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Review

A new generation plant for the conventional cuisine: Quinoa (*Chenopodium quinoa Willd.*)

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ABSTRACT

Background: The quinoa herb belongs to the family of Chenopodiaceae where spinach and beet are also found. It is a kind of herb that is native to South America and there are about 250 kinds of *Chenopodium* species worldwide. It is considered a sacred herb by humans due to the high level of protein in its composition and its content of essential amino acids in a balanced manner. In addition, due to the fact that quinoa has a high value of energy and nutrients and because of its therapeutic properties as well as the absence of gluten in it, it is thought to be beneficial for consumers like children, elderly people, high performance athletes, individuals with lactose intolerance, women with a tendency to osteoporosis and those in a risk group such as anemia, diabetes, dyslipidemia, obesity or celiac disease. The useage of quinoa as a main ingredient in salads and meatball and the useage of which in preparation of pastries such as cakes, cookies, etc., dietary meals, and various foods have increased the demand for it within the gastronomy field.

Scope and approach: The present review reports the general characteristics of quinoa, its composition, its impact on health, its use in the food industry and gastronomy.

Keys findings and conclusions: Quinoa, which does not include gluten and has a perfect content of food quality, is a good alternative product for the people with celiac disease who have to sustain their lives without a gluten-free diet and whose number is rising day by day. Besides, with its unique aroma, quinoa is thought that its usage in traditional foods and its production will increase with its substitution for flour, bulgur, and rice.

1. Introduction

Perceived as an element of culture by the communities, the food carries an artistic characteristic that is performed by people upon their requests and has been continuing since the beginning of the human history. Different cultures affected from each other by means of immigration, wars, weddings, border neighbouring, and start and development of trade routes and they introduced their own cuisine cultures. The diversity in diet directed the people to have taste and pleasure beyond the aim of eating and sustaining their lives which are physiological needs of the people. Therefore, new cooking methods were created by combining the foods belonging to different countries with domestic products. As the geographical factors played a role in the making of the foods whose preparations were completed, regional, even conventional cuisines emerged (Deveci, Türkmen, & Avcıkurt, 2013). (see Fig. 1)

The cuisine is identified as a concept with which both location and culture are associated. It is identified as the location where eating and drinking service is made and as the place in which the foods are prepared, cooked and consumed (Kaya, 2000). There are over 2500 kinds of foods in the Turkish cuisine giving rich examples from every branch of the gastronomy. The Turkish cuisine was combined with the Central Asian migrant people's use of meat and the fermented dairy products; the grains of Mesopotamia; the fruits and vegetables of Mediterranean region; the spices of South Asia and had influence in the creation of a rich Turkish food culture (Baysal, 1993; Ceyhun-Sezgin, Şeren-Karakuş, & Şanlıer, 2015).

2. General characteristics of quinoa

Being a dicotyledonous pseudo-grain, quinoa belongs to the Chenopodiaceae family botanically. It is an annual plant and its name in Latin is *Chenopodium quinoa Willd* (Abugoch, 2009; Yıldız, Tansı, & Sezen, 2014). There are approximately 250 species of the *Chenopodium* species worldwide (Vega-Gálvez et al., 2010). Quinoa seeds are the main edible parts of the plant. The colour of the quinoa seeds varies

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Fig. 1. The quinoa plant and seed.

Table 1
Comparison of the nutritional values of grains with quinoa (in edible 100 g) (Navruz-Varlı; Şanlıer, 2016).

Compound	Quinoa	Rice	Barley	Wheat	Corn	Rye	Sorghum
Fat (g)	6.07	0.55	1.3	2.47	4.74	1.63	3.46
Protein (g)	14.12	6.81	9.91	13.68	9.42	10.34	10.62
Cinder (g)	2.7	0.19	0.62	1.13	0.67	0.98	0.84
Pulp (g)	7.0	2.8	15.6	10.7	7.3	15.1	6.7
Carbohydrate (g)	64.16	81.68	77.72	71.13	74.26	75.86	72.09
Energy (kcal)	368	370	352	339	365	338	329

from white to black though they are in light yellow generally (Abugoch, 2009; Repo-Carrasco-Valencia & Serna, 2011). Called as mother grain by South Americans (Incas), quinoa has an agricultural history dating back to approximately 5000–7000 years ago in the Andes Region (Bolivia, Peru, Ecuador) (Abugoch, 2009; Geren, Kavut, Demiroğlu Topçu, Ekren, & Iştipliler, 2014; Vega-Gálvez et al., 2010). Taking the place of corn that was very important to Incas, quinoa was accepted as sacred in this community (Abugoch, 2009; Bhargava, Shukla, & Ohri, 2006).

