SPELT VS COMMON WHEAT: POTENTIAL ADVANTAGES AND BENEFITS

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Abstract
This work gives a brief review of existing studies that compares spelt and modern wheat from various aspects of quality including technological, nutritional, functional and safety performance. Spelt shows acceptable bread-making performances. It can be used for bread, cookie, cracker and pasta manufacture with some adaptations in processing. Regarding nutritional quality, spelt is very similar to wheat and represents richer source of selenium, folates, phytosterols and alkilresorcinols than modern wheats. From the aspect of food safety, spelt shows advantages as being a hulled wheat.

Keywords
spelt, common wheat, advantages, food safety

Introduction
Spelt *(Triticum aestivum ssp.* spelta*)* is a hulled form of bread wheat *(Triticum aestivum)* and belongs to a hexaploid series of the Triticum genome. Spelt is considered a subspecies of the *Triticum aestivum* because of large genetic similarity between them. The only difference is in the hulled character of the spelt grain which is regulated by mutations at solely two genetic loci [1]. Scanning electron micrograph (SEM) of spelt spikelet cross-section showed that spelt wheat has hard hulls clinging tightly to the grain [Fig. 1].

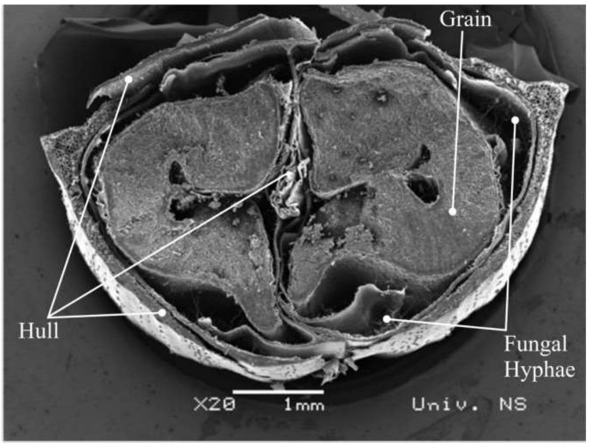

Fig. 1. SEM of spelt spikelet cross-section (× 20 magnification). *Source: [2]*

Spelt belongs to the group of the, so called, ancient wheats [3,4]. Among other ancient wheats, emmer and einkorn, spelt is chronologically the „latest" as hexaploid wheat species appeared thousand years later than the diploid (einkorn) and tetraploid (emmer) wheats. Spelt is a cross between emmer and bread wheat [5].

Ancient wheats have great potential for cultivation under organic, bio-dynamic or low-input farming conditions. The great interest of consumers for ecologically grown food that supports sustainable crop production has led

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to the rediscovery of ancient wheats cultivation. Spelt production has been increased in recent years [6]. Spelt has been readily chosen by organic farmers and has became an alternative crop to common wheat, especially where conventional wheat varieties adapted for organic production are lacking [7]. The suitability of spelt to low-input farming is due to its better adaptation to a wider range of environments [4].

Another reason for the renewed interest for ancient grains is that, unlike modern wheat, they were not subjected to extensive genetic improvements directed towards enhancement of numerous agronomic and technological quality traits such as yield increase, high loaf volume capacity for bread production, high gluten content for pasta production, reduced susceptibilty to diseases and insect attack, increased tolerance to environmental stresses, homogenous maturation, etc. [4,8]. Numerous concerns exist in relation to the undesirable effects of intensive breeding programmes on nutrient composition and allergic potential of modern wheat. There are indications that substantial decline in nutritional and nutraceutical attributes as well as an increase in gluten immunoreactivity of modern wheats may be associated with breeding intervetions. Moreover, clinical studies exert that modern wheats produce higher inflammatory response in patients and healthy subjects and have impaired antioxidant potential in comparison to ancient and heritage wheats [9]. Due to lack of human intervention, the genetic diversity of ancient wheats population is much larger than that of modern wheat. Ancient wheats populations are made of heterogeneous, closely related strains referred to as land races whereas modern wheat consists of homogeneous strains as a result of breeding [8]. Greater diversity of populations of old wheats is related to their better adaptability to harsher growing conditions and poor soils [4] and may be useful in withstanding the stresses caused by ongoing climate changes.

