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Optimization of Pasta Formulation Containing Wheat, Quinoa Flour and Purslane Leaves Powder

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ABSTRACT: Pasta is a product of wheat flour, which is one of the most important cereal products in the world. While pasta contains 11-15% protein, it is deficient in the amino acids lysine and threonine. Therefore, the objective of this study was to evaluate the effect of enrichment with Quinoa flour and *Portulaca oleracea* leaves powder on physicochemical, sensory and nutritional properties of pasta. The present study was undertaken to optimize the level of wheat, quinoa flour and purslane leaves powder for the development of pasta using response surface methodology. In order to enrich the pasta, different levels of quinoa flour and *Portulaca oleracea* leaves powder were substituted for semolina in the pasta formulation according to the RSM plan, and the moisture, protein, total ash, fiber, α-tocopherol (vitamin E) contents of all treatments, as well as the color indicators and sensory properties (shape, color, aroma and taste, texture, and overall acceptability) were evaluated. Pasta samples with a higher level of quinoa flour and purslane leaves powder showed higher protein, moisture, ash, crude fiber, total color difference with control sample (ΔE), tocopherol (vitamin E), as well as the cooking number. By increasing the level of quinoa flour and purslane leaves powder, L* index and b* index were decresed. The optimized pasta contained 5.89% quinoa flour and 0.74% *Portulaca oleracea* leaves powder. Sensory evaluation showed that there was no significant difference between the taste and smell score, color, shape, texture and overall evaluation of the control pasta sample and the produced pasta sample based on optimization formulation (P>0.05).

Keywords: Enrichment, Nutritional quality, Pasta, *Portulaca oleracea* Leaves Powder, Quinoa Flour, Semolina.

Introduction

In recent years, noodle and pasta products have been considered as one of the most important staple foods for a large number of the world's population (Gharibzahedi *et al.*, 2019). Pasta is a healthy nutritional diet and has great scope as an ideal functional food if supplemented with additional healthy ingredients. Pasta has been recognized as an identifying ingredient of a traditional healthy diet all over the world. Besides, supplementation of the health ingredient should in no way affect the palatability as well as the consumer preference. Apart from the additional health benefits it offers, it

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should be delicious as well (Krishnan *et al.,* 2012). Pasta could be appropriately designed and would operate as a functional food if healthy components were to be incorporated into its formulation (Borneo *et al.*, 2008). Pasta is a source of carbohydrates (74–77%, dry basis) whose interest is increasing due to its nutritional properties, particularly its low glycemic index (GI) (Monge *et al.,* 1990). Pasta also contains 11–15% proteins but is deficient in lysine and threonine, common to most cereal products. This provides an opportunity for the use of non-traditional raw materials to increase the nutritional quality of pasta (Bashir *et al.,* 2012).

Quinoa (*Chenopodium quinoa Willd*.) is a good source of dietary fiber and vitamins such as thiamin, riboflavin, folate as well as a great source of minerals like ferric, magnesium, phosphorus, copper, zinc and manganese. Quinoa has a considerable amount of phenolic components like flavonoids and overall antioxidants, in addition to containing essential fatty acids like oleic and linoleic acids (Jaldani *et al.,* 2018). Quinoa contains proteins with a high level of essential amino acids, and among these, lysine is present in a high percentage; Furthermore, it contains dietary fiber, lipids rich in unsaturated fats, important amounts of micronutrients such as phosphorus, magnesium, iron, vitamin C, bioactive compounds like saponins, phytosterols, squalene, fagopyritols, and polyphenols. Its consumption has been linked to the decrease of the risk of diseases associated with oxidative stress, such as cancer and cardiovascular diseases (Gómez-Caravaca *et al.,* 2011).

Purslane (*Portulaca oleracea* L.) is an annual green herb with edible succulent stems and leaves, slightly acidic and spinach-like taste (Oliveira *et al.,* 2009). Purslane has been ranked as the eighth most common plant in the world (Coquillat, 1959), and is listed in the World Health Organization as one of the most used medicinal plants, and it has been given the term "Global Panacea" (Anthony & Dweck, 2001; Samy, 2005). Recent research demonstrated that purslane is a good source of compounds with a positive impact on human health. Those compounds include omega-3 fatty acids and β-carotene (Liu *et al.,* 2000). Vitamins and essential amino acids, α-tocopherols, ascorbic acid, and glutathione, as well as phenolics and coumarins. Organic acids are also present and alkaloids have been reported to be important chemical constituents of this species (Oliveira *et al.,* 2009).