Quinoa can be used in food, feed, and non-food industrial areas in several countries (El Hafid, Aitelmaalem, Driedger, Bandara, & Stevenson, 2005). The main countries producing quinoa are Peru and Bolivia. Alongside these countries, China, European countries, Canada, and India also cultivate this plant. Being cultivated in Finland and England experimentally, quinoa is being exported to European countries and the USA in increasing quantities (Jacobsen, Jorgensen, & Stolen, 1994; Jacobsen & Stolen, 1993). Started to be cultivated as of the 20th century in European countries (Geren et al., 2014), quinoa has started to be cultivated by Turkey in several districts (Yıldız et al., 2014).

Being able to adapt to extreme ecological conditions (Abugoch, 2009; Jacobsen, 2003), quinoa is resistant to different ecological stress factors such as the weathers too hot and below 0 °C at nights, the lands with different pH degrees and that are arid, salty, or poor, and the exposure to the radiations emitted from the sun lights (Gonzalez, Gallardo, Hilal, Rosa, & Prado, 2009; Repo-Carrasco-Valencia & Serna, 2011; Keskin & Kaplan-Evlice, 2015).

Food and Agriculture Organisation (FAO) identified quinoa as one of the plants promising for humanity by notifying that the high nutrient value and genetic diversity of quinoa may contribute to food safety in the 21st century. The United Nations declared the year 2013 as “International Quinoa Year” in order to increase the interest in this plant (FAO, 2014).

3. Compound of quinoa

Having a protein amount equal to at least as much as in the milk protein because it includes all the essential amino acids, quinoa has the protein content of 12–20% though this changes according to its species (Abugoch, 2009; Repo-Carrasco-Valencia & Serna, 2011; Yıldız et al., 2014). According to the conducted studies, of quinoa in terms of compound, 60–69% is carbohydrate, 13–20% is protein, 9–12.6% is moisture, 4–10% is lipid, and 3–4% is mineral (Reichert, Tatarynovich, & Tyler, 1986; Koziol, 1992). Comparison of quinoa with other grains in terms of some nutrients is given in Table 1 (Navruz-Varlı; Şanlıer, 2016).

As quinoa does not include gluten, it is a nutritious and delicious food ingredient meeting the protein and carbohydrate needs of the people with celiac disease, the individuals allergic to wheat, and the vegetarian persons. It includes more protein than wheat, rye, oat, millet, corn, and rice and has other essential amino acids in its compound as well as being rich in lysine that is an essential and limited amino acid especially in some grains and wheat. It has a balanced amino acid composition (James, 2009; Nowak, Du, & Charrondiere, 2016; Watanabe et al., 2014). The total fibre rate in quinoa is about 10%. The amount of fibre in the compound of quinoa is higher than the other grains and lower than the legumes. Fibre, the insoluble part of the phytonutrients, is important as it facilitates digestion and prevents constipation (Champ, Langkilde, Brouns, Kettlitz, & Le Bail Collet, 2003). Of its seed, 5% is oil, 60% is carbohydrate, and 4% is pulp/fibre (Cardozo & Tapia, 1979). Because the fact that quinoa is a herbal product, it includes cholesterol-free (Miranda et al., 2012), high-quality, and edible vegetable oil and the oil rate (6–7%) is higher when compared to the grains (Wood, Lawson, Fairbanks, Robison, & Andersen, 1993). The ratio of ω-6/ω-3 within the compound of quinoa is approximately 1/6th. The oil content is more in the red quinoa than the other types (Alvares-Jubete, Auty, Arendt, & Gallagher, 2010; Valencia-Chamorro, 2003).

In addition, it also contains components of polyphenol (colour pigment), phytosterol (vegetable oil), and flavonoid (taste-odour compounds) and has nutraceutical effects (James, 2009). That the functional characteristics of quinoa include its suppressive effect on high blood pressure and the cholesterol-lowering effects in serum and liver were expressed and its introduction to the functional food status with its all these favourable characteristics has increased the interest in this grain for producing various products in the food industry (Watanabe et al., 2014).