There have been claims that ancient wheats have better nutritional and nutraceutical properties than modern wheats [4]. In addition, ancient wheat grains were anecdotally reported to be better tolerated by consumers suffering from various forms of sensitivities or intolerances to wheat proteins. Many of these claims lack scientific substantiation but some scientific studies supported the existence of differences between modern and old wheats regarding nutritional composition and allergenic potential. On the other hand, there also exist contrasting studies that do not support these conclusions. Controversial results gained increasing attention of researchers that resulted in several detailed studies and critical reviews on the available information regarding the differences between modern and traditional wheats in their composition and health benefits [3,4,8]. Studies that focus on searching for biological markers that may help discerning between organically and conventionally grown wheat may also complement the knowledge regarding the differences between ancient and modern wheats. Moreover, to get a more complete insight into the potential advantages of old wheat grains, it is necessary to consider the role of hull in protecting the grain from harmful environmental influences such as the accumulation of pollutants and mycotoxins.

Economic viability of spelt could be improved by using new innovative technologies aimed at improving the use of waste materials from spelt (straw, chaff) or recovering valuable compounds from them [10, 11]. Cereal husk can be used to replace wood in manufacturing composite materials for automobile, packaging and construction industries [12]. Spelt husk was found to be a suitable alternative filler to replace soft wood in reinforcing composite materials, providing 15% better strength than wood components [12]. Spelt contains more gluten than modern wheat, but its performance in bakery and pasta industry is poor. However, it might have potential for use as an edible coating to prevent oil uptake during deep-frying [13]. As particularly suitable for cultivation in organic farming systems, spelt kernels are suitable for production of sprouts. Pulsed electric field treatment was found efficient in stimulating the growth, increasing the strength and optimizing the nutrient composition (higher content of total phenolics, minerals, free amino acids, carotenoids, chlophylls, soluble proteins) of wheat sprouts [14].

This work attempts to give a brief overview of technological and nutritional characteristics as well safety concerns of spelt wheat compared to modern wheat.

Technological quality of spelt wheat

Although spelt is a bread wheat, its breadmaking potential is inferior in comparison to modern wheat. Many studies showed that spelt doughs are difficult to handle due to noticeable softness, increased adhesivity, low stability to mixing and low oven rise which result in poorly developed bread crumb and low loaf volume [15, 16, 17]. On the other hand, there are positive reports that demonstrated the suitability of spelt in breadmaking [18, 19] and comparable bread quality to that of modern wheat. Lacko-Bartošová and Rédlová [20] noted that

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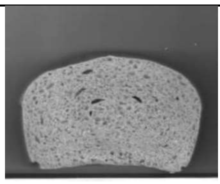
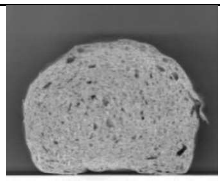
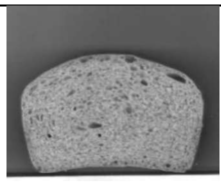
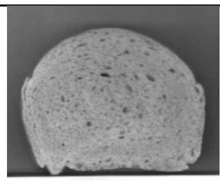
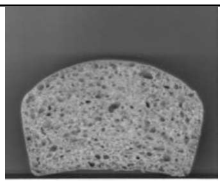
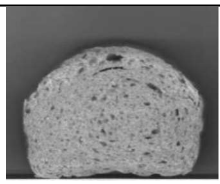
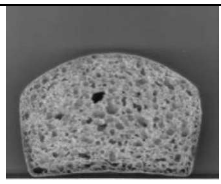
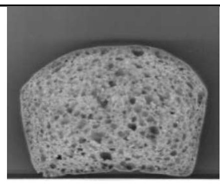
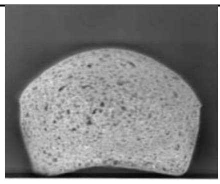
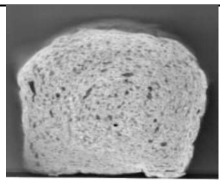
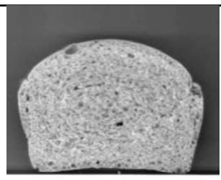
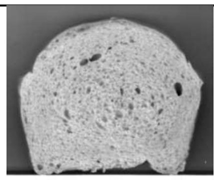
genetically pure spelt varieties have diminished baking potential whereas spelt varieties resulted from inter-breeding with bread wheat have acceptable baking performance. The baking performance of spelt is mainly driven by the quality of gluten proteins [21], but not on the their quantity [22]. In a later work, Schober et al. [21], proposed a classification of spelt wheat into 3 groups: group 1 would be spelt varieties crossed with modern wheat; group 2 would be typical spelt varieties and group 3 would be weak spelts unsuitable for food applications. The bread-making performance of spelt wheat can be improved by the use of additives suitable for organic products (ascorbic and citric acid, xylanase) (Table 1) [22].

