Hindawi
Journal of Food Quality
Volume 2022, Article ID 8622114, 7 pages
https://doi.org/10.1155/2022/8622114

Research Article

Evaluation of Physicochemical, Functional, and Sensorial Characteristics of Gluten-Free Turkish Noodle "Erişte" Formulated with Oat and Quinoa Flours

Gülşah Çalışkan Koç[1] **and Ravi Pandiselvam**[2]

[1]*Uşak University, Eşme Vocational School, Food Processing Department, Food Technology Program, Eşme, Uşak, Turkey*
[2]*Physiology, Biochemistry and Post-Harvest Technology Division, ICAR–Central Plantation Crops Research Institute, Kasaragod 671124, Kerala, India*

Correspondence should be addressed to Ravi Pandiselvam; r.pandiselvam@icar.gov.in

Received 21 May 2022; Revised 1 August 2022; Accepted 17 August 2022; Published 29 August 2022

Academic Editor: Zhen Zhen Cao

This study aimed to develop and characterize the new gluten-free erişte formulated by using oat flour (100%), quinoa flour (100%), and oat + quinoa flour blend (50% + 50% by weight). The physicochemical, functional, and sensorial properties of developed gluten-free eriştes were evaluated. The moisture content values of gluten-free erişte samples were lower than 12% wet basis (w.b.). The highest ash (3.74 ± 0.63%), fat (8.17 ± 0.19%), and protein (18.74 ± 0.41%) content values were obtained for quinoa flour erişte. The highest water (76.67 ± 9.07%) and oil holding capacity (49.50 ± 7.78%) values were observed for quinoa flour erişte and oat + quinoa flour erişte samples, respectively. The highest brightness ($L*$) value was observed for oat + quinoa flour erişte ($p < 0.05$). The quinoa flour erişte sample has the highest weight (354.22 ± 20.14%) and volume (268.20 ± 9.01%) increase values. The lowest (10.56 ± 1.83%) and highest (13.71 ± 0.83%) cooking loss values were observed from oat flour and quinoa flour erişte samples, respectively. In the light of the findings, it can be concluded that both oat and quinoa flours and their mixtures can be used to make gluten-free erişte, and the erişte samples were liked by the panelists.

1. Introduction

The consumption of pasta is increasing worldwide because of its easy preparation, convenience, palatability, and long shelf life. The nutritional benefits such as having low sodium and fat contents and high carbohydrate, vitamin, and iron contents [1] of pasta pay attention to the consumers. Erişte (Turkish noodle and Turkish egg pasta) is a traditional Turkish food that is prepared from wheat flour, whole egg, salt, water, and vegetable oil [2, 3].

Celiac disease is a food sensitivity that occurs with the consumption of various grains which include gluten-forming proteins, especially wheat. According to statistical findings, approximately 1% of the world population has celiac disease [4]. The rise in celiac disease increases the demand for healthy, nutritious, and economic gluten-free products [5]. Since there is no cure for celiac patients, lifelong gluten-free diets are required [6]. Following a gluten-free diet generally causes various nutrient deficiencies. For this reason, developing gluten-free product formulations for pasta that are nutritious and economic are very important [7]. In addition to celiac patients, some people avoid celiac consumption and follow a gluten-free diet for health reasons [8].

The cereals (rice, corn, and others), pseudocereals (buckwheat, quinoa, amaranth, and others), minor cereals (teff, proso millet, jungle rice, and others), and legumes (chickpea, lentil, soybean, and others) are generally used for gluten-free food formulations due to being gluten-free [7]. Quinoa (*Chenopodium quinoa*) is one of the pseudo-cereal grains and is widely preferred in the gluten-free diet and in the production of gluten-free processed foods. Although oat