Being a good source of fibre, quinoa has superior nutritional properties as it contains various minerals (magnesium, zinc, iron, potassium, phosphorus) and vitamins (E, B group and C) and with its high level of quality protein, fat, and essential amino acid content. And with these aspects of it, it is a good green vegetable and dried legumes supplement (Abugoch, 2009; Bhargava et al., 2006; Bilalis et al., 2013; Geerts et al., 2008; Miranda et al., 2012). Quinoa seeds are regarded as a source of vitamin E. Tocopherols and tocotrienols are compounds of another type that can be dissolved in the oil available in quinoa seeds. These compounds help to prevent the formation of free radicals by showing a

Table 2
Ingredients lists and the instruction steps of the foods with quinoa.

Dishes	Ingredients	Instruction Steps
Bulgur Salad with Quinoa 	1 cup (200 g) quinoa 2 cups (400 g) water 1 tablespoon (10 g) tomato paste ½ tablespoon (5 g) paprika paste 2 pieces medium size (240 g) cucumbers 8 pieces (240 g) cherry tomatoes 1/2 bunch (50 g) parsley 2 tablespoons (20 g) olive oil 1 tablespoon (10 g) lemon juice 1 tablespoon (14 g) pomegranate syrup 1 teaspoon (5 g) sumac ½ teaspoon (2.5 g) black pepper 2 teaspoons (10 g) salt *Energy (kcal):* 58 *Macro components* Carbohydrate (g): 6.8 Fat (g): 2.4 Protein (g): 1.6 Fiber (g): 1.2	Put the quinoa in a bowl and add some water until the water level passes over the quinoa Pick over the ones on the water surface and then strain the water Put the quinoa in a pot and add water on it Keep cooking it at a low heat until it drains Take the cooked and a bit warmed quinoa into a bowl Then add tomato and paprika pastes and mix until it takes a homogenous shape Peel and chop the cucumbers in small pieces Then chop the cherry tomatoes and add them into the bowl Add the finely chopped parsley after adding salt, black pepper and sumac Mix by adding the olive oil, lemon juice, and pomegranate syrup.
Gluten-Free Cake 	3 tablespoons (30 g) butter 1/3 cup coconut oil 1 cup (200 g) quinoa 3 pieces (150 g) eggs 100 g brown sugar 2 pieces medium size (150 g) bananas 1 package (5 g) vanilla 1/3 cup (40 g) coconut oil 1 package (2 g) baking powder 1/3 cup (70 g) milk *Energy (kcal):* 207 *Macro components* Carbohydrate (g): 23 Fat (g): 11 Protein (g): 5 Fiber (g): 2	Add butter, coconut oil, and sugar to the mixer and mix them until it blends to a creamy consistency Add the eggs one by one and whisk them until they have a homogenous appearance Add vanilla and milk Crush the bananas with a fork in another bowl completely and mix them by adding to the mixture Add the sieved flour, baking powder, and coconut oil and mix them until the flour disappears Pour the mixture into the cake mould by coating the mould with grease-proof paper and cook at 165 °C for 40 min.
Quinoa Salad with Mung Bean 	1/2 cup mung bean 1/2 cup (100 g) quinoa 7 pieces (35 g) spring onions 6 pieces (50 g) fresh mint leaves 10 pieces (15 g) fresh basil leaves *For sauce:* 15 pieces (200 g) strawberries 1 piece (150 g) medium size tomato 1 tablespoon (10 g) vinegar 2 tablespoons (20 g) olive oil 1/2 teaspoon (2.5 g) salt *Energy (kcal):* 84 *Macro components* Carbohydrate (g): 10 Fat (g): 2.8 Protein (g): 3.6 Fiber (g): 2.8	Pre-soak the mung beans Boil the beans in salted boiling water for 15–20 min Wash the quinoa and leave it in water for 10–15 min and remove the shell parts Boil the washed and soaked quinoa seeds in 1 cup of hot water until it drains all the water Chop spring onions and mint and basil leaves finely Leave boiled ingredients to cool For sauce of the salad; mix the strawberries without stems, peeled tomato, olive oil, vinegar, and salt until they become a homogenous sauce Blend the chopped green vegetables, cooled quinoa and mung beans and add the red sauce on it and mix

(*continued on next page*)