Materials and Methods

- *Materials*

Purslane (*Portulaca oleracea*) was procured from the local market in Ahvaz, Khouzestan, south of Iran. Quinoa flour was purchased from the Elia trade company in Mashhad, Iran; besides, commercial pasta wheat flour was obtained from the Research and Development department of the Zar Macaron factory. Purslane leaves were washed, rinsed, and air-dried at room temperature (25–30°C) until a constant weight was attained. Dried leaves were milled (China Flour Mill, China), and sifted to produce purslane green leaves flour. Flour samples were stored in air-tight dark plastic bags until needed for pasta production.

- *Pasta preparation*

Semolina, quinoa flour and *Portulaca oleracea* leaves powder blends were prepared according to the RSM plan, Table 1. Pasta samples were manufactured following a small-scale pilot procedure (Le monferrina, Masoero Arturo, Italy) in the Zar Macaron factory. In order to produce the samples, the ratios of wheat, quinoa flour and *Portulaca oleracea* leaves powder were mixed according to Table 1; furthermore, the mixture of water (30%) and 0.0001% beta-carotene were added in the mixing chamber of the double screw extruder (Le monferrina, Masoero Arturo, Italy) for 10 min to distribute the water uniformly throughout the flour. They were then mixed well until the dough was smooth. The dough was inserted into the extruder tube and kneaded under high pressure. The dough was pressed out of the pasta mold, and formed into pasta strands. The strands were then cut and transferred to the incubator. The samples were kept in the incubator at a maximum temperature of 40°C for about 12 hours. After cooling, the pasta was packed in 500 g packages. The samples were then subjected to various physicochemical, sensory, and nutritional analysis.

- *Physicochemical analysis*

The ash, the protein, the moisture and the crude fiber content of samples was determined according to the ISIRI 2706, the ISIRI 19052, the ISIRI 2705 and the ISIRI 3105, respectively.

- *Cooking quality*

The cooking quality and the cooking loss were determined according to the ISIRI 213.

- *Sensory evaluation*

A panel consisting of 10 trained panelists (n=10)was employed for indicating the (Shape, color, aroma and taste, texture, and overall acceptability) of the samples. To this aim, a five-point hedonic rating scale, where 1 corresponded to extremely unpleasant, 5 to extremely pleasant was used.

- *Nutritional value evaluation*

Vitamin E analysis of samples was conducted by the spectrophotometric method and a solution of 1 mmol/litre uric acid was used as standard (Koracevic *et al.*, 2001).

- *Color measurement*

The values of surface color (L*, a* and b*) of raw pasta in terms of lightness (L) and color (+a: red −a: green; +b: yellow −b: blue) were measured using Hunter Lab color measuring system (Color measuring Lab Scan XE system, USA). All the parameters were carried out in triplicate and the means values were reported.

- *Statistical analysis*

Analysis has been performed based on using Design-Expert software for Response Surface Methodology (RSM).

Results and Discussion

- *Sensory characteristics of pasta samples*

Sensory evaluation was carried out as per five-point hedonic rating scale. A panel consisting of 10 trained panelists (n=10) was employed for indicating the (Shape, color, aroma and taste, texture, and overall acceptability) of the samples. There is no significant difference between the shape, color, aroma and taste, texture, and overall acceptability points of control pasta samples and pasta samples produced based on optimization formulation. Texture and appearance are the most important sensory attributes, therefore typical consumers would prefer products with desirable hardness and brightness without any discoloration (Hatcher & Anderson 2007).

- *Optimization*

The numerical optimization was performed to calculate optimal values for independent variables. The most desired formulation with high desirability was chosen to produce a high-quality product. Based on optimization results, the selected sample consisted of 5.89% Quinoa flour and 0.74% *Portulaca oleracea* leaves powder.

Table 1. Full experimentally response surface method of quinoa flour and *Portulaca oleracea* leaves powder in pasta formulation

Run	Factor1 A: Quinoa flour%	Factor2 B: Purslane leaves%
1	7	0/6
2	8	0/8
3	8	0/8
4	8	0/8
5	8	1
6	8	0/8
7	8	0/6
8	5	0/5
9	10	0/5
10	5	0/5
11	5	1/5
12	10	0/6
13	10	1/5

Table 2. Results of comparing the mean scores of sensory evaluation parameters of control and optimized pasta samples

Sample	Aroma and Taste	Color	Shape	Texture	Overall acceptability
Control pasta	4.70± 0.48[a]	4.90± 0.31[a]	4.90± 0.31[a]	4.40± 0.51[a]	4.80± 0.42[a]
Optimized pasta	4.60± 0.51[a]	4.60± 0.51[a]	4.80± 0.42[a]	4.30± 0.48[a]	4.70± 0.48[a]

* Means of three replicates ± SD
* The presence of at least one similar letter in each column indicates that no significant difference is between the values ($p>0.05$).