(*Avena sativa*) includes gluten; however, as a result of the studies, it was concluded that the amount of gluten in oats can be tolerated by celiac patients [9]. As an alternative cereal, by incorporating oats into gluten-free product formulations, new product formulations rich in nutrient-enhanced fiber can be developed. When the studies on gluten-free noodle production were examined, it was found that amaranth, buckwheat, and quinoa flour blends were added to wheat flour on a substitution basis max. 30%, [10], buckwheat flour, rice flour, and corn starch combinations [11], *Macrolepiota procera* mushroom by substituting rice flour [12], quinoa and quinoa + buckwheat blends [14], and chia flour by substituting rice flour: corn starch [13] were used. When the studies were examined, although there were studies on pasta produced by adding a small amount of wheat flour, no study was found on the use of quinoa in making gluten-free erişte. Erişte is an important traditional product produced by mixing wheat flour, water, salt, and egg. Although its ingredients vary from region to region, it is produced by thinning, cutting, and drying the dough. It is a pasta-like product that differs from pasta by using flour instead of semolina. While its production at home was quite common in the past, it has started to be produced in factories due to factors such as being nutritious, easy accessibility and production, low cost, and long shelf life together with production for the developing industry. However, both home and factory productions need to develop healthy, suitable, tasty, and economic recipes using new and alternative flours for erişte, which is not suitable for consumption for individuals with celiac disease because it contains wheat flour. It is also known that vitamin and mineral deficiencies are observed in celiac patients due to malabsorption of nutrients. For this reason, the selection of the main ingredient for the gluten-free product is very important. Quinoa is rich in essential amino acids, and oat is rich in β-glucan. Besides being gluten-free, oat + quinoa flour blend has health beneficial effects such as lowering blood cholesterol and preventing heart diseases [15]. For this reason, this study aims to investigate the utilization of oat flour, quinoa flour, and oat + quinoa flour blend in the Turkish noodle (erişte) formulation and the effect of oat, quinoa, and oat + quinoa flour blend on the chemical and functional properties and consumer preferences of gluten-free erişte samples.

2. Materials and Methods

2.1. Material. Oat and quinoa flours (Naturelka CC Tourism Limited Company.), sunflower oil (Küçükbay Oil and Detergent Inc.), eggs (Keskinoğlu Poultry and Breeding Plant Inc.), and table salt (Refined Billur Salt Ind. Inc.) were purchased in fresh form from a local supermarket (Metro, Alanya, Turkey).

3. Methods

3.1. Erişte Production. In noodle production, the method specified by Dirim and Çalışkan Koç [16] was based on dough preparation, and minor modifications were made to provide the desired dough structure. All ingredients (210 g oat, quinoa, or oat + quinoa flours (50% + 50% by weight) (52 g whole egg, 8 g sunflower oil, 3 g table salt, and 72 g distilled water) were mixed in a bowl, and the production steps of gluten-free erişte are shown in Figure 1.

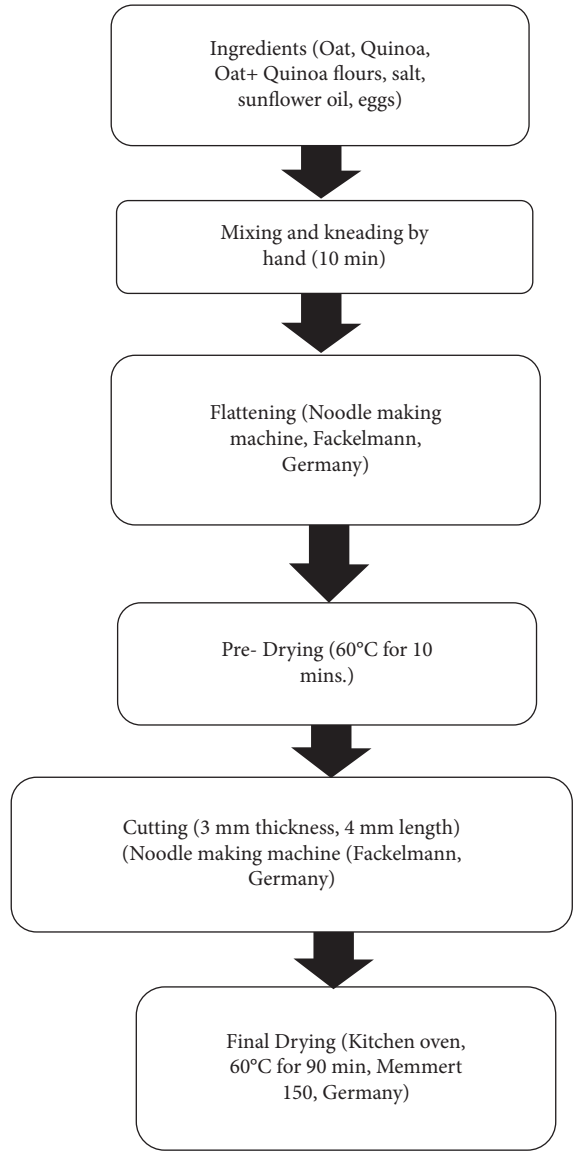

Figure 1: Preparation of gluten-free erişte.