Table 2 (*continued*)

Dishes	Ingredients	Instruction Steps
Vegetable Meatballs with Quinoa 	1 cup (200 g) quinoa 2 cups (400 g) hot vegetable juice 1 piece (50 g) egg 2 pieces boiled (240 g) small size potatoes 1 piece small size (70 g) zucchini 1 piece small size (40 g) carrot 2 sprigs (10 g) spring onions 1/4 bunch (25 g) parsley 1/4 bunch (20 g) dill 1/2 teaspoon (2.5 g) salt 1/2 teaspoon (2.5 g) black pepper 1/2 teaspoon coriander *For frying* 3 tablespoons (30 g) olive oil *For service* 1 package seasonal green vegetables 1 piece small size (250 g) pomegranate *Energy (kcal):* 102 *Macro components* Carbohydrate (g): 13.2 Fat (g): 4.2 Protein (g): 2.6 Fiber (g): 2.1	Boil the sluiced and strained quinoa seeds in hot vegetable juice for about 15–20 min until it drains Grate the peeled and boiled carrot and zucchini Chop spring onion, dill, and parsley finely Put the quinoa boiled in vegetable juice in a glass mixing bowl and leave it on a side to cool Mix the chopped green vegetables with shredded carrot, zucchini, and boiled potatoes Add salt, black pepper, and coriander After adding the egg, mix all the ingredients with a spoon until it gets purified Fry the prepared vegetable meatballs with quinoa by heating olive oil in a frying-pan Filter the excess oil off the fried meatballs and take the seasonal green vegetables into the serving plate Place the meatballs and serve them after garnishing with pomegranate seeds.
Quinoa Salad 	130 g quinoa 70 g red cabbage 1 bunch (100 g) parsley 30 g dried tomato 1/2 piece (100 g) medium size grapefruit 1/2 piece medium size (150 g) pomegranate *For sauce* 1 teaspoon coriander 3 tablespoons (30 g) olive oil 1 dessertspoon (9 g) sour grape molasses 1 dessertspoon (7 g) pomegranate syrup 1/2 teaspoon mustard 1 teaspoon honey 1/2 teaspoon (2.5 g) salt 50 g roquefort cheese *Energy (kcal):* 26 *Macro components* Carbohydrate (g): 2.9 Fat (g): 1.3 Protein (g): 0.8 Fiber (g): 0.5	Sluice the quinoa and strain the excess water Take the measured water and salt into a medium-sized pot and after boiling the quinoa taken in the pot, lower the heat and close the lid of the pot, cook it for 5–10 min until it drains and leave it to brew. Prepare fruits and vegetables by washing them Mix the chopped parsley, red cabbage, and dried tomato in a bowl Add the brewed and rested quinoa to this mixture Add coriander seeds to this mixture by mixing olive oil, pomegranate syrup, mustard, honey, sour grape molasses, and salt Mix well by adding the sauce mixture with olive oil to the prepared quinoa mixture Serve after adding the roquefort cheese, grapefruit slices, and pomegranate seeds into the salad.
Chocolate Cookie with Quinoa 	1 cup (200 g) quinoa flakes 1/3 cup flax seeds 1/3 cup (200 g) pounded almonds 1 piece (75 g) banana 3 tablespoons (20 g) cacao 1 dessertspoon cinnamon 2 tablespoons honey *Energy (kcal):* 182 *Macro components* Carbohydrate (g): 8.2 Fat (g): 13.7 Protein (g): 6.7 Fiber (g): 4.6	Preheat oven to 170 °C Mix the mashed banana with honey, cinnamon, and cocoa Mix the cookie dough to which quinoa flakes, ground flax seeds, and pounded almonds are added until it comes to a slightly sticky consistency Place the prepared cookies on the baking tray Cook for 15–20 min in the oven until their upper and bottom parts get coloured slightly Melt the bitter chocolate put in a glass bowl after being cut into small pieces Take the cookies out of the oven and left them to get warm, cover their bottom or side parts with melted bitter chocolate and cool them on a grease-proof paper.