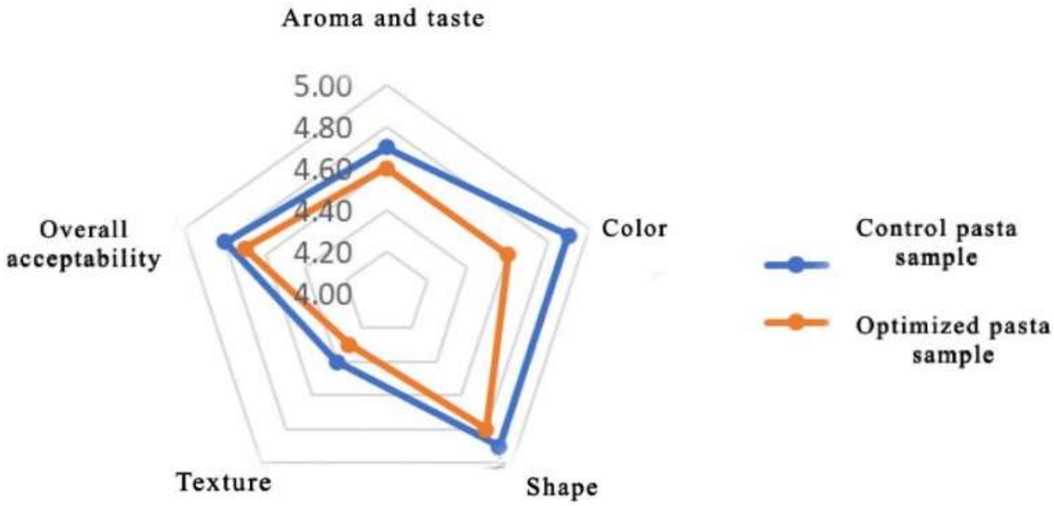

Fig. 1. Spider diagram of the sensory evaluation

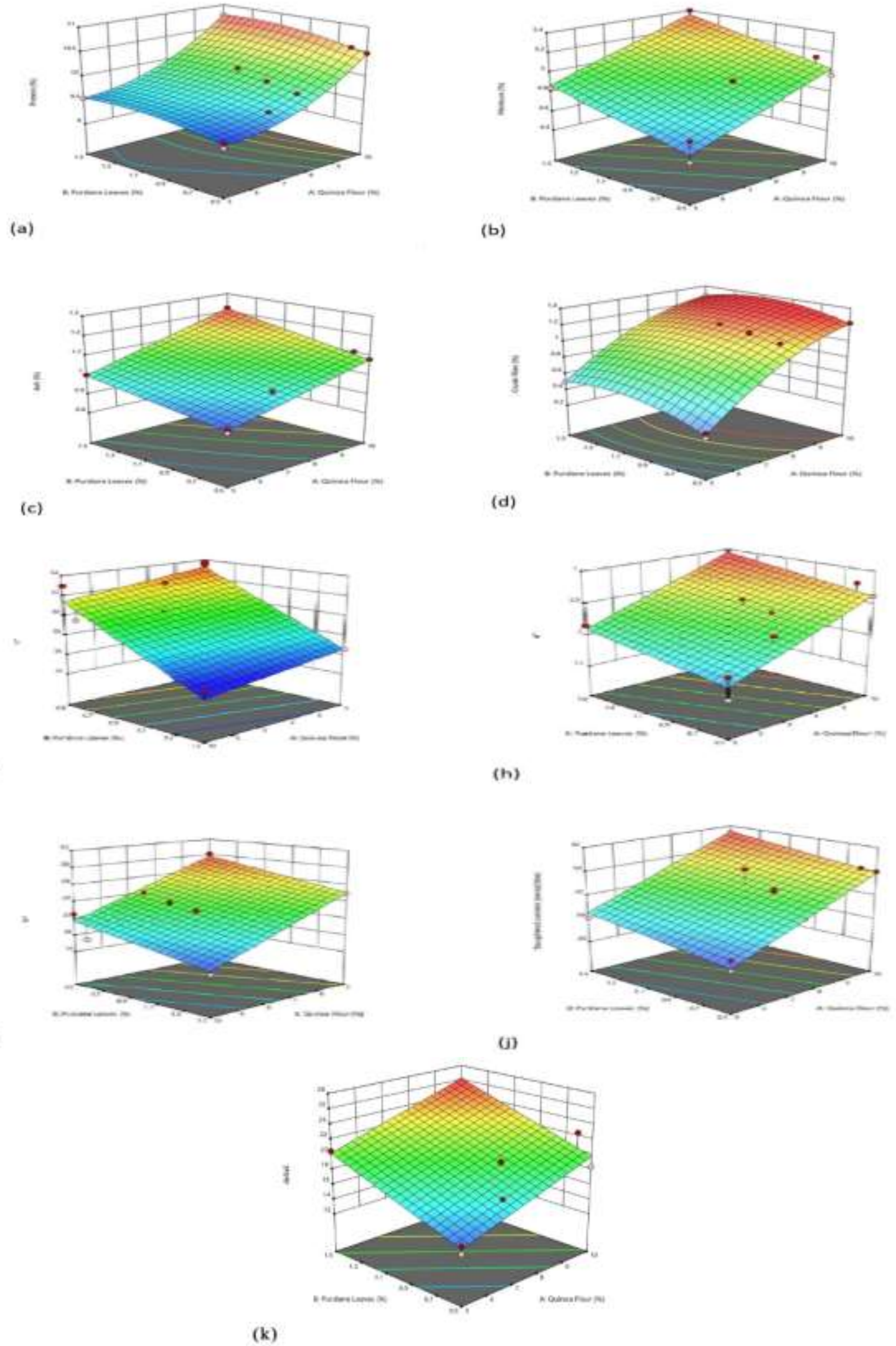

Fig. 2. Response surfaces plots for the effects of: (a) Protein, (b) Moisture, (c) Ash (d) Fiber (e) Cooking number (f): Cooking loss (g): L* index (h): a* index (i): b* index (j): α-tocopherol (k): ΔE.

- Protein

According to Figure (2-a), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant increase in protein percentage of the produced pasta samples ($P<0.05$). The protein in quinoa is one of the few non-animal proteins that is quantitatively and qualitatively better than other grains and its protein content is twice that of wheat. (James, 2009). Since, *Portulaca oleracea* powder is rich in protein, adding it to wheat flour increases the protein content of wheat flour (Goli *et al.*, 2019).

- Moisture

According to Figure (2-b), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant increase in moisture content of the produced pasta samples ($P<0.05$). Increasing the amount of quinoa flour in the formulation has increased the moisture content between the samples, which is most likely due to the presence of fiber and protein compounds in quinoa seeds. The increase in water uptake is due to a large number of hydroxyl groups present in the fiber molecules, which allow more interaction with water through hydrogen bonds. (Cho, 2001).

- Ash

