



Research Article

**CONSUMER OPINIONS ON THE GASTRONOMIC PRODUCTS PRODUCED WITH  
ANATOLIA'S WHEAT HERITAGE IZA**

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**Özet**

Artan insan nüfusunun ileride yiyecek kıtlığına neden olacağı düşünülmektedir. Bu nedenle en çok tüketilen ürün olan buğdayın önemi de artacaktır. Günümüzde modern buğdaylar soframızda daha çok yer almasına rağmen atasal buğdayların önemi giderek artmaktadır. Bu buğdayların besin değerinin yüksek olması organik besin ile beslenen insanların daha çok dikkatini çekmektedir. Atasal buğdaylardan biri olan *Triticum monococcum* ssp. *monococcum* (einkorn, cv IZA) da bunlar arasında yerini yavaşça almaktadır. Besin içeriğinde B ve E vitamini diğer buğdaylara oranla daha fazla olması ve antioksidan özellik taşıması nedeniyle önemli tüketim ürünleri arasında yer almaktadır. Antioksidan aktivitesi nedeniyle einkorn, kardiyovasküler hastalıklar, tip 2 diyabet, bazı kanser türleri ve yaşa bağlı hastalık riskini azaltmaktadır. Glütten içeriğinin az olması halk arasında ekmeğe uygun olmadığı düşüncesini geliştirmiş olsa da yapılan çalışmalarda bunun doğru olmadığı ortaya çıkmıştır. Hatta ekşi maya ile yapılan IZA ekmeği ürünleri tadının güzel olması nedeniyle tüketiciler tarafından çok beğenilmiştir. Böcek ilacı kullanılmadan yetişebilen, tuz ve kuraklığa karşı dayanıklı olan bu bitki çiftçiler tarafından da beğeni almaktadır. Ancak günümüzde *Triticum monococcum* ssp. *monococcum* tüketimi sadece yerel halk tarafından tanınmaktadır. Bu nedenle yerel tanımından çok küresel tanımına önem verilmesi gerekmektedir. Bu çalışmada IZA buğdayının yerel Seben ilinde başlayan macerası ve halka tanıtımına yer verilmektedir. Dahası, IZA buğdayının içeriği hakkında bilgi verilmekte olup dayanıklılığı hakkında çalışmalar da bulunmaktadır. Son olarak ekmeğe dışında yapılan ürünlerin duyu analizi anketine yer verilmiştir. Ankete elli kişi katılmıştır. Köy Çorbası, Köy Ekmeği, Kısır, Bulgur Plavı, Dört Peynirli Kremalı Makarna, Pesto Soslu Makarna, Domates Soslu Makarna, Trileçe yapıp ankete tabi tutulmuştur. Yemekler tüketiciler tarafından tekstür, koku, çiğnenebilirlik, lezzet ve genel değerlendirme adı altında değerlendirilmiştir. Çalışmada çok kötü (1) ile mükemmel (7) arasında değişen bir ölçek uygulanmıştır. Bu çalışma için etik kurul raporuna ihtiyaç duyulmamıştır. Panel performansı, duyu profil verilerinin varyans analizi (ANOVA) ile değerlendirilmiştir. Varyansların homojenliği testi, verilerimizin ANOVA için uygun olduğunu göstermiştir (Sig >0,05). En çok trileçe beğenilirken en az bulgur pliavının beğenildiği görülmüştür.

**Anahtar Kelimeler:** Atasal Buğday, Sağlık, IZA, Siyez, Yerel Çeşit, Duyusal Analiz, Gastronomik Ürün

**Abstract**

The growing human population is thought to cause food shortages in the years to come. Therefore, the importance of wheat, the most consumed product, will also increase. Although modern wheat is more common on our table today, the importance of ancient wheat has been increasing. The high nutritional value of these kinds of wheat has attracted the attention of people who are eating organic food. *Triticum monococcum* ssp. *monococcum* (einkorn, cv IZA), one of the ancient kinds of wheat, is slowly taking its place among them. It is recognized as one of the most important consumption crops because it contains more vitamin B and vitamin E in its nutritional content than other wheats and has antioxidant properties. Due to its antioxidant activity, einkorn reduces the risk of cardiovascular diseases, type 2 diabetes, some types of cancer and age-related diseases. Although its low gluten content has led people to think that it is not suitable for bread making, studies have shown that this is not true. In fact, IZA bread products made with sourdough have been highly appreciated by consumers due to their good taste. This crop, which can be grown without the use of pesticides and is resistant to salt and drought, is also appreciated by farmers. However, today *Triticum monococcum* ssp. *monococcum* consumption is only known by local people. Therefore, it is necessary to give more importance to its global status rather than its local status. In this study, the adventure of IZA wheat, which started in the province of Seben, and its introduction to the public is presented. Furthermore, it provides information about the content of IZA wheat and there are also studies on its durability. Finally, a survey regarding the sensory analysis of products other than bread has been included. Fifty people participated

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in the survey. Village Soup, Village Bread, Kısır, Bulgur Pilaf, Pasta with Four Cheese Cream, Pasta with Pesto Sauce, Pasta with Tomato Sauce, Trileçe were made and surveyed. The dishes were assessed by the consumers under the categories of texture, smell, chewiness, flavor and overall evaluation. A scale ranging from very poor (1) to excellent (7) was applied in the study. Ethics committee report was not needed for this study. Panel performance and sensory profile data were evaluated by analysis of variance (ANOVA). Variances homogeneity test showed that our data were suitable for ANOVA (Sig > 0.05). It was observed that trileçe was favored the most and bulgur pilaf the least.