(*continued on next page*)

Table 2 (*continued*)

Dishes	Ingredients	Instruction Steps
Crete Zucchini with Quinoa 	6 pieces Crete zucchinis 1 cup (200 g) quinoa 2 cups (400 g) hot water 6 tablespoons (60 g) olive oil 2 pieces (120 g) onions 1 piece (40 g) carrot 1 piece sweet yellow pepper ½ teacup dried blueberries ½ teacup (35 g) peanuts ½ teacup pumpkin seeds 1 teaspoon (5 g) salt ½ teaspoon (2.5 g) black pepper *For sauce* 1 tablespoon (10 g) olive oil 1 teaspoon (5 g) tomato paste 1.5 cups (300 g) hot water 1 teaspoon (0.5 g) mint *Energy (kcal):* 272 *Macro components* Carbohydrate (g): 11.4 Fat (g): 21 Protein (g): 7.1 Fiber (g): 4	Chop the onions in small cubes Cut the peeled carrot like the onions Chop the sweet yellow pepper that is cut into two pieces in the middle and removed from its seeds, in small pieces Heat olive oil in a frying-pan Saute the chopped onions until they get coloured Continue to saute by adding the carrot and yellow pepper cubes Add dried blueberries, peanuts, pumpkin seeds, salt, and black pepper Boil quinoa in hot water until it drains its water Mix the sauteed mixture having vegetables and dried fruits with boiled quinoa Cut the heads of Crete zucchinis in a way to be cap and keep them at a side Pile the inner parts of the zucchinis with filling mixture with quinoa after carving them by using a spoon Close the caps and lay them together in a broad pot For the sauce of stuffing; dilute the tomato paste with hot water Mix after adding olive oil, mint, and salt Pour the sauce all over the stuffed vegetables in the pot Cook at low heat for about 30 min until the zucchinis get soft.
Quinoa Hash Browns with Poached Eggs 	1 cup (200 g) quinoa 2 cups (400 g) hot vegetable juice 1 piece (50 g) egg 1/2 cup (55 g) flour 1 piece (70 g) zucchini 1 piece (40 g) carrot 4 sprigs (20 g) spring onions 1/4 bunch (20 g) dill 1/4 bunch (25 g) parsley 2 tablespoons shredded (50 g) kashar cheese 1/2 teaspoon (2.5 g) salt 1/2 teaspoon (2.5 g) black pepper *For frying* 3 tablespoons (30 g) olive oil *For poached eggs* 2 pieces (100 g) eggs 4 cups (800 g) hot water 1 tablespoon (10 g) apple cider vinegar 1/2 teaspoon (2.5 g) salt *For service:* 10 pieces young spinach leaves 4 pieces (120 g) cherry tomatoes *Energy (kcal):* 118 *Macro components* Carbohydrate (g): 10 Fat (g): 6.4 Protein (g): 5.2 Fiber (g): 1.7	Boil the sluiced and strained quinoa seeds in hot vegetable juice for about 15 min until it drains Grate the peeled carrot and zucchini Chop spring onion, dill, and parsley finely Put the boiled quinoa in a glass mixing bowl and leave it at a side to cool Mix the chopped green vegetables and the shredded carrot and zucchini Flavour with salt and black pepper Mix all ingredients with a spoon until they get purified by adding the shredded kashar cheese, flour, and egg Heat olive oil in a teflon frying-pan and fry the prepared mixture of hash browns with quinoa until both sides of them get coloured Leave the fried hash browns to lose their oil for 2–3 min For the preparation of the poached eggs; boil water, apple cider vinegar, and salt in a deep pot Break the eggs one by one in a bowl and drop them in the boiling water slowly Slowly mix with a colander from time to time and make sure that egg whites are not deformed and the yolk is covered Place spinach leaves in the serving plate Carefully take the poached eggs cooked for about 2 min out of the pan with a colander and place them on the hash browns Serve by adding black pepper and cherry tomatoes.
Quinoa Salad with Tuna 	1 cup (200 g) quinoa 1.5 cups (300 g) water 200 g canned tuna 2 pieces (240 g) cucumbers 10 pieces (300 g) cherry tomatoes 4 sprigs (20 g) spring onions 1/2 bunch (40 g) dill 1/2 bunch (50 g) parsley 3 tablespoons (30 g) olive oil 1 tablespoon (10 g) grapes vinegar 1 teaspoon (5 g) salt *Energy (kcal):* 91 *Macro components* Carbohydrate (g): 8.6 Fat (g): 4.7 Protein (g): 5.8 Fiber (g): 1.5	Keep the quinoa in a large bowl with enough water to pass over it Transfer the swollen quinoa to a strainer, rinse with plenty of water and strain the water, then put them in a pan Cook in the pan closed after adding approximately 1.5 cups of water for 15 min To avoid the strained and boiled quinoas from sticking together, mix them with a wooden spoon and leave them to get warm Chop the peeled cucumbers in big cubes Cut cherry tomatoes into two pieces in the middle Chop spring onions in rings Chop parsley and dill finely For the preparation of salad sauce; mix olive oil, vinegar, and salt in a bowl by whisking them Transfer the warmed and boiled quinoa, the tuna and all the salad ingredients into a deep mixing bowl and serve after blending with its sauce.