According to Figure (2-c), a higher level of quinoa flour and purslane leaves powder showed a significant increase in ash content ($P<0.05$). Ghasemzadeh *et al.* (2017) showed that increasing the percentage of quinoa in the formulation, also increased the amount of ash and minerals in gluten-free bread.

- Fiber

According to Figure (2-d) a higher level of quinoa flour and purslane leaves powder showed a significant increase in the crude fiber content ($P<0.05$). Naghavi *et al.* (2011) found that increasing the amount of *Portulaca oleracea* powder in the amounts of 5, 10, 15 and 20%, also increased the amount of crude fiber.

- Cooking number

According to Figure (2-e), a higher level of quinoa flour and purslane leaves powder showed a significant increase in the number of cooking pasta samples ($P<0.05$). The increase in the cooking number in samples containing quinoa flour and *Portulaca oleracea* powder may be due to gluten dilution. In this way, the more the amount of pasta protein increases due to the addition of ingredients with protein, the higher the amount of cooking due to the dilution of gluten (Shakeri *et al.*, 2012).

- Cooking loss

According to Figure (2-f), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant increase in protein percentage of total solids in the cooking water of the produced pasta samples ($P<0.05$). In the control sample, to which no protein was added, the rate of cooking loss was less than that produced from quinoa flour and *Portulaca oleracea* leaves powder. This shows that there is a direct relationship between the amount of protein and the decrease in the product produced (Kooshki *et al.*, 2021).