**Anahtar Kelimeler:** Ancient Grain, Health, IZA, Einkorn, Landrace, Sensory Analysis, Gastronomic Product

## Introduction

Although agriculture started in a small region around Southeastern Turkey, western Iran, and Levant around 9,500-8,500 BC, it quickly spread in the area in all directions. Wheat (*Triticum* ssp), barley, and lentil, which were the first crops cultivated between 9,000 and 3,500 BC, are still consumed in the world and provide 90% of daily calories. As the first domesticated plant, wheat has become the most important ring in human food since the domestication of the goat in 9,000 BC. It was a plant grown only in the Middle East 10,000 years ago, but then it spread all over the world in a couple of thousand years. Wheat was not grown in those days in North America but now is grown on thousand square kilometers. This surely demonstrates the adaptive ability of wheat to grow on larger acreages (Harari, 2015).

Einkorn, the first-primary cereal crop that originated in and spread around Turkey, has been cultivated in Morocco, Germany, Switzerland, Spain, Italy, and some other Balkan countries. Around 10,000 BC, diploid (AA) einkorn (*Triticum monococcum* ssp. *monococcum*) was cultivated in earlier agricultural villages (Stallknecht et al., 1996). The decrease in the cultivation of einkorn after the Bronze Age was due to barley, emmer (*Triticum dicoccon*), and spelt (*Triticum aestivum* subsp. *spelta*) cultivation. Tetraploid emmer (AABB) was a major cultivated wheat species in the Neolithic and Bronze Ages. The decline in einkorn cultivation has been because of higher yields of emmer and spelt, and their easier harvest (Hammed and Simsek, 2014; Marino et al., 2009).

Organic foods have recently received an accelerated interest from the larger human community. There is no need to use fertilizers and pesticides to grow hulled kinds of wheat such as einkorn. Moreover, einkorn is considered to be genetically unaltered by man (Hammed and Simsek, 2014). Therefore, these naturally grown wheat species have attracted the attention of organic food consumers.

Çankırı, Çorum, Sinop, Kayseri, Kayseri, Kastamonu, Bolu, Bilecik and to some extent Kütahya provinces have been historical einkorn cultivation areas in Türkiye. The locals have called the einkorn by different local names; the people of Bolu, Bilecik and Kütahya call it "IZA", while in the other cities it is called "Siyez". IZA, which is grown in Seben, a district of Bolu, has regained popularity across Turkey (Figure 1).



**Figure 1.** IZA (*Triticum monococcum* ssp. *monococcum*)

## Conceptual Framework

This study includes the mineral and chemical contents of IZA wheat which are beneficial for human health. It also contains information about the resistance of IZA wheat to environmental stress. People think that it is not possible to make bread with IZA due to the low gluten content of it. This study has eliminated these prejudices by showing how to make bread, cookies, and several dishes. At the end of this article, there is a sensory analysis survey that includes the opinions of people about the foods that were prepared with IZA.

### *IZA and Seben (Bolu)*

It is known that IZA wheat yields less crops than bread and durum wheat. Moreover, having limited IZA plantation area prevents its wider recognition throughout Turkey. However, IZA has been well known by the local people, especially in Seben (Bolu). IZA, which is mostly grown in Seben (Bolu) today, has generally been consumed as bulgur and animal food for years. IZA was often sold by farmers to their acquaintances (Yaman, 2018). Due to its regional popularity and health values, it has been cultivated in relatively large areas. Since IZA is considered to be a symbol that is about to disappear in the region, a geographical indication (GIS) protocol was signed between Bolu Abant İzzet Baysal University (BAIBU) and Bolu Municipality on February 2, 2018 (Göder, 2018). Seben and Bolu Municipalities distributed IZA seeds to encourage the farmers in Seben, Gerece, Göynük, and Mudurnu to cultivate IZA.

Bolu Municipality signed a contract with the farmers who live in Seben, Mudurnu, and Göynük provinces and increased the cultivation area of IZA between the years of 2017-2021. Bolu municipality wanted to encourage the farmers to grow wheat. Therefore; IZA seeds were distributed to the farmers and the municipality gave a guarantee to re-buy the harvest an acceptable guaranteed price – twice as much as the first-class durum wheat top price. This was an important factor for the farmers to plant. The peeling of IZA is a very difficult process for farmers. For this reason, IZA wheat is purchased in hulls by the municipality and separated from the hulls before making bulgur.