strong antioxidant property that protects the oil from oxidation (Li et al., 2012, 2014). Because the saponin, which is an anti-nutritional element in the shell of its seed (0.14–0.73%), gives a bitter taste, the seed must be removed from its shell before consumption (Abugoch, 2009; Bhargava et al., 2006; Chauhan, Eskin, & Tkachuk, 1992). Saponin, which negatively affects the taste and colour of quinoa, has no negative effect on proteins and especially on amino acid composition (Enriquez, Peltzer, Raimundi, Tosi, & Pollio, 2003; Keskin & Kaplan-Evlice, 2015).

4. Its effect on the health

Quinoa is a functional nutrient as it contains many components that are important in terms of health. For this reason, besides its compound and nutritional properties, its effects on health have also been studied. Because it has high nutritional value and therapeutic properties and is gluten-free, it has been reported that quinoa is beneficial for sensitive groups such as children, elderly people, high activity athletes, people with lactose intolerance, women with a tendency to osteoporosis, and people with diabetes, dyslipidemia, obesity, anemia, and celiac disease. It is reported that these properties stem from dietary fibre, mineral substances, vitamins, fatty acids, antioxidants, and especially phytochemicals. These properties make quinoa superior to the other grains in terms of human nutrition and health (Navruz-Varlı; Şanlıer, 2016). Other bioactive components available in the structure of quinoa are polyphenols, saponin, phytic acid, squalene, and phytosterol that can show antibacterial, antiviral, and antiallergic effects and help to reduce the risk of cardiovascular diseases and diabetes (Demir, 2014; Gawlik-Dziki et al., 2013; Keskin & Kaplan-Evlice, 2015).

Ruales, Grijalva, Lopez-Jaramillo, and Nair (2002) reported that the baby food with quinoa was given to children in two meals per day for 15 days and, as a result of the study, baby food with quinoa supplied enough protein and essential nutrient groups and provided a solution to malnutrition in infants. Farinazzi-Machado, Barbalho, Oshiiwa, Goulart, and Pessan Junior (2012) stated that quinoa contains the proteins with high biological value, the low glycemic indexed carbohydrates, the phytosteroids, and the fatty acids of omega 3 and omega 6. To determine the effect of quinoa on the risk of cardiovascular diseases, anthropometric profile and blood pressure parameters were used and for 30 days, 18 to 45 years-old students were given the cereal bar-shaped quinoa on a daily basis and biochemical analyses were performed before and after treatment in order to determine the glycemic and biochemical profile of the group. As a result of the study, they reported that quinoa has a positive effect on total levels of cholesterol, triglyceride, and LDL and that the use of quinoa in diet may be useful in the prevention and treatment of risk factors related to cardiovascular diseases. Zevallos et al. (2014) gave 50 g of quinoa to people with celiac disease as gluten-free food every day for 6 weeks and noted that the gastrointestinal parameters were normal in patients to whom serological and gastrointestinal tests were applied. They designated that the addition of quinoa to the gluten-free food diet for people with celiac disease tolerated the disease at a good level and did not worsen it. Kaur and Tanvar (2016) examined the antioxidant, antidiabetic, and antihypertensive properties of the quinoa beverages produced from quinoa flour which they pre-treated with different techniques (raw, soaked, germinated, and malted). They determined that the beverages they prepared by using malt flour had higher antidiabetic activity with total phenolic substance and antioxidant activity.