3.2. Physicochemical Analysis. The moisture (No: 44–01), ash (No: 08–01), fat (No: 30–25), and protein (No: 46–12) contents of gluten-free erişte were determined according to AACC [17]. The pH and color values of gluten-free erişte samples were measured using a pH meter (Seven Excellence S 400 Mettler Toledo AG, China) and colorimeter (Minolta CR-400, Japan), respectively.

3.3. Functional Properties. Water hydration and oil holding capacity analysis were performed by using the method given by Stone et al. [18].

3.4. Cooking Quality. Volume expansion (%), water absorption (%), optimum cooking time, and cooking loss values were determined according to Yalçın and Basman [19] and AACC [17], respectively.

3.4.1. Sensory Evaluation. Before the sensory panels, the optimum cooking times of the erişte samples were determined, and the erişte samples were boiled in distilled water for the specified times. Sensory tests were conducted with untrained 20 panelists (AHEP University, Antalya, Turkey). The sensory test included attributes such as color, odor, hardness, elasticity, stickiness, homogeneity, flavor, residual taste, off-flavor, and overall acceptability (1-poor; 10-excellent).

3.5. Statistical Analysis. Erişte samples were produced two times, and analyzes were performed in three replicates. Statistical differences between samples were determined by ANOVA (analysis of variance, $\alpha = 0.05$, SPSS 20.0, SPSS Inc., Chicago, IL, USA.).

4. Results and Discussion

As a result of the published research, it has been observed that the dough structure of the pasta produced only with the use of gluten-free flour or cereals is not formed. For this reason, additional structuring agents such as hydrocolloid, egg white powder, and so on are necessary to obtain the desired dough structure in order to use in the extrusion process [20]. It can be stated that the nutritious gluten-free pasta using oat flour, quinoa flour, and oat + quinoa flour blend which is easy to make at home or in any commercial production can be successfully produced without any structuring agents. The main component of Turkish erişte is the whole egg, and it can be the reason to obtain the desired pasta dough structure. Guo et al. [21] also reported that the addition of egg white improved the quality of oat noodles. Schoenlechner et al. [5] reported that the addition of egg white improved the quinoa pasta quality by increasing the cooking weight and decreasing the cooking loss. In addition, the homemade Turkish noodle (erişte) is generally produced by traditional techniques; the extrusion process is not performed. It can be another reason for obtaining a successful dough formulation. Gao et al. [22] also reported that buckwheat, amaranth, quinoa, and oat flours have been widely used in the production of gluten-free products such as pasta due to their high nutritional value and being gluten-free. For this reason, the results of this study will supply useful information related to the utilization of oat flour, quinoa flour, and oat + quinoa flour blend in the gluten-free erişte formulation.

4.1. Physicochemical Properties of Gluten-Free Erişte Samples. The physicochemical and functional properties of the gluten-free erişte samples are presented in Table 1.