- L* index

According to Figure (2-g), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant decrease in the L* index of the produced pasta samples ($P<0.05$). The darker color of quinoa flour than control bread is due to the presence of Betalain pigment in it and also quinoa flour was used as whole flour (along with bran) which has darkened its color. On the other hand, the presence of reducing sugars and amino acids such as lysine in quinoa causes non-enzymatic browning of Millard during the baking process, which itself causes the color of bread to darken (Ghasemzadeh *et al.*, 2017).

- *a* index*

According to Figure (2-h), a higher level of quinoa flour and purslane leaves powder showed a significant increase in a* index and the redness of the pasta samples ($P<0.05$). The use of *Portulaca oleracea* leaves powder due to its dark green color and quinoa flour due to its darker color has increased the a* index (Jaldani *et al.*, 2018). Ghasemzadeh *et al.* (2017) found that with the addition of quinoa flour, a* index increased significantly ($P<0.01$).

- *b* index*

According to Figure (2-i), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant decrease in the b* index and the yellowness of the produced pasta samples ($P<0.05$) The use of *Portulaca oleracea* leaves powder due to its dark green color and quinoa flour due to its darker color has reduced the b* index (Jaldani *et al.*, 2018). Ghasemzadeh *et al.* (2017) showed that with the addition of quinoa flour, b* index decreased significantly ($P<0.01$).

- *α-tocopherol*

According to the Figure (2-j), it can be seen that a higher level of quinoa flour and purslane leaves powder showed a significant increase in the tocopherol content of the pasta samples. ($P<0.05$) *Portulaca oleracea* is rich in phenolic, polyphenolic compounds and antioxidants (Simopoulos *et al.*, 1995). The amount of α-tocopherol increased with the increase of *Portulaca oleracea* powder in the samples due to the high amount of tocopherol in *Portulaca oleracea* powder compared to wheat flour.

- *ΔE*

According to Figure (1-k), the increase in percentage of quinoa flour and purslane leaves powder lead to a significant increase in the total color difference with control sample (ΔE) ($P<0.05$).

Conclusion

Quinoa, scientifically known as *Chenopodium quinoa Willd.*, is rich in fiber, vitamins B, C and E and contains minerals such as iron, zinc, magnesium and potassium. *Portulaca oleracea*, scientifically known as *Portulaca oleracea L.*, is an excellent source of α-linolenic acid, an omega-3 fatty acid that plays an important role in human growth and disease prevention. Pasta samples with a higher level of quinoa flour and purslane leaves powder showed higher protein, moisture, ash, crude fiber, index a*, total color difference with control sample (ΔE), tocopherol (vitamin E), as well as the cooking number ($P<0.05$). Moreover, increasing the quinoa flour and *Portulaca oleracea* leaves powder decreased the index L* and the index b* ($P<0.05$). Based on the optimization formulation, it was found that the best percentage of quinoa flour was 5.89% and the best percentage of *Portulaca oleracea* leaves powder was 0.74%. Such pasta samples had 9.53% protein, 4.71% moisture, 0.96% ash, 0.69% crude fiber, 77.12 g cooking number, 13.06% total solids in cooking water, 61.28 L* index, 2.00 a* index, 26.05 b* index and the amount of tocopherol and the desirability were 31.17 mmol/liter and 0.858 respectively. Sensory evaluation showed that there was no significant difference between the taste and smell score, color, shape, texture and overall evaluation of the control pasta sample and the produced pasta sample based on optimization formulation (P>0.05).

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References

Anthony, C. & Dweck, F. L. S. (2001). Purslane (Portulaca oleracea) the global panacea. *Personal Care Magazine*, *2*(4), 7-15.

Bashir, K., Aeri, V. & Masoodi, L. (2012). Physio-chemical and sensory characteristics of pasta fortified with chickpea flour and defatted soy flour. *Journal of Environmental Science, Toxicology and Food Technology*, *1*(5), 34-39.

Borneo, R. & Aguirre, A. (2008). Chemical composition, cooking quality, and consumer acceptance of pasta made with dried amaranth leaves flour. *LWT-Food Science and Technology*, *41*(10), 1748-1751.

Cho, S. S. (Ed.). (2001). *Handbook of dietary fiber*. CRC Press.

Coquillat, M. (1959). Cl.-Ch. Mathon. — La greffe végétale. Col. «Que sais-je ?» N° 814, Paris, *Publications de la Société Linnéenne de Lyon*, 239-240.