As a result of these efforts, producers expanded their cultivation areas due to the increasing prices of IZA products and seeds. As the increase in the selling price increases the income of farmers, it is projected that cultivation may expand to a wider area in the following years and production may increase accordingly (Table 1). However, there was a decline in IZA cultivation in 2022. There were several different reasons for the decline in wheat cultivation in 2022. One of these reasons was the increase in oil prices due to Covid-19.

**Table 1.** The increase in IZA cultivation areas between 2017-2019

Years	Planted Field (m <sup>2</sup> )	Amount of Seeds which are Sown (kg)	Harvest (kg)	Seed Price (₺)
2017-2018	73000	1095	14550	2.00
2018-2019	610000	9286	110378	3.00
2019-2020	847000	12705	198981	3.60
2020-2021	1668000	29020	118088	3.60
2021-2022	711000	14220	nt	8.00

\*₺: Turkish Lira

\* nht: not harvested yet

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### *The health benefits of IZA*

Thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5), pyridoxine (B6), biotin (B7), and folates (B9) of B vitamins are found in wheat (Pehlivan Karakas et al., 2021). These vitamins are important, as they take a part in carbohydrate (thiamine), fat (riboflavin and pyridoxine), and protein metabolism (K. R. Davis et al., 1981; K. R. Davis et al., 1984; Johnson and Mattern, 1987; Pomeranz, 1988, 1992). There are significant differences in B vitamin concentrations due to variety, soil type, growing location, and year (Pomeranz, 1988). Einkorn has B1, B2, B3, B5, B6, B7, and B9 vitamins, thiamin, riboflavin, and pyridoxine in higher concentrations than emmer, spelt, and common wheat (Abdel-Aal et al., 1995; Hammed and Simsek, 2014). These vitamins are very vital for human health. Thiamine, for example, is very essential to maintain the blood level and takes place in energy production. The deficiency of thiamine leads to Beriberi disease (Martel and Franklin, 2019). Riboflavin is, as well, important for reducing the risk of cardiovascular disease, anemia, nerve

degeneration, and skin lesion (Thakur et al., 2016). Moreover, pyridoxine takes place in carbohydrate, amino acid, and lipid metabolisms. Besides these, fetal brain development depends on pyridoxine as well (Brown and Beier, 2018). That is why; selecting wheat species or cultivars with a higher concentration of water-soluble B complex vitamins, may lead to a healthier life.

The radical scavenging in antioxidants decreases the damage and mutagenesis in cells. They also, reduce the risk of cardiovascular diseases, type 2 diabetes, some types of cancer, and age-related diseases (Serpen et al., 2008). Antioxidants such as phenolic acids, carotenoids, tocols, flavonoids, anthocyanins, lignans, and phytosterols exist in wheat (Hidalgo and Brandolini, 2014; Pehlivan Karakas et al., 2022; Ward et al., 2008). Different parts of the kernel such as bran, endosperm, and germ contain different antioxidant capacities, whereas bran has the highest antioxidant properties among those (Liyana-Pathirana and Shahidi, 2007). Some factors such as genetics, processing techniques, and cropping environment affect the concentration of phenolic contents. Moreover, different species of wheat show distinct antioxidant and total polyphenol content (TPC) capacities (Yilmaz et al., 2015). According to Yilmaz et al. (2015), *T. monococcum* ssp. *monococcum* has higher antioxidant activity and TPC than *T. turgidum* ssp. *durum*, *T. aestivum* ssp. *spelta*, and *T. aestivum* ssp. *aestivum*. The research showed that ancient wheat contained higher radical scavenging values than modern wheat was supported by Şahin (2016). Besides, he concluded that the phenolic content of IZA was significantly higher than bread and durum wheat. Especially bound phenolic content was three times higher than the free phenolic content in all wheat species. Bound phenolic acid is important for the reduction of colon cancer and gastrointestinal diseases because the bound form of phenolic acids is the time when they reach the colon after passing through the upper gastrointestinal tract. They are digested with the help of colonic microflora and therefore reduce the risk of colon cancer and gastrointestinal diseases (Liu, 2007). Compared to modern wheat varieties (durum and bread wheat), IZA has been found to have a higher value in terms of phenolic molecules, total flavonoid content, and antioxidant potential (Pehlivan Karakas et al., 2022).