The moisture content values of erişte samples were lower than 12.00%. This value was found within the acceptable limits for Turkish Food Codex Pasta Communiqué (TFCPC, 2002/20) [23]. Differences between the moisture content values may be because of different moisture content and water hydration capacity of the flours. Zhang et al. [24] reported that the moisture content of pasta samples produced by wheat flour, wheat flour + 20% of ungerminated white quinoa, wheat flour + 20% of germinated white quinoa, wheat flour + 20% of ungerminated red quinoa, wheat flour + 20% of germinated red quinoa, wheat flour + 20% of ungerminated black quinoa, and wheat flour + 20% of germinated black quinoa are 8.42%, 8.91%, 9.61%, 8.74%, 8.93%, 8.69%, and 9.27%, respectively. Different pasta formulations may be the reason for different moisture content values. The carbohydrate, fiber, protein, and fat contents of oat and quinoa flours are 60.9%, 6.70%, 12.60%, and 5.50% and 58.00%, 12.25%, 14.50%, and 5.81%, respectively. The utilization of different flours in the erişte production did not result in a significant change in the ash and fat contents of samples ($p > 0.05$), whereas the protein and pH values changed significantly ($P < 0.05$). As expected, the higher fat and protein contents of quinoa flour compared to oat flour resulted in a higher fat and protein contents of quinoa flour erişte. Bilgiçli [14] studied the production of erişte by replacement of quinoa flour (100%) and quinoa + buckwheat flour blends (50% + 50%) at levels of 10, 20, and 30% with wheat flour. Results showed that the highest ash (1.8% dry basis (d.b.)), protein (13.4% d.b), cellulose (1.21% d.b), and fat (3.4% d.b) contents were obtained samples which include 30% quinoa flour due to high ash (2.30% d.b), protein (12.5% d.b), cellulose (2.50% d.b), and fat (5.5% d.b) contents of quinoa flour compared to wheat flour (ash: 0.45%, protein: 11.2%, cellulose: 0.51%, and fat: 0.6%, d.b) and buckwheat flour (ash: 1.91%, protein: 11.5%, cellulose: 1.20%, and fat: 2.3%, d.b). Similarly, in this study, noodles with high nutritional value (ash, protein, and fat contents) were obtained with the use of quinoa flour compared to oat flour. The reason for this is the composition of quinoa. Espinosa-Solis et al. [25] reported that replacing 50% of durum wheat semolina with oat bran resulted in higher lipid (2.78%), protein (13.52%), and ash (1.91%) contents than the control sample (100% durum wheat semolina, lipid: 2.67%, protein: 12.78%, and ash: 0.84%) due to high lipid (3.82%), protein (16.94%), and ash (6.68%) contents of oat bran. In this study, higher lipid, protein, and ash content values were observed due to different pasta formulations. According to TFCPC (2002/20), there is no limitation for the ash content of enriched pasta samples; however, the ash content of plain and enriched pasta should be higher than 15.5% (d.b.). The findings of this study are consistent with the TFCPC (2002/20).

5. Functional Properties of Gluten-Free Erişte Samples

The high-water hydration capacity and low-oil holding capacity are desired for food products due to storage stability, staling, and so on [26, 27]. Depending on this, it can be concluded that the quinoa flour erişte has superior properties in water hydration capacity, whereas the oat flour erişte has superior properties in oil holding capacity. The

Table 1: Physicochemical and functional properties of gluten-free erişte samples ($n = 3$).

Properties	Oat flour erişte	Quinoa flour erişte	Oat + Quinoa flour erişte
Moisture content (% wb)	11.41 ± 0.29 b	6.49 ± 0.97a	10.63 ± 0.36 b
Ash content (%, db)	3.38 ± 0.27a	3.74 ± 0.63a	3.24 ± 0.48a
Fat content (%, db)	8.02 ± 0.49a	8.17 ± 0.19a	8.14 ± 0.29a
Protein content (%, db)	15.51 ± 0.04a	18.74 ± 0.41c	16.52 ± 0.24 b
pH	6.54 ± 0.03 b	6.39 ± 0.01a	6.64 ± 0.01c
Water hydration capacity (%)	44.00 ± 4.58a	76.67 ± 9.07c	64.33 ± 4.79 b
Oil holding capacity (%)	42.50 ± 2.12a	44.67 ± 2.12a	49.50 ± 7.78a

Different letters in the rows indicate significant differences ($P < 0.05$).

higher dietary fiber content of 12.25% quinoa flour may be effective on the higher water hydration capacity of quinoa flour erişte. The lower moisture content of quinoa flour erişte may also be the reason for higher water hydration capacity. The differences between the oil holding capacity values of erişte samples were insignificant ($p > 0.05$).

5.1. Color Profile of Gluten-Free Erişte Samples. In Turkey, since vegetable-added pasta has been produced in recent years, green with spinach, orange with carrot, and so on, traditionally produced erişte are more yellow (golden yellow) than pasta because it contains eggs [28]. Therefore, the color of gluten-free noodles is an important quality factor in order to meet the color perception and expectation of consumers in traditional noodles. The color of food has an impact on purchasing preference [29]. The color values of gluten-free erişte samples are presented in Figure 2.

By visual inspection, it can be stated that the erişte samples have light brown color due to the brown color of oat and quinoa flours compared to wheat flour (Figure 3). Significantly high brightness values and low greenness and yellowness values were observed for oat + quinoa flour erişte ($p < 0.05$). The different colors of the flours used may also have affected the colors of the erişte samples. Barakat et al. [30] reported that the incorporation of 10–50% red-colored quinoa flour in wheat flour resulted in lower brightness values due to pigmented polyphenols of the quinoa.