Table 1. Effect of improvers on crumb structure of spelt breads. *Source: [22]*

Spelt genotype	Improver treatment			
	Control	**TG**	**GOx**	**ASC**
Genotype 1				
Genotype 2				
Genotype 3				

TG, transglutaminase (dose 1.5 U/g flour); GOx, glucose oxidase (0.1 g/kg flour); ASC, acorbic acid (0.2 g/kg flour).

In the study on the breadmaking properties of dominant spelt varieties in Serbia, it was demonstrated that, among all tested improvers (ascorbic acid, glucose oxidase and transglutaminase) they showed the highest response towards ascorbic acid. The same study confirmed that the spelt varieties with better genetic potential for breadmaking had higher response to the action of improvers. To sum up, some adaptations in the bread-making process are necessary when using spelt: higher doses of ascorbic acid, shorter mixing time and longer resting times with frequent roundings [23].

Spelt wheat is suitable for other uses, particularly cracker and cookie manufacture because these applications require weaker gluten properties. Spelt showed better cracker-making performance compared to common wheat as it yielded less deformed, soft and thin crackers [24]. Within spelt varieties of different baking potential, better performance was exerted by „stronger“ spelt varieties in comparison to the „weak“ ones as they exhibited higher oven rise and conversely yielded well-developed crumb and flaky cracker structure [24].

<u>Nutritional properties and health benefits of spelt wheat</u>
Spelt has gained an image of „healthier, more natural, less over-bred“ cereal in comparison to modern wheat [21]. Myriad of studies reported that spelt is higher in proteins, lipids (especially Δ^7-avenasterol) and minerals (Mg, P, Fe, Cu, Zn) than conventional wheat [25]. Bonafaccia et al. [26] reported that spelt wheat was higher in soluble fibres and proteins in comparison to standard bread wheat and durum wheat. But, the same authors found that spelt bread contained more rapidly digestible starch that wheat bread. On the other hand, Abdel-Aal and Rabalski [27] reported that wholegrain flours from commercial spelt varieties contained 8-10 times higher