Another antioxidant compound found in einkorn is tocol, which is a lipid-soluble antioxidant. Tocols are divided into two groups; tocopherols, a saturated phytyl group, and tocotrienols, a tri-unsaturated phytyl group. Tocotrienol and tocopherols have four derivatives which are  $\alpha$ -tocopherol,  $\alpha$ -tocotrienol,  $\beta$ -tocopherol,  $\beta$ -tocotrienol,  $\gamma$ -tocopherol,  $\gamma$ -tocotrienol,  $\delta$ -tocopherol, and  $\delta$ -tocotrienol (Hidalgo et al., 2006). Free radicals are reduced with the help of tocopherols and in this way they protect the photosynthetic pathways in plants. Tocopherols save the other tissues as well by preserving polyunsaturated fatty acids from oxidation (Goffman and Böhme, 2001; Yamauchi and Matsushita, 1979). Since tocopherols cannot be synthesized by animals, they take these antioxidant compounds through nutrients (Hidalgo et al., 2006). Despite having the highest vitamin E activity of  $\alpha$ -tocopherol, other tocopherols and tocotrienols have the same or better antioxidant activity. For example, the physiological activity of tocotrienols is better than tocopherol and reduces the risk of cancer and cardiovascular diseases (Theriault et al., 1999).  $\beta$ -tocotrienols have been found to be the main tocol in wheat, which indicate how valuable wheat consumption is for health (Abdel-Aal and Rabalski, 2008; Brandolini et al., 2015; Hidalgo et al., 2006). Şahin (2016) found that IZA has got low  $\alpha$ -tocopherol concentration ( $3.61 \mu\text{g g}^{-1}$ ) than other wheat species such as *T. aestivum* ssp. *aestivum* ( $3.68 \mu\text{g g}^{-1}$ ) and *T. turgidum* ssp. *durum* Desf. ( $4.06 \mu\text{g g}^{-1}$ ). Similar results were found by Hidalgo et al. (2006), the average value of  $\alpha$ -tocopherol of einkorn was lower than the total value of  $\alpha$ -tocopherol of all eight *T. turgidum* and seven *T. aestivum* cultivars. On the other hand,  $\beta$ -tocotrienol was higher in einkorn than other species (Table 2). Like Hidalgo et al. (2006) and Abdel-Aal and Rabalski (2008) found that  $\beta$ -tocotrienol was higher in all groups of wheat, and concluded that einkorn has a higher concentration of  $\beta$ -tocotrienols than *T. turgidum* ssp. *durum*, *T. aestivum* ssp. *spelta* and *T. aestivum* ssp. *aestivum*. So, if Şahin (2016) had looked at the other tocol groups such as  $\beta$ -tocotrienol, he would probably have had the same result as Hidalgo et al. (2006), Abdel-Aal and Rabalski (2008), and probably found  $\beta$ -tocotrienols and total tocol concentration of IZA has more concentration than pasta and bread wheat.

Carotenoids which are highly effective as singlet oxygen scavengers have been detected in wheat, as well (Türkcan and Ökmen, 2012). They are lipid-soluble antioxidants and produced by photosynthetic organisms such as cyanobacteria, photosynthetic bacteria including *Alphaproteobacteria*, algae, high plants, as well as some non-photosynthetic bacteria, yeasts, and fungi (Türkcan and Ökmen, 2012). Carotenoids give yellow and orange color to plant parts such as flowers and fruits. As tocopherols, carotenoids cannot be synthesized by animals and animals take these compounds from nutrients (Türkcan and Ökmen, 2012). Some types of carotenoids, for example,  $\beta$ -carotene and  $\alpha$ -carotene, have provitamin A activity. Carotenoids prevent the risk of some eye-related diseases, cardiovascular diseases, and certain types of cancer (Namitha and Negi, 2010). Among hulled and modern wheat species, carotenoid content has been the highest in einkorn (Giambanelli et al., 2013).

Moreover, with the comparison of modern wheat, einkorn has twice the higher carotenoid content (Giambanelli et al., 2013; Grausgruber et al., 2010). Because of the positive effect of carotenoids on health and the high concentration of einkorn, the consumption of einkorn is very important.

**Table 2.** Carotene and tocol derivatives in wheat species.

Wheat species	$\mu\text{g g}^{-1}$ dry matter								
	Lutein	$\alpha$ -carotenea	$\beta$ -carotenea	Total caroten	$\alpha$ -T	$\alpha$ -T3	$\beta$ -T	$\beta$ -T3	Total tocols
<i>T. monococcum ssp. monococcum</i>	7.69	0.53	0.19	8.41	12.18	12.77	4.79	48.22	77.96
<i>T. turgidum ssp. durum</i>	3.15	n d	0.04	3.19	10.00	4.86	3.92	31.72	50.5
<i>T. turgidum ssp. dicoccum</i>	1.90	n d	n d	1.90	2.21	4.71	5.05	45.83	57.8
<i>T. aestivum ssp. aestivum</i>	1.79	0.06	0.10	1.95	14.10	5.36	7.92	34.09	61.47
<i>T. aestivum ssp. spelta</i>	2.58	0.31	0.09	2.98	15.20	5.83	10.11	37.21	68.35

- N d: Not determined.
- T3: tocotrienol, T: tocopherol

Hidalgo et al., 2006

Cereals contribute to minerals as Italian people take 18% of Zn, 30% of Fe, 35% of Cu and 27% of Mg from wheat in their daily intake (Lombardi-Boccia et al., 2003). Cereals are the primary source of nutrients in developing countries, moreover, they, provide some micro and macro elements via wheat in their diet. The concentration of these micro and macro elements in cereals is low and only when consumed with other nutrients, it meets the daily intake enough (Cakmak, 2002).