Gharibzahedi, S. M. T., Yousefi, S. & Chronakis, I. S. (2019). Microbial transglutaminase in noodle and pasta processing. *Critical reviews in food science and nutrition*, *59*(2), 313-327.

Ghasemzadeh, S., Nasehi, B. & Noshad, M. (2017). Formulation Optimization of Gluten-free Bread based on Quinoa, Corn and Rice Flour. *Iranian Journal of Nutrition Sciences & Food Technology*., 12, 59-68.

Goli, M., Zia, M. A. & Sadeghzadeh, N. (2019). Determination of pharyngeal characteristics of wheat flour dough enriched with portulaca oleracea powder. *Iranian Journal of Food Science and Technology*, *16*(91), 57-63.

Gómez-Caravaca, A. M., Segura-Carretero, A., Fernandez-Gutierrez, A. & Caboni, M. F. (2011). Simultaneous determination of phenolic compounds and saponins in quinoa (*Chenopodium quinoa Willd*) by a liquid chromatography–diode array detection–electrospray ionization–time-of-flight mass spectrometry methodology. *Journal of Agricultural and Food Chemistry*, *59*(20), 10815-10825.

Hatcher, D. W. & Anderson, M. J. (2007). Influence of alkaline formulation on oriental noodle color and texture. *Cereal Chemistry*, *84*(3), 253-259.

Jaldani, S., Nasehi, B., Barzegar, H. & Sepahvand, N. (2018). Optimization of physical and imaging properties of flat bread enriched with quinoa flour. *Nutrition and Food Sciences Research*, *5*(3), 33-42.

Kooshki, N., Haddad Khodaparast, M. H., Najafi Mirak, T., Vazifeh Doost, M. & Naghi Pour, F. (2021). Effect of Tahini Meal Isolated Protein Addition on Technological and Sensory Characteristics of Pasta Prepared from Durum Wheat and Bread Wheat. *Journal of Innovation in Food Science and Technology*, *12*(4(46)), 41-53 [In Persian].

Koracevic, D., Koracevic, G., Djordjevic, V., Andrejevic, S. & Cosic, V. (2001). Method for the measurement of antioxidant activity in human fluids. *Journal of Clinical Pathology*, *54*(5), 356-361.

Krishnan, M. & Prabhasankar, P. (2012). Health based pasta: redefining the concept of the next generation convenience food. *Critical reviews in food science and nutrition*, *52*(1), 9-20.

James, L. E. A. (2009). Quinoa (*Chenopodium quinoa Willd*.): composition, chemistry, nutritional, and functional properties. *Advances in Food and Nutrition Research*, *58*, 1-31.

Liu, L., Howe, P., Zhou, Y. F., Xu, Z. Q., Hocart, C. & Zhang, R. (2000). Fatty acids and β-carotene in Australian purslane (Portulaca oleracea) varieties. *Journal of chromatography A*, *893*(1), 207-213.

Monge, L., Cortassa, G., Fiocchi, F., Mussino, G. & Carta, Q. (1990). Glycoinsulinaemic response, digestion and intestinal absorption of the starch contained in two types of spaghetti. *Diabetes, Nutrition and Metabolism*, *3*, 239-246.

Naghavi, S., Jafarzadeh Moghadam, M., Payghambardoost, S. H., Oladghaffari, A. & Azadmard-Damirchi, S. (2011). Fortification of wheat flour with purslane seed powder: Studying flour characteristics and dough rheological properties. *Journal of Food Research (Agricultural Science)*, *21*(3), 281-294 [In Persian].

Oliveira, I., Valentão, P., Lopes, R., Andrade, P. B., Bento, A. & Pereira, J. A. (2009). Phytochemical characterization and radical scavenging activity of Portulaca oleraceae L. leaves and stems. *Microchemical Journal*, *92*(2), 129-134.

Samy, J. (2005). Herbs of Malaysia: an introduction to the medicinal, culinary, aromatic and cosmetic use of herbs. *Malaysia: Times Editions*.

Shakeri, V., Tarzi, B. G. & Ghavami, M. (2012). The effects of wheat germ on chemical, sensorial, cooking and microbial properties of Pasta. *Iranian Journal of Nutrition Sciences & Food Technology*, *7*(3(26)), 89-100.

Simopoulos, A. P., Norman, H. A. & Gillaspy, J. E. (1995). Purslane in human nutrition and its potential for world agriculture. *Plants in human nutrition*, *77*, 47-74.