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amounts of resistant starch in comparison to modern wheat. The drawback of the majority of these reports was that they did not account for environmental differences and compared grain samples obtained from different locations and origins, commercial samples, samples with no indication of origin etc. Grain composition is strongly influenced by genotype, environment, their interaction and farming method (organic or inorganic). Therefore, only studies that minimize the impact of environment and compare varieties grown together under same treatments can provide relevant information [4,6]. In this respect, the largest body of data on the composition of ancient and modern wheats grown under the same environmental influences, collected within the frame of the EU HEALTHGRAIN project (2005-2010), allows the comparison of 5 lines of einkorn, emmer and spelt together with 161 modern wheat varieties regarding the content of dietary fibres and phytochemicals (minerals, trace elements, polyphenols, carotenoids, folates, sterols, alkylresorcinols, betaine, choline) [3]. From this dataset, it can be concluded that spelt wheat contained less total fibres, less total phenolic acids, slightly less total tocols, α-tocopherol and ferulic acid but higher content of folates, alkylresorcinols and phytosterols in comparison to modern wheat [4]. It was also shown spelt contained higher concentrations of selenium [28]. Spelt was reported to be the lowest in phytic acid by 40%, compared to modern wheat [29], which is particularly important for the bioavailability of minerals. Bodroža Solarov et al. [30] reported that there were differences in the non-saponifiable lipid fractions in the set of 7 bread wheats and 10 spelts and suggested the adequacy of this parameter as a tool in discerning between common and spelt wheat. Similarly, Righetti et al. [31] found best discrimination between spelt, emmer and einkorn using alkylresorcinols. Brandolini et al. [32] found that bread wheats *(T. aestivum* and *T. aestivum* spp. spelta) contained high amounts of bound phenolic acids in comparison to *T. monococcum* and *T. turgidum*. Ferulic acid was dominant in all tested samples. Phenolic acids were not uniformly distributed in the kernel: they were abundant in bran and germ but rare in the endosperm.
In spite of the general perception of spelt as a healthy cereal, there is little scientific evidence for the definite support of this statement. Dinu et al. [4] presented a review on the health effects of ancient wheat species taking into consideration existing data from in vitro studies, animal models, immune toxicity studies and human studies. In an animal model using diabetic fatty rats [33], the effects of diets based on emmer, einkorn and spelt on the onset of type 2 diabetes mellitus were investigated. Development and progression of diabetes was less pronounced in the group fed by ancient wheat grains as compared to those fed by refined *T. aestivum*. Spelt was reported to significantly improve glycemic index. This contrasts the earlier finding of Marques et al. [34] who observed similar glycaemic profile for spelt and refined wheat bread in healthy subjects. Spelt bread was reported to have high glycaemic index of 93±9 [34]. In a human study conducted on wheat allergy sufferers (Baker's asthma), it was suggested that spelt is potentially hypoallergenic wheat that could be tried in patients with wheat allergies as it produced less allergenic response [35].On the other hand, cytotoxicity of spelt was confirmed in the studies of Vincentini et al. [36, 37] and van der Broeck et al. [38] and was similar to that of *T. aestivum,* therefore it cannot be recommended to coeliac sufferers.

Epidemiological and intervention studies showed that consumption of wholegrain cereals is associated with a range of positive health effects and indigestible dietary fibres were emphasized as major contributors to this effect. Some authors suggest that not only fibres but numerous other bioactive compounds (proteins, microelements, ferulic acid) present in the aleurone layer of bran have their role in health-promoting activities [39]. Spelt was reported to produce similar yields of fine and coarse bran fractions during milling but aleurone layer contained in the spelt bran had higher amounts of lipids and unsaturated fatty acids as well as minerals [40]. The spelt aleurone layer was indicated as a possible marker to discriminate between modern and spelt wheat.

Protective effect of hull in spelt wheat

The presence of hard adherent hull is believed to protect the grain from harmful environmental effects such as accumulation of pollutants and mycotoxins as well as insect damage. Spelt wheat is less prone to fungal infestation owing to higher stalk and hulled kernel [41].
But cultivation under organic conditions without the use of conventional crop protection agents may increase the risk for the occurrence of fungal infestation and consequent mycotoxin accumulation in spelt grains. Data on spelt fungal contamination is not abundant, but lately it has been in the focus of researchers. Moudrý et al. [42] investigated and compared 23 varieties of hulled wheat (emmer, einkorn and spelt) with landraces and modern wheat in organic cultivation and observed that the hull-less whets were less prone to fungal diseases (mildew and brown rust) and accumulated less DON. Krulj et al. [43] reported lower incidence of grain infestation with *Fusarium* spp. and *Alternaria* spp. in spelt than in modern wheat. The majority of studies imply that hull exert a protective role against accumulation of fungal toxins but only to a certain extent. Mankevičiene et al. [44]