Micronutrient deficiency is a hidden hunger, and two billion people suffer from this type of disease (Food and Agriculture Organization of the United Nations (FAO), 2023). While 40% of the world population suffers from a deficiency of Fe, 33% of the population shows a deficiency of Zn. Whereas the deficiency of Fe can cause anemia, the deficiency of Zn can decrease growth, fertility, reproduction, and the immune system (Berg et al., 2002; Gibson, 2006). Due to the low concentration of Zn in soil, the concentration level of Zn is also low in wheat in Turkey as well as in some countries (Cakmak et al., 1999). It is thought that the hidden hunger can be possibly eliminated by improving high mineral varieties and increasing the production of plants that contain high mineral concentrations. One of the modern wheat varieties of *T. aestivum* L. has been consumed by a large population in the World. Although it is consumed in large amounts, *T. aestivum* L. has a low concentration of minerals. Wild varieties are explored, however, to have more potential. These results are supported by Yaman (2018) who studied IZA, an einkorn landrace. IZA has got higher concentration of Zn and Fe than durum (*T. durum*; Kunduru-1149,) and bread wheat (*T. aestivum*; Bezostaja-1), (Yaman, 2018).

The roles of gluten and wheat in our diet have been questioned. The public is suspicious about if gluten and therefore wheat is bad for health. There are two sides to the discussion with two opposite thoughts (Kucek et al., 2015). While gluten-free diet promoters claim that gluten is poison, the commodity groups claim that it is not bad at all (W. Davis, 2011; National Association of Wheat Growers, 2022). Although the causes have not been fully identified, celiac disease has increased 2-4 times in the last 70 years. (Lohi et al., 2007). This increase may have been related to wheat breeding activities in the last 70 years. These wheat varieties can cause more reactive activity (W. Davis, 2011). Each genotype produces different and unique types of gluten since wheat protein-coding regions are polymorphic (Metakovsky et al., 1991; Nakamura et al., 2005; Payne, 1987; Salentijn et al., 2013). After digesting a certain wheat variety, a "reactive profile" can be formed showing the amount and potential of reactive isotopes. The reactivity profile is unique for every patient since they give a distinct defense against gluten (Kucek et al., 2015). Because of that, scientists experiment on the reactivity of different wheat species. There is a belief that immunoreactivity differs in distinct wheat genomes. A brief summary of the genomes of wheat species is important to understand more about gluten expression. Common wheat is haploid and has three genomes ( $2n = 6x = 42$ , AABBDD); on the other hand, ancient wheat of einkorn is diploid and had one genome ( $2n = 2x = 14$ , AA). *T. turgidum* L. subsp. *dicoccum* Schrank, moreover, is tetraploid with A and B genomes ( $2n=4x=28$ , BBAA). There are variations in immune reactivity to the different species of wheat. D genome of the wheat expresses several immunogenic  $\alpha$ - gliadin (Molberg et al., 2005; Spaenij-Dekking et al., 2005; van Herpen et al., 2006). Despite the absence of the D genome in emmer, einkorn, and durum, low reactivity has been seen, as well. Moreover, there is the fewest  $\alpha$ - gliadin encoded from the B genome in wheat (van Herpen et al., 2006). This knowledge is supported by einkorn which expresses fewer celiac epitopes since it only has an A genome. In Pizzuti et al. (2006) experiment, the reduction of enterocytes depends on bread wheat gliadins; on the other hand, there is no effect on enterocytes when patients are exposed to einkorn. There are also, no differences in IFN- $\gamma$  concentration between control and celiac patients after they were exposed to einkorn gliadin (Pizzuti et al., 2006). However, T-cell immunogenic einkorn  $\alpha$ - and  $\gamma$  -gliadin epitopes are still expressed (Molberg et al., 2005; van Herpen et al., 2006). Emmer and durum, in other words, show less immunoreactivity than bread wheat since they have only A and B genomes, therefore they are more reactive than einkorn (Kucek et al., 2015).

When the nutritional quality of ancestral wheat has been re-evaluated, einkorn has shown some dietary advantages compared to polyploid wheat species. Einkorn is rich in protein and some trace elements such as Zn and Fe (Table 3). It is also rich in lipids (mostly unsaturated fatty acids) and fructans. Higher concentrations of carotenoids, tocopherols, phytosterols, alkylresorcinols, and conjugated polyphenols give antioxidant abilities to einkorn. On the other hand, it has low  $\beta$  - amylase and lipoxygenase activities. When we see that they reduce antioxidant activity, their low activity of them is beneficial for health (Hidalgo and Brandolini, 2014). Proteins, carbohydrates, lipids, and minerals are mostly seen in wheat grains (Table 3).