6. Cooking Quality of Gluten-Free Erişte Samples

In this study, the cooking quality covers the volume expansion, water absorption, cooking loss, and optimum cooking time of gluten-free erişte samples, and the results are presented in Table 2.

The high weight and volume increase values may be the reason for the high-water absorption value of the quinoa flour erişte.

During the cooking of pasta, water-soluble substances such as nonstarch-polysaccharides in the structure pass into the boiling water [31]. Low stickiness and cooking loss values indicate the quality of the pasta [32]. The lowest cooking loss was obtained from oat flour erişte which includes gluten. The higher loss of total soluble solid of quinoa flour erişte maybe because of the lack of gluten. The

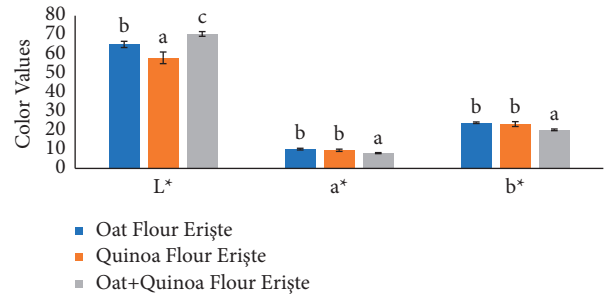

Figure 2: Color values of gluten-free erişte samples.

higher cooking loss values of quinoa flour erişte may also be due to the disruption of the protein-starch matrix by the fiber (12.25%), and the nonhomogeneous distribution of water within the erişte matrix may be due to the competitive hydration tendency of the fiber. The highest cooking time was observed for oat flour erişte, whereas the lowest cooking time was observed for oat + quinoa flour erişte ($p < 0.05$). Schoenlechner et al. [5] reported that cooking time, cooking weight, cooking loss, and firmness of pasta produced from 100% quinoa flour and quinoa flour + egg white (3% of flour) blend are 2.5 min, 244%, 10.21%, and 0.77 N, and 7 min, 279%, 8.88%, and 1.22 N, respectively. In addition, researchers reported that an increase in the egg white percentage (3, 6, 9, 12, and 15%) resulted in higher cooking time, cooking loss (except for 15%), and firmness, whereas lower values were observed for cooking weight. Different cooking time, cooking weight, and cooking loss values may be due to different pasta formulations. Moreover, in this study, the amount of egg was approximately 25% of the flour. The high amount of eggs may be the reason for the long cooking time and high cooking loss. Similar findings also observed by Guo et al. [21] revealed that the addition of the fresh egg white (0–30%) to the pasta formulation increased the cooking time and water absorbtion of 70% oat noodles. Bilgiçli [14] reported that an increase in the quinoa flour percentage (10–30%) resulted in a decrease in both water uptake (223–211%) and volume increase (228–215%) values; however, the opposite effect was observed for cooking loss (6.9–7.4%). Zhang et al. [24] reported that the addition of 20% of ungerminated and germinated white quinoa (6.77% and 9.78%), red quinoa (6.96% and 6.58%), and black quinoa (7.13% and 8.17%) flours to the wheat flour resulted in higher cooking loss values compared to the control

Figure 3: Gluten-free erişte samples.

Table 2: Cooking quality of gluten-free erişte samples ($n = 3$).

	Oat flour erişte	Quinoa flour erişte	Oat + quinoa flour erişte
Volume expansion (%)	143.40 ± 10.20a	354.22 ± 20.14 b	138.89 ± 5.43a
Water absorption (%)	158.80 ± 19.03a	268.20 ± 9.01 b	143.50 ± 9.19a
Cooking loss (%)	10.56 ± 1.83a	13.71 ± 0.83 b	11.89 ± 1.34a
Optimum cooking time (min)	14.75 ± 0.35 b	10.50 ± 0.70a	10.00 ± 0.00a

Different letters in the rows indicate significant differences ($P < 0.05$).

group (wheat flour, 6.14%). Barakat et al. [30] reported that the rehydration time, cooking loss, and water absorption values of pasta produced from wheat flour + 10–50%, red-colored quinoa flour and wheat flour +10–50%, and noncolored quinoa flour ranged between 246 and 280 s, 0.92–0.96%, and 68.08–70.52% and 245–278 s, 0.83–0.97%, and 67.56–70.11%, respectively. Espinosa-Solis et al. [25] reported that replacing 50% of durum wheat semolina with oat bran resulted in higher optimal cooking time (8.10 min), cooking loss (5.52 g/100 g), and water absorbtion index (269.33 g/100 g) compared to the control group (100% durum wheat semolina). It is thought that the reason for the higher cooking loss values observed in this study is that wheat flour is not used in erişte formulations.