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investigated the occurrence of several mycotoxins (DON, ZEA, T-2/HT-2) on organically cultivated spelt and common wheat. It was concluded that hull provided certain protection as the concentration of examined mycotoxin was the lowest in dehulled spelt whereas hulls were highly contaminated with the toxins. Similar conclusion was made by Suchý et al. [45] who examined the accumulation of toxins produced by *Fusarium* spp. and *Alternaria* spp. but it was outlined that the protective effect of hulls is only partial. Protective effect of hulls against fungal contamination and accumulation of Alternaria toxin was inferred in the study of Vučković et al. [46]. Zrcková et al. [47] concluded that hulls represent an important factor of passive resistance against *Fusarium* spp. infection. It seems that tight and hard hulls represent a mechanical barrier to the propagation of fungal hyphae in the spikelet tissue. The authors propose secondary protective mechanism: narrow opening of the flowers of hulled wheat may reduce the entry of fungal spores to flowers. Suchowilska et al. [48] investigated the mycotoxicological profile of einkorn, emmer and spelt after artificial inoculation in the field with *Fusarium culmorum* and concluded that the ability of grains to accumulate toxins is species specific i.e. the wheat species differed in their resistance towards *Fusarium* infestation. Spelt hulls efficiently protect grains from *A. flavus* infestation and their toxicological metabolites [49]. Krulj et al. [2] investigated the effect of storage conditions on accumulation of aflatoxin B1 in spelt grains and observed that water activity was more important factor than storage temperature for toxin accumulation. In addition, husk removal prior storage decreased the toxin accumulation and distribution. Low-temperature plasma is an emerging new technology that was reported to successfully reduce the number of fungal colonies on stored wheat grains and positively affect germination process and initial growth of germinated seeds [50]. Selective heating with radio frequency energy was effective in destroying storage insects (rusty grain beetle) in wheat grains without causing harmful effects commonly induced after thermal treatment [51].

Table 2. Distribution of AFB1 in hulls and dehulled grains of wheat samples. *Source: [2]*

Code	**Variety**	**Samples**	**AFB1 concentration (µg kg^{-1})**		
			Control	***Aspergillus flavus* No. 1**	***Aspergillus flavus* No. 2**
SH	Spelt	Hulls	7.10±0.20^a	648.03±23.07^d	97.34±3.09^c
SDG		Dehulled grains	<LOQ*	256.46±12.81^c	30.68±5.34^b
CWH	Common wheat	Hulls	<LOQ	18.30±0.29^a	4.83±0.33^a
CWDG		Dehulled grains	<LOQ	<LOQ	<LOQ
HWH	Hybrid wheat	Hulls	<LOQ	49.10±1.59^b	109.54±1.82^d
HWDG		Dehulled grains	<LOQ	<LOQ	<LOQ

Impact

Increasing pressure for transition in agricultural practise caused by upcoming climatic changes and growing human population has led to the renewed interest for low-input wheat varieties. Spelt is a hulled subspecies of wheat bread that has been cultivated as a marginal crop on small areas in Europe and north America. It became an interesting alternative to modern wheat due to its good adaptability to different environments and suitability for organic cultivation. It has been evidenced from previous studies [52] that various forms of farming systems (organic, biodynamic) other than conventional have positive ecological impact due to noticeably reduced ecological footprint per product unit. Attempts to introduce and popularise organic crops greatly contribute to increased biodiversity and formation of ecosystems more durable and able to sustain changing environmental conditions. Besides positive environmental impact and high biodiversity, growing organic crops contribute to production of wholesome, naturally nutritious food without the need for industrial fortification and excessive rafination. Part of the results sublimated in this opinion paper has been produced as a result of national project III 46005, funded by the Serbian Ministry of Education of Science and Technological Development over period from 2011 to 2019. In Serbia, spelt cultivation area in this period has increased by 10 times. Also during this period, dozens of new innovative spelt-based products appeared on the Serbian market as the result of research activities carried out within the project.

Conclusions

Data available until today on the composition and health benefits of spelt and other ancient wheats does not allow definite conclusion that these varieties are superior in comparison to the conventional wheat mainly due to lack of adequately designed comparative and clinical studies. Nevertheless, available information is positive and demonstrate that spelt is a richer source of some bioactive compounds (selenium, folates, phytosterols and alkylresorcinols). From agronomic and food safety point of view, advantages of spelt over modern wheats are related to the ability of spelt to grow in unfavourable weather conditions without high-input and the protective effect of hull against accumulation of fungal toxins. Disadvantages of spelt are low yields, more complicated processing due to dehulling step and somewheat lower bread-making performance in comparison to that of modern wheats.

Conflict of Interest
There are no conflicts to declare.

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