**Table 3.** Nutritional contents of IZA, spelt and common wheat.

Contents	IZA	Spelt	Common Wheat
Digestible carbohydrate (%)	57.23	65.90	73.00
Starch (%)	56.24	63.84	62.40
Protein (%)	18.20	17.90	14.82
Lipid (%)	3.50	2.39	2.80
Ash (%)	2.30	2.10	1.83
Phosphorus (g kg <sup>-1</sup> )	5.20	4.70	4.18
Sulfur (g kg <sup>-1</sup> )	1.93	1.80	1.40
Magnesium (g kg <sup>-1</sup> )	1.63	1.50	1.44
Iron (mg kg <sup>-1</sup> )	76.30	50.00	37.50
Zinc (mg kg <sup>-1</sup> )	53.75	47.00	35.00
Manganese (mg kg <sup>-1</sup> )	31.07	27.00	26.00

Abdel-Aal et al., 1995; Brandolini et al., 2008; K. R. Davis et al., 1981; Hidalgo et al., 2009; Suchowilska et al., 2009; Suchowilska et al., 2012; Yaman, 2018

### ***The resistance of IZA***

In agriculture, drought, salinity, high temperature, toxic substances, and oxidative stresses are serious yield-decreasing factors and detrimental to the environment (Wang et al., 2003). In other words, biotic and abiotic stresses such as diseases, insects, drought, high temperatures, and colds limit the production of economically important crops, including wheat (Aslan et al., 2017).

One of the negative impact on crops is drought stress. In developing countries, 37% of common wheat is cultivated in semi-arid places and the production of this wheat hinges on rainfall (Aslan et al., 2017; Baloch et al., 2017). Nevertheless, unfavorable soil or harsh climatic conditions are, fortunately, not obstacles to the growing of hulled wheats (Arzani, 2011). Ancient kinds of wheat such as einkorn, emmer, and spelt are resistant to cold, salinity, drought, and biotic stress; that's why, it will be appropriate to use them in breeding programs (Arzani and Ashraf, 2017). Sustainable wheat production is possible with the selection of drought-stress-adapted wheat genotypes in many countries (Cattivelli et al., 2008). It was reported by Aslan et al. (2017) that IZA has a better performance against drought than bread wheat.

In addition to drought, cold also has a negative impact on crops. Crop yields around the world have been decreasing to varying degrees due to the cold. Fortunately, plants adapt themselves to cold stress through some response mechanisms such as changing their morphological, physiological, and biochemical structures to protect themselves (Bohnert et al., 1995; Gill et al., 2003). Although the most appropriate temperature for wheat seed germination is between 12-25°C, temperatures between 4°C and 37°C are also considered sufficient. In wheat, growth stages such as early growth and germination have been shown to be highly sensitive to cold stress (Khodabandeh, 2003). Although plants are sensitive to cold, there are genetic varieties with better tolerance (Zencirci et al., 2019). When bread wheat and IZA wheat were compared, IZA proved to be more tolerant at the germination stage (Aslan et al., 2016).

### ***The events to inform the public about IZA***

Primitive einkorn wheat has survived and been rehabilitated in some Western European regions. It has aroused great interest thanks to its healthy and organic characteristics, making it highly preferred in markets



(Giambanelli et al., 2013). Although IZA currently needs to be introduced to more people, it has become very popular in Bolu due to its health benefits.

Farmers and consumers have continued to be encouraged through panels, field days, festivals, symposiums, and conferences. At the 1st and 2nd IZA Wheat Festival and Field Days, it was stated that it would be more prominent in popular culture in the future as it is a beneficial species in terms of health, such as reducing the risk of lung, stomach, and breast cancer. For this reason, farmers were encouraged to cultivate it (Anadolu Agency, 2018). As a result, farmers have been cultivating IZA in larger areas. In 2019, the cultivation was about five times higher compared to 2018 (Küçük, 2019).

In 2018, Bolu Abant İzzet Baysal University organized the Symposium of Wheat Landraces in Turkey. In this symposium, the farmers who attended the presentations of faculty members were informed about IZA. Farmers learned that IZA has a lower yield than other wheat species, but is resistant to harsh climatic conditions and insect infestation. Increasing numbers of organic consumers and the desire to eat nutritious products grown without pesticides have been encouraging farmers to plant IZA. In addition to the use of IZA wheat as bulgur and animal feed, farmers and consumers have learned how to make baked products with IZA (Özdemir Yaman, 2018). Here at this symposium, recipes and ingredient details of bakery products made with IZA wheat were presented. (Figure 2). These products served at the symposium were highly appreciated by the tasters (Özdemir Yaman, 2018). In this way, the dream of seeing IZA products on market shelves has come one step closer.



**Figure 2.** A) Artizan Bread, B) Cookies, C) Tiny Pogacas, D) Muffins, E) Tiny Pogacas

In spite of these promotional activities that have been taking place at the events, people still have very little information about how to use IZA in cooking. IZA has a low concentration of gluten that's why it is hard to give dough texture, thus, it is hard to make bread with it. Nevertheless, it is thought that the consumption of IZA may increase with the inclusion of cooking techniques in recipe books. Besides, the sour bread types written in the article of Keskin et al. (2022) eliminated this judgment. Whole Grain IZA, Three Grain IZA, Carrot Purple IZA, Village Bread, German Bread, Walnut Bread, Yellow Gelin, and Focaccia with Olives of bread types were developed. These breads took place in the sensory analysis test and were highly appreciated by the participants (Keskin et al., 2022).

## Materials and methods

The harvested wheat was milled by the municipality of Bolu. IZA wheat flour and grains were used to create products such as pasta, dessert, bread and local dishes. Village soup, village bread, kısır, bulgur pilaf, pasta with four cheese cream, pasta with pesto sauce, pasta with tomato sauce, trilece were made with IZA. The materials that were used have been presented in Table 4. Ethics committee report was not needed in this study.

