indexed in the Web of Science and Scopus databases in a time frame between 2002 and 2022. The data were then analysed and presented in a comprehensive manner. The information identified and analysed forms the basis for research to be carried out using analytical methods to develop flour products with reduced gluten-allergenic characteristics.

RESEARCH RESULTS

Nutritional properties of ancient wheat species

Ancient wheat species exhibit higher protein contents, ranging from 16% to 28%, in comparison to modern varieties [4]. Given that gluten content in wheat is roughly proportional to its protein content (constituting 70-75% of the total protein), early farmers initially selected seeds with lower protein and gluten content. Despite the generally elevated protein levels in ancient or heritage cultivars under similar crop conditions, their gluten quality differs significantly, displaying a weaker structure and strength [24,29].

Gluten, present in all wheat grains, can induce coeliac disease in genetically susceptible individuals. Analyses of "ancient" and "modern" wheats reveal a decreasing trend in the protein content of common wheat over time, coupled with an increase in starch content [12]. These findings have implications for celiac disease research, hinting at the potential identification or breeding of wheat species with lower or absent harmful gluten proteins [23].

In conventional breeding, continuous interest is evident in selecting heat-tolerant wheat species, focusing on dietary fiber, protein quality, and polyphenolic contents [24]. Significant variability among wheat species in antioxidant composition opens up opportunities for developing functional foods in the food industry [11].

Concerning macro- and micronutrient composition, no significant differences have been reported between "ancient" and "modern" wheats. Conversely, secondary metabolites and polyphenols appear more abundant and diverse in older cultivars. Studies on micronutrients suggest potential differences, particularly in mineral content, favoring ancient wheats [13].

While total phenolic content remains relatively consistent among wheat species, substantial differences in total ferulic acid and carotenoid content exist, with carotenoids exhibiting notable variations in lutein, zeaxanthin, and beta-cryptoxanthin [2,16,17].

Einkorn boasts the highest levels of all-trans-lutein, averaging 7.41 μg/g. Additionally, it contains small amounts of all-trans-zeaxanthin, cis-lutein isomers, and β-carotene. Comparatively, durum, kamut, and khorasan exhibit intermediate levels of lutein (5.41−5.77 μg/g), while common wheat has the lowest content (2.01−2.11 μg/g) [2].

Moreover, einkorn presents dietary advantages over polyploid wheats, being low in dietary fiber but rich in proteins, lipids (mostly unsaturated fatty acids), fructans, and trace elements (including zinc and iron). Its concentration of various antioxidant compounds contributes to limiting antioxidant degradation during food processing, providing high-quality nutritional properties for the flour, superior to other wheats [18,25].

The expansion of spelt cultivation hinges on its potential use in various products such as pasta and flakes, with favorable sensory and nutritional properties [1,9]. Spelt wheat and its products could serve as abundant sources of protein and soluble fiber [8]. With increasing consumer interest in health and a growing awareness of the link between diet and well-being, wheat spelt is likely to gain popularity. As the consumption of spelt food products rises, there is a need to assess their nutritional quality in comparison with normal wheat products [1].

Spelt wheat emerges as a promising candidate for producing food products with ample protein and soluble fiber content [30].

Einkorn stands out for having the highest carotenoid levels, contributing to its health-promoting effects [21,22]. Carotenoids, primarily lutein, exhibit an average content of 8.41 μg/g dm, two to four times more than non-einkorn wheats, with some instances reaching a maximum of 13.4 μg/g dm. Einkorn also contains significant amounts of carotenes (above 25% of total carotenoids), often accompanied by high lutein contents. Tocols are present in good levels, averaging 77.96 μg/g dm, surpassing non-einkorn wheats, with a maximum of 115.85 μg/g dm [18].

Health implications of wheat species

The health advantages of whole grains are, in part, attributable to their unique phytochemical composition [2]. However, the commonly underestimated phytochemical contents in grains arise from not considering bound phytochemicals [4]. Whole grain consumption is linked to a decreased risk of chronic diseases, particularly cardiovascular diseases and cancer, primarily due to the distinctive phytochemicals present in grains [5].

Research on gluten immune toxicity predominantly focuses on Celiac disease (CD) and non-celiac wheat sensitivity (NCWS). Celiac disease is a prevalent condition characterized by chronic intestinal inflammation driven by T cells specific to ingested wheat gluten peptides. Treatment involves excluding all gluten proteins from the diet [28]. A diet based on baking-quality gluten from a wheat species expressing little to no T-cell stimulatory gluten peptides demonstrates good tolerance by celiac patients and may be considered beneficial for disease prevention. Distinct differences in intestinal T-cell responses to diploid species have been identified, holding implications for celiac disease by suggesting the potential identification or breeding of wheat species with low or absent harmful gluten proteins [23,26].