5. Its use in gastronomy and the food sector

Recently, quinoa has also drawn the attention of the food industry for it is identified as a healthy grain for its nutritional value, especially because of the protein and lipid composition in its seed. In the food industry, quinoa seeds are ground in the form of flour, mixed with pseudo-cereal flours such as buckwheat and amaranth as well as wheat or other grains, and used in making of bakery products such as bread, pasta, pancakes, biscuits, noodles, cakes, and crackers (Valencia-Chamorro, 2003; Repo-Carrasco-Valencia & Serna, 2011). Quinoa is consumed as traditional food by the indigenous people of South America. Its seeds are used in soup-making in a similar way with rice and their flour are benefitted for production of baked products such as cookies, bread, biscuit, pasta, flakes, and pancake (Bhargava et al., 2006). In Chile, Ecuador, Bolivia, and Peru, quinoa seeds are used in the preparation of various baked desserts as well as stew, red pepper, casserole, salad, and soup. Quinoa can be used instead of rice as hot breakfast flakes or baby cereals obtained by boiling in water. Seeds can be popped as corn, ground to use as flour, or made germinate. Buds must turn green before being added to salads (Valencia-Chamorro, 2003). After removing the saponins, quinoa seeds are boiled in water for about 15–20 min and served as cereal. The cooked seeds rise two or three times more than the uncooked seeds and have a transparent appearance with the thin white strips encircled all through the middle part.

Various levels of substitution of quinoa flour have been reported as the flour obtained by grinding the quinoa seeds can be mixed with corn or wheat flour. For example; quinoa can be used at the rates of 10–13% in bread, 30–40% in noodle and pasta, and 60% in sweet biscuit (Tang et al., 2015). As the gluten-free products available on the market are of low quality, their nutrient values are also low (Schober, 2009). Low level of rising characteristics in gluten-free doughs is one of the biggest problems encountered in the production of grain products. The bread obtained by mixing up with quinoa flour rise better than the ones made from other gluten-free flour (Ruales & Nair, 1994). In the studies on the mixture of wheat and quinoa seeds, it was aimed to combine quinoa and whole grain flour with gluten-free bread. Quinoa starch draws attention as it is more resistant to water than the wheat starch and has high viscosity and low gelatinization temperature. Therefore, the use of quinoa white flour is seen as an important opportunity for making gluten-free bread (Schober, 2009; Verheyen, Jekle, & Becker, 2012).

The effects of quinoa flour on the quality and sensorial properties of the products are tried to be stated by conducting various studies on the use of quinoa in the production of products such as bread, cakes, and biscuits. It has been stated that quinoa can be mixed with wheat flour up to 60% and cakes, cookies and biscuits with high protein content can be produced. Thus, both energy and nutritional value are increased and the foods with acceptable aroma are obtained. However, the fact that quinoa does not have gluten in its compound limits its use in making bread (Ahamed, Singhal, Kulkarni, & Pal, 1998; Vilehe, Gely, & Santalla, 2003). Repo-Carrasco, Espinoza, and Jacobsen (2003) reported that quinoa flour can be added at the rates of 20% to making bread and 50% to pastry products. Lorenz and Coluter (1991) identified that the quality of the bread to which quinoa was added was good, that as the rate of the quinoa flour increased in the formulations the volumes of the bread decreased, that the pore structure in the bread was open, and that the texture hardened. They also expressed that its excessive use caused the taste of product to become bitter. And in the production of cakes, they identified that the addition of quinoa at the rate of 5–10% was acceptable and the softness of cakes decreased as the addition rate increased. Enriquez et al. (2003) reported that when compared to the dough made with wheat flour, the development time and stability of the quinoa flour added doughs decreased and the doughs that are harder and with less extensibility were obtained. It has been identified that the volume of bread decreased with the increase in the amount of quinoa in the bread as a result of the addition of quinoa leaf to wheat flour in the levels of 1–5%, and the hardness and stickiness of bread increased (Swieca, Seczyk, Gawlik-Dziki, & Dziki, 2014). Baker et al. (2013) reported that quinoa substitution does not have any effect on the water activity and volume of cakes and does not make a big difference on flexibility by reducing the hardness, one of the textural properties. The changes in appearance, odour, flavour, and taste of quinoa flour added doughs were found insignificant.