**Table 4.** Ingredients of Village soup, IZA kısır, IZA pilaf, Pasta with pesto sauce, Pasta with tomato sauce, Pasta with four cheese cream, IZA village bread, Trilece.

<b>Village Soup</b>	<b>Kısır</b>	<b>Bulgur Pilaf</b>	<b>Pasta with Pesto Sauce</b>
1 kg of IZA bulgur	3 kg IZA fine bulgur	2.5 kg Iza bulgur	50 g IZA spaghetti pasta
1 kg of flour	500 g tomato paste	5 capsicum peppers	20 g pesto sauce
500 g noodles	500 g capia pepper	10 green peppers	1 zucchini
1 kg boiled beef ribeye	3 bunches of spring onions	1.5 kg of onions	1 carrot
750 g tomato paste	250 g California pepper	300 g garlic	1 clove of garlic
500 g butter	2 bunches of parsley	400 g butter	100 ml cream
500 ml Sunflower oil	Juice of 8 lemons	300 g Sunflower oil	1 sprig of fresh basil
Boiling water	250 ml pomegranate syrup	15 canned tomatoes	1 capsicum pepper
Salt, pepper, cayenne pepper, mint	Salt, pepper, cayenne pepper	Salt, pepper, cayenne pepper, mint	3 pcs Bolu yellow mushrooms
	500 ml olive oil	4 liters of broth	
<b>Pasta with Tomato Sauce</b>	<b>Pasta with Four Cheese Cream</b>	<b>IZA Village Bread</b>	<b>Trilece</b>
50 g Iza spaghetti pasta	50 gr IZA sedani rigati	200 g sourdough	<i>Ingredients for the cake:</i> 6 eggs
2 tomatoes	10 g cheddar cheese	20 g fresh yeast	260 g Iza flour
1 clove of garlic	10 g Tulum Cheese	150 g salt	160 g sugar
1 sprig of fresh basil	10 g cheddar cheese	1 kg of boiled potatoes	45 g semolina
20 g olive oil	10 g curd cheese	8 kg of Iza flour	15 g baking powder
10 g butter	100 ml cream	Warm water	10 g vanilla
Salt, pepper, ground basil	Ground basil, salt, pepper		5 g carbonate
			5 g of salt
			230 ml of water
			<i>Ingredients for the milk sauce:</i> 1350 g milk
			700 g cream
			150 g sugar
			Caramel sauce

## Results

Sensory analysis tests are important in terms of potential food products. With sensory analysis tests, products which are eliminated because of out of favor can save the money in the future.

In this study; village soup, IZA kısır, IZA pilaf, pasta with pesto sauce, pasta with tomato sauce, pasta with four cheese cream, IZA village bread, and trilece were presented to the public and a sensory analysis was conducted (Figure 3). Ethics committee report was not needed for this study. A total of 50 semi-trained panelists participated in the survey and they were asked to rate the products from 1 to 7. Nine of the participants were female and forty-one were male. The average age of the participants was  $41.96 \pm 12.25$  years. A statistical analysis was performed using SPSS 18.0 Software (SPSS Inc., Chicago, USA). The panel performance was evaluated using analysis of variance (ANOVA) of sensory profile data. The homogeneity of variances test showed that our data were appropriate for ANOVA (Sig > 0.05). Duncan pairwise mean comparison was used to determine the differences between the products. As a consequence of the Duncan test, it was seen that trilece was liked the most and bulgur pilaf was liked the least. Six groups were formed according to the average scoring. The first group consisted of trilece, the second group consisted of village soup, the third group consisted of IZA village bread and pasta with four cheese cream, the fourth group consisted of pasta with pesto sauce, the fifth group consisted of pasta with kısır and tomato sauce and the sixth group consisted of bulgur pilaf. The averages for texture, smell, chewiness, flavor and overall evaluation were calculated (Table 5). In general, the panelists agreed that the IZA product should be well promoted.

There are very few studies on sensory analysis of food production with einkorn. Corbellini et al. (1999) made various cakes and bakery products with einkorn before demonstrating that they could make pastry products

with it. Gazza et al. (2022) made pasta with IZA and submitted it to sensory analysis. The pastas that they made were evaluated as quality products, but they could not achieve good results in terms of hardness and stickiness (Gazza et al., 2022). In other studies, bread was made from twenty-five different einkorn wheat flours and the ideal gluten value was only found in one-third of them (Borghi et al., 1996; Brandolini and Hidalgo, 2011).