Non-celiac wheat sensitivity (NCWS) is induced by gluten ingestion, resulting in intestinal and/or extraintestinal symptoms. It is diagnosed after ruling out celiac disease and wheat allergy. Besides gluten, other components such as amylase trypsin inhibitors (ATIs) and fermentable short-chain carbohydrates (FODMAPs) may trigger symptoms in NCWS subjects. Some studies suggest that ancient diploid wheat species, compared with modern tetraploid and hexaploid wheats, might exhibit lower immunogenicity for NCWS subjects [28].

Research on the glycemic effects of whole and ancient cereals indicates that consuming whole cereals can improve their glycemic impact, reducing the risk of type 2 diabetes. For instance, the consumption of whole modern wheat provided modest benefits in the development and progression of type 2 diabetes in rats, whereas the introduction of whole wheat made from emmer and einkorn led to a downregulation of key regulatory genes in glucose metabolism, resulting in a significant reduction in insulin levels in rats. Complete substitution of modern wheat with heritage Khorasan wheat reduced fasting glucose and insulin levels in both healthy subjects and those at high cardiovascular risk [29].

While ancient, heritage, and modern wheat varieties may seem nutritionally similar, sharing a comparable gluten content but with different physiological responses, ancient and

heritage wheat varieties exhibit distinct anti-inflammatory and antioxidant properties compared to modern ones. It is reasonable to assume that the health properties attributed to older species make them suitable for the food industry, garnering increasing consumer appreciation [Abdel-Aal]. A notable difference between products based on modern wheats and those on ancient or heritage ones is that modern wheat products often undergo rigorous industrial processes, whereas ancient and heritage cultivars are typically processed using more traditional methods [9].

Indeed, products derived from ancient varieties have shown a significant reduction in total cholesterol, low-density lipoprotein (LDL)-cholesterol, and blood glucose, while no significant differences were reported during phases with modern varieties. Additionally, a significant increase in circulating endothelial progenitor cells was observed after consuming products made from the ancient "Verna" variety. Dietary consumption of bread from ancient grain varieties proved effective in reducing cardiovascular risk factors [27]. Although recent findings suggest that ancient grains may provide cardiovascular benefits and reduce inflammation, thus lowering the risk of inflammation-related diseases such as irritable bowel disease, research on einkorn is still relatively underdeveloped [12,19].

Technological properties of wheat species

The consumption of whole ancient grains is considered nutritionally important, but the positive effects are not completely known. Only with the development of yeast-fermented (leavened) bread baking the grains with higher protein content have started to be selected, due to the fact that leavened bread requires a relatively high gluten content: 10–11% of protein content is considered minimal for bread making. It is possible that this selection also increased the gluten strength of wheat, measured with the modern W index [28].

Furthermore, the utilization of sourdough fermentation appears to preserve carotenoids in the final product, even with the extended processing time. Substantial changes in the phenolic acid composition of breads are also evident, specifically a distinct distribution in their forms, displaying a cereal-specific effect. In vitro digestion experiments reveal that sourdough fermentation influences the bioaccessibility of carotenoids, with higher retention in microbially fermented breads compared to yeast-fermented ones, possibly due to the increased solubilization of fibers mediated by lactic acid bacteria. Despite these considerations, the results affirm einkorn as a promising candidate for producing bakery products with enhanced nutritional properties [10, 6].

Sourdough has traditionally served as a leavening agent in bread making [7]. While it continues to be utilized in artisanal baking and for specialty product production, its industrial-scale use remains limited in bakeries. The primary goal of incorporating sourdough at an industrial level is to enhance bread quality and replace additives [15]. When used in optimized proportions, sourdough can improve the volume, texture, flavor, and nutritional value of bread. Additionally, it may extend the shelf life by retarding the staling process and protecting the bread from mold and bacterial spoilage [30]. Ancient or heritage cultivars are often stone-milled, and for bread preparation, they are leavened using traditional yeasts or even sourdough, which is rich in lactobacilli capable of effectively degrading one of the inflammatory components of wheat proteins [14,15].

CONCLUSIONS

The paper undertakes a comparative literature review, exploring the distinctions between ancient and modern wheat species concerning their nutritional and technological properties, specifically examining their health implications. The heightened nutritional attributes of primitive wheat varieties stem from their significant concentration of

antioxidants and other health-promoting compounds. Under comparable crop conditions, ancient cultivars exhibit higher protein content, and consequently, a greater gluten content than their modern counterparts. Notably, the gluten quality in ancient wheat species differs significantly from that of modern varieties, featuring a notably weaker structure and strength. The consumption of whole grains is linked to a diminished risk of chronic diseases, such as cardiovascular diseases and cancer, primarily due to the unique phytochemical composition found in ancient wheat grains. The pursuit of innovative developments in functional bakery products based on ancient wheat species necessitates a deep understanding of how formulation and processing methods impact the levels of health-promoting compounds in these grains.

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