7. Sensory Evaluation

Sensory ratings for gluten-free erişte samples are given in Figure 4.

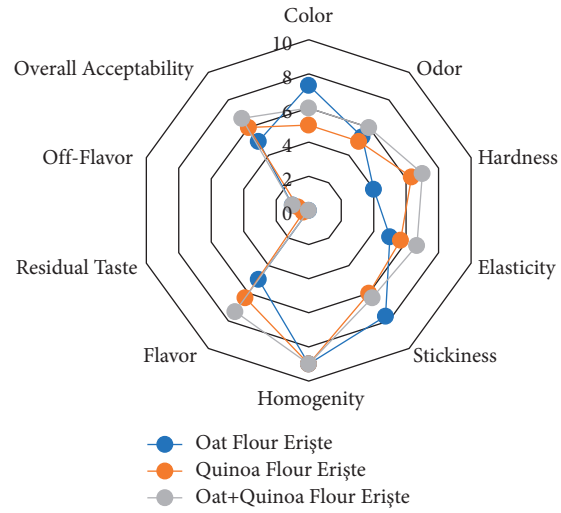

Figure 4: Sensory ratings for gluten-free erişte samples.

When the sensory analysis results are evaluated, it can be said that the panelists noticed that there was a difference between the erişte samples. The highest scores for color and stickiness were obtained for oat flour erişte, whereas the highest scores for odor, hardness, elasticity, flavor, and overall acceptability were obtained for the oat + quinoa flour erişte sample. The traditionally produced erişte should have a golden color. Depending on the results, although the erişte samples have a light brown color, the color scores of the erişte samples were higher than 5. The quinoa flour erişte has the lowest color score by the panelist which also has the lowest $L*$ value. Depending on this finding, it can be concluded that light brown color is acceptable for gluten-free erişte samples. No significant differences were observed for odor and homogeneity scores ($p > 0.05$). A significantly lower hardness score was observed for oat flour erişte ($p < 0.05$). Del Nobile et al. [33] reported that there is an inverse relationship between the protein content of pasta and its stickiness. Similar results were also obtained in this study. The highest stickiness score (7.66) was obtained for oat flour erişte which also has the lowest protein content (15.51%). The flavor scores of erişte samples were higher than 5 (oat flour erişte). The residual taste and off-flavor were not detected. Depending on the scores of overall

acceptability, it can be concluded that all gluten-free erişte samples are acceptable; however, a higher score was observed for the oat + quinoa flour erişte sample ($p < 0.05$). Bilgiçli [14] reported that an increase in the quinoa flour percentage (10–30%) resulted in a decreased taste, odor, chewiness, and overall acceptability scores of erişte samples. Barakat et al. [30] reported that the incorporation of 10–50% red-colored and noncolored quinoa flours in wheat flour caused a significant decrease in the stickiness, firmness, and overall acceptability scores of pasta samples. In addition, researchers reported that quinoa-based pasta products are acceptable to panelists. On the contrary, Mastromatteo et al. [34] investigated the effect of quinoa + oat flours, quinoa + oat + legume (chickpea and broad bean) flours, oat + maize flours, and quinoa + maize + soy flours on the sensory properties of the spaghetti samples. Results showed that although quinoa + oat flour spaghetti is suitable for processing according to its rheological properties, it had an unpleasant taste.

8. Conclusion

In a conclusion, Turkish traditional pasta (erişte) can be produced by using oat flour, quinoa flour, and their mixtures. The moisture contents of erişte samples were below 12%, which is within the limit set by TFCPC (2002/20) and is important for shelf life. The highest ash, fat, and protein contents were observed for quinoa flour erişte. Although erişte made from quinoa flour is advantageous in terms of volume increase, erişte made from oat flour has the lowest cooking loss value. It can be stated that the utilization of oat flour, quinoa flour, and oat + quinoa flour blend in the gluten-free erişte formulation resulted in acceptable sensorial properties. The effect of storage conditions and the addition of hydrocolloids such as gum, etc. to the gluten-free eri□te formulation on the chemical, functional, and cooking quality of the samples can be studied in further studies.