**Figure 3.** Village Soup, Village Bread, Kısır, Bulgur Pilaf, Pasta with Four Cheese Cream, Pasta with Pesto Sauce, Pasta with Tomato Sauce, Trilece

**Table 5.** The Average values of products. GE: General Evaluation

	Village Soup	Kısır	Bulgur Plaf	Four Chees cream pasta	Pasta with Pesto Sauce	Pasta with Tomato Sauce	Trilice	Village Bread
<b>Texture</b>	4,48 ± 0,84	5,26 ± 1,78	5,50 ± 1,53	6,18 ± 1,06	6,06 ± 1,22	5,78 ± 1,31	6,76 ± 0,59	6,02 ± 1,04
<b>Odor</b>	6,46 ± 0,89	5,74 ± 1,44	5,64 ± 1,51	6,22 ± 1,02	6,18 ± 1,02	5,78 ± 1,40	6,74 ± 0,63	6,36 ± 0,90
<b>Chewiness</b>	6,52 ± 0,89	5,50 ± 1,76	5,60 ± 1,50	6,32 ± 0,91	6,32 ± 0,91	5,84 ± 1,28	6,66 ± 0,82	6,16 ± 0,93
<b>Flavor</b>	6,62 ± 0,70	5,70 ± 1,58	5,54 ± 1,53	6,32 ± 0,91	6,14 ± 1,23	5,78 ± 1,27	6,80 ± 0,45	6,48 ± 0,79
<b>General Evaluation</b>	6,66 ± 0,69	5,84 ± 1,45	5,56 ± 1,53	6,34 ± 0,90	6,12 ± 1,24	5,78 ± 1,28	6,82 ± 0,44	6,64 ± 0,73

### Discussion and Conclusion

The discovery of the benefits of IZA has restored its former reputation. IZA is rich in some types of B vitamins such as thiamine (B1), riboflavin (B2) and pyridoxine (B6) (Abdel-Aal et al., 1995; Hamed and Simsek, 2014). In addition to these B vitamins, einkorn also contains antioxidant compounds (Hidalgo and Brandolini, 2014; Ward et al., 2008). These antioxidants are bound phenolic acids, tocols, and carotenoids. Although IZA is not rich in minerals, Fe and Zn elements are found to be higher than other elements (Yaman, 2018).

In addition to the significance of wheat as a grain, the consumption of wheatgrass has recently increased in importance. Due to its antioxidant content, wheatgrass is consumed as a beverage by producers by blending the grass or adding water to the powdered grass. However, bread wheat (*Triticum aestivum*) is preferred for wheatgrass consumption. The increasing popularity of wheatgrass has accelerated the studies of scientists on the content of wheatgrass. IZA wheatgrass has been found to have strong antioxidant activity (2.98 µg/mL) compared to other wheatgrasses (emmer, durum and bread wheatgrass). Moreover, overall flavonoid values of IZA (179.50 mg/g dw) are found to be higher than emmer (141.58 mg/g dw). It has also been concluded that IZA wheatgrass is rich in p-coumaric (1.360 µg/g dw) and trans-ferulic (0.490 µg/g dw) acids among other wheat species (Pehlivan Karakas et al., 2022). Vitamin B species and tocol species showing vitamin E activity were also examined in different wheatgrasses. As a result, the highest levels of vitamin B1, vitamin B2 and vitamin B5 were found in IZA wheatgrass. In vitamin E activity, α-tocopherol and α-tocotrienol content was higher in IZA wheatgrass than in other wheat species (Pehlivan Karakaş et al., 2021). For all these reasons, people should consume IZA wheat both as a grain and as a grass for its health benefits.

IZA is very easy-to-grow for farmers. It is resistant to both drought and cold stresses (Aslan et al., 2017; Aslan et al., 2016). Bolu municipality helps farmers to overcome some problems such as the peeling of hulls of IZA.

Also, encourage farmers to increase planting area. Faculty members of BAIBU made great contributions, as well. Although IZA has low gluten, BAIBU Nutrition and Dietetics Department and local bakers are trying to do their best to make bread or pastries. In addition, pupils and faculty members of the Faculty of Arts and Sciences are working in the laboratory. With the tissue culture experiments, drought and cold resistance of IZA are approved (Aslan et al., 2017; Aslan et al., 2016). The planting of IZA wheat in a small district like Seben has provided a disadvantage for its promotion. For this reason, taking place in symposiums and food festivals has increased its popularity. However, this is not enough. For this reason, it is requested to open to the global. Apart from the use of IZA wheat in making bulgur, bakery products were also presented in symposiums (Özdemir Yaman, 2018). Concerning einkorn product making, only a few studies have been performed. Gazza et al. (2022) made pasta from einkorn wheat and submitted it to the sensory analysis test. As a result, einkorn wheat under the name of Hammurabi was evaluated as good quality. In this study, two einkorn varieties and one durum variety were used. Einkorn varieties showed low values in terms of firmness and stickiness (Gazza et al., 2022). It has been revealed that einkorn, which has a low gluten value, is not ideal for making bread. However, studies denied this. For example, twenty-five types of einkorn were used in a study, and one-third of them showed ideal gluten value for making bread (Borghi et al., 1996; Brandolini and Hidalgo, 2011). In addition, einkorn wheat is successful in making cakes, bakery products, and unleavened bread (Corbellini et al., 1999). The popularity of IZA has grown through symposiums, panel discussions, important meetings, and festivals. Most importantly, the farmers and the public have been informed about the health benefits of IZA. It is believed that it will become a product that everyone can consume, not only those who are well-off.

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