In a study conducted to produce gluten-free cakes and biscuits for people with celiac disease and autism (Atef, Abou-Zaid, El Faham, & Wafaa Emam, 2014), quinoa flour was used as a substitute for wheat flour. As the amount of quinoa flour increased, the water retention capacity of the flour, the development time and the softening degree of dough increased but the stability of the dough decreased. The use of quinoa flour in the formula of biscuit dough in increasing proportions increased the diameter values of biscuits while it decreased their thickness values. Wang, Opassathavorn, and Zhu (2015) produced bread and biscuit by mixing quinoa flour with wheat flour. Compared to wheat flour, the specific volumes of the products produced with quinoa flour + wheat flour decreased and their values of density, hardness, chewiness, and colour increased. It has been reported that the shelf lives of bread and biscuits increase as the ratio of quinoa flour in the dough composition increases.

Schumacher et al. (2010) added quinoa flour to bitter chocolate. They expressed that as the proportion of quinoa increased in the final product, the protein concentration of the products also increased and the sensorial properties of the products were acceptable. Pineli et al. (2015) recorded that in the preparation of quinoa milk, the protein content was increased by 3-fold as a result of soaking and then cooking in salty water by acidifying, but the aroma of the products should be improved. They also reported that quinoa milk has no known side effects in humans and may be a new alternative product with its increasing protein content and low glycemic index. Lorusso et al. (2017) recorded that the nutritional fibre, protein, and free amino acid contents of the pasta produced by fermented quinoa flour was higher, the contents of free amino acid, total phenolic substance, and antioxidant activity were 2 times more, the water absorption was low, and the cooking loss was low. It was also identified that the stickiness and elasticity of quinoa containing pasta were higher. In addition, they informed that the protein dietary indices such as *in vitro* protein digestibility and essential amino acid index, biological value, protein activity ratio, and nutritional index increased in the ones produced from fermented quinoa flour and that glycemic index decreased. Uncu, Jolayemi, and Unluturk (2017) reported that the breakfast puree they obtained from quinoa seeds had pseudoplastic properties and its colour was acceptable. They reported that this product could be an alternative to the breakfast cereals containing gluten.

The fact that it has a unique aroma and it does not have an intense taste/odour allowed quinoa, which is among the main ingredients of many foods and meals in cuisines worldwide, to be used in the cuisines. The kernels are cooked like rice or bulgur in various dishes and pilafs, the germinated seeds are used in salads and cold dishes as quinoa sprouts, and the leaves are used as vegetables similar to spinach. Quinoa flour is consumed by being added to a broad range of pastries such as bread, pasta, pancakes, biscuits, noodles, cakes, and crackers. It is also used by being fermented with millet in the production of beer-like beverages (Demir, 2014; Kaya, 2010; Koyun, 2013). It is stated that the consumption of one portion of quinoa (approximately 40 g) will meet a large part of the recommended dietary allowance (RDA) of the major nutrients and the health-related compounds.

Quinoa leaves can be compared with spinach leaves in terms of taste, while its leaves can be cooked as green vegetables, it can be consumed raw in salads as well as being used for preparing tonics, puddings, syrups, it can be used in all kinds of meat and vegetable dishes in which bread, pilaf, rice and bulgur take place, and in many areas such as pastries, etc. In addition, quinoa is a strategic crop that can be used for supplemental nutrition in rural areas where energy-protein malnutrition affects most of the population of developing countries.

In Table 2, the detailed information about the photos, ingredients, and preparations of the dishes with quinoa is given. Also the energy level and macro component contents of 1 portion of meals are given in Table 2.

6. Conclusion

Quinoa is a functional food as it contains many components that are important in terms of health. Quinoa, which does not include gluten and has a perfect content of food quality, is a good alternative product for the people with celiac disease who have to sustain their lives without a gluten-free diet and whose number is rising day by day. The fact that it has a unique aroma and it does not have an intense taste/odour has allowed quinoa, which is among the main ingredients of many foods and meals in cuisines worldwide, to be used in the cuisines worldwide. Used in various dishes by being cooked like rice and bulgur, quinoa also takes place in the preparation of many salads. Moreover, its flour obtained by grinding its seeds is added to various pastries and a wide range of usage area is created for it. It is thought that there needs to be more studies aiming to research the effects of energy and nutritional values of quinoa, which has an agricultural production history in Turkey, on the health. Besides, with its unique aroma, quinoa is thought to appeal to the taste buds of the people who do not have it in their cuisines and it is also thought that its usage in traditional foods and its production will increase with its substitution for flour, bulgur, and rice.

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Conflicts of interest

The authors declare no conflict of interest.

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