Data Availability

The datasets recorded during the current study are available from the corresponding author on request.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] M. Alireza Sadeghi and S. Bhagya, "Quality characterization of pasta enriched with mustard protein isolate," *Journal of Food Science*, vol. 73, no. 5, pp. S229–S237, 2008.

[2] N. Bilgicli, "Effect of buckwheat flour on cooking quality and some chemical, antinutritional and sensory properties of erişte, Turkish noodle," *International Journal of Food Sciences & Nutrition*, vol. 60, no. sup4, pp. 70–80, 2009.

[3] K. Aktaş, N. Bilgiçli, and H. Levent, "Influence of wheat germ and β-glucan on some chemical and sensory properties of Turkish noodle," *Journal of Food Science & Technology*, vol. 52, no. 9, pp. 6055–6060, 2014.

[4] M. Malalgoda and S. Simsek, "Celiac disease and cereal proteins," *Food Hydrocolloids*, vol. 68, pp. 108–113, 2017.

[5] R. Schoenlechner, J. Drausinger, V. Ottenschlaeger, K. Jurackova, and E. Berghofer, "Functional properties of gluten-free pasta produced from amaranth, quinoa and buckwheat," *Plant Foods for Human Nutrition*, vol. 65, no. 4, pp. 339–349, 2010.

[6] A. Rubio-Tapia, I. D. Hill, C. P. Kelly, A. H. Calderwood, J. A. Murray, and A. C. Gastroenterology, "ACG clinical guidelines: diagnosis and management of celiac disease," *American Journal of Gastroenterology*, vol. 108, no. 5, pp. 656–676, 2013.

[7] P. Jnawali, V. Kumar, and B. Tanwar, "Celiac disease: overview and considerations for development of gluten-free foods," *Food Science and Human Wellness*, vol. 5, no. 4, pp. 169–176, 2016.

[8] A. Marti and M. A. Pagani, "What can play the role of gluten in gluten free pasta?" *Trends in Food Science & Technology*, vol. 31, no. 1, pp. 63–71, 2013.

[9] M. C. P. de Souza, M. E. Deschênes, S. Laurencelle, P. Godet, C. C. Roy, and I. Djilali-Saiah, "Pure oats as part of the Canadian gluten-free diet in celiac disease: the need to revisit the issue," *Canadian Journal of Gastroenterology and Hepatology*, vol. 2016, pp. 1–8, 2016.

[10] E. Öncel and M. K. Demir, "Farklı oran ve kombinasyonlarda kullanılan yalancı tahıl unlarının erişte özelliklerine etkisi," *Akademik Gıda*, vol. 17, no. 4, pp. 468–475, 2019, (in Turkish).

[11] N. Bilgicli, "Utilization of buckwheat flour in gluten-free egg noodle production," *Journal of Food Agriculture and Environment*, vol. 6, no. 2, pp. 113–115, 2008.

[12] Ö. Süfer, "Gluten-free traditional Turkish noodle with Macrolepiota procera mushroom: functional, textural, thermal and sensory characteristics," *Cereal Chemistry*, 2022, (in Press).

[13] H. Levent, "Effect of partial substitution of gluten-free flour mixtures with chia (Salvia hispanica L.) flour on quality of gluten-free noodles," *Journal of Food Science and Technology*, vol. 54, pp. 1971–1978, 2017.

[14] N. Bilgiçli, "Effect of pseudocereal flours on some chemical properties and phytic acid content of noodle," *Quality Assurance and Safety of Crops & Foods*, vol. 6, no. 2, pp. 175–181, 2014.

[15] G. E. Inglett, D. Chen, and S. X. Liu, "Pasting and rheological properties of quinoa oat composites," *International Journal of Food Science and Technology*, vol. 50, no. 4, pp. 878–884, 2015.

[16] S. N. Dirim and G. Ç. Koç, "Functional properties of parsley fortified homemade Turkish noodles (Erişte)," *Croatian Journal of Food Science and Technology*, vol. 11, no. 1, pp. 88–96, 2019.

[17] AACC, *Approved Methods of the American Association of Cereal Chemists*, The Association, St Paul, MN, 8 edition, 1990.

[18] A. K. Stone, A. Karalash, R. T. Tyler, T. D. Warkentin, and M. T. Nickerson, "Functional attributes of pea protein isolates prepared using different extraction methods and cultivars," *Food Research International*, vol. 76, pp. 31–38, 2015.

[19] S. Yalçın and A. Basman, "Quality characteristics of corn noodles containing gelatinized starch, transglutaminase and gum," *Journal of Food Quality*, vol. 31, no. 4, pp. 465–479, 2008.

[20] A.-S. Hager, F. Lauck, E. Zannini, and E. K. Arendt, "Development of gluten-free fresh egg pasta based on oat and teff flour," *European Food Research and Technology*, vol. 235, no. 5, pp. 861–871, 2012.

[21] X. N. Guo, F. Gao, and K. X. Zhu, "Effect of fresh egg white addition on the quality characteristics and protein aggregation of oat noodles," *Food Chemistry*, vol. 330, Article ID 127319, 2020.

[22] Y. Gao, M. E. Janes, B. Chaiya, M. A. Brennan, C. S. Brennan, and W. Prinyawiwatkul, "Gluten-free bakery and pasta products: prevalence and quality improvement," *International Journal of Food Science and Technology*, vol. 53, no. 1, pp. 19–32, 2018.

[23] *Turkish Food CodexCommunique on Pasta, Communique No: 2002/20*, https://www.resmigazete.gov.tr/eskiler/2002/03/20020305.htm#10, 2021.

[24] Y. Zhang, Z. Ma, H. Cao, K. Huang, and X. Guan, "Effect of germinating quinoa flour on wheat noodle quality and changes in blood glucose," *Food Bioscience*, vol. 48, Article ID 101809, 2022.

[25] V. Espinosa-Solis, P. B. Zamudio-Flores, J. M. Tirado-Gallegos et al., "Evaluation of cooking quality, nutritional and texture characteristics of pasta added with oat bran and apple flour," *Foods*, vol. 8, no. 8, p. 299, 2019.

[26] M. Hayta, M. Alpaslan, and A. Baysar, "Effect of drying methods on functional properties of tarhana: a wheat flour-yogurt mixture," *Journal of Food Science*, vol. 67, no. 2, pp. 740–744, 2002.

[27] M. Siddiq, R. Ravi, J. B. Harte, and K. D. Dolan, "Physical and functional characteristics of selected dry bean (Phaseolus vulgaris L) flours," *LWT - Food Science and Technology*, vol. 43, no. 2, pp. 232–237, 2010.

[28] S. N. Dirim and G. Çalışkan, "Enhancement of the functional properties of home-made style Turkish noodles (Eriste) with the addition of fresh mints," *Journal of Food Physics*, vol. 30, pp. 4–14, 2017.

[29] E. Carini, E. Vittadini, E. Curti, and F. Antoniazzi, "Effects of different shaping modes on physico-chemical properties and water status of fresh pasta," *Journal of Food Engineering*, vol. 93, no. 4, pp. 400–406, 2009.

[30] H. Barakat, A. Shams, P. Denev, and I. Khalifa, "Incorporation of quinoa seeds accessions in instant noodles improves their textural and quality characteristics," *Journal of Food Science & Technology*, vol. 59, no. 5, pp. 1912–1921, 2022.

[31] C. M. Ajila, M. Aalami, K. Leelavathi, and U. P. Rao, "Mango peel powder: a potential source of antioxidant and dietary fiber in macaroni preparations," *Innovative Food Science & Emerging Technologies*, vol. 11, no. 1, pp. 219–224, 2010.

[32] M. Lucisano, C. Cappa, L. Fongaro, and M. Mariotti, "Characterisation of gluten-free pasta through conventional and innovative methods: evaluation of the cooking behaviour," *Journal of Cereal Science*, vol. 56, no. 3, pp. 667–675, 2012.

[33] M. A. Del Nobile, A. Baiano, A. Conte, and G. Mocci, "Influence of protein content on spaghetti cooking quality," *Journal of Cereal Science*, vol. 41, no. 3, pp. 347–356, 2005.

[34] M. Mastromatteo, S. Chillo, V. Civica, M. Iannetti, N. Suriano, and M. A. Del Nobile, "A multistep optimization approach for the production of healthful pasta based on nonconventional flours," *Journal of Food Process Engineering*, vol. 35, no. 4, pp. 601–621, 2012.