Research Paper

The Quality of Pasta with the Addition of Buckwheat Microgreens or Sprouts

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ABSTRACT

Sprouts and microgreens are important functional foods used as nutrition supplements. The aim of this work was to test the possibility of pasta production with different proportions of buckwheat sprouts or microgreens and evaluate their selected qualitative properties. Semolina pasta containing different proportions of flour from buckwheat sprouts (10-20%) and buckwheat microgreens (10%) were produced. Optimal cooking time, cooking water absorption, swelling, cooking losses, adhesion, color, overall look, surface, elasticity, translucency, flavour, taste, and the overall impression were evaluated. For pasta production, buckwheat sprout flour can be recommended in a portion of up to 10%.

INTRODUCTION

Buckwheat sprouts have a slightly crispy texture and an attractive fragrance (Kim et al. 2004). They are abundant in amino acids (28–38% higher than in seeds), especially lysine, vitamins (especially vitamins C and B, α-tocopherol, and carotenoids), minerals, crude fiber, and flavonoid contents (Sun Lim et al., 2001).

Microgreens are slightly larger and older (usually 5-10 cm tall) than sprouts. They are harvested after the cotyledon leaves have developed, at the first true leaf stage (Treadwell et al. 2020). Microgreens are used as a nutrition supplement, visual enhancement, and food flavour and texture enhancement (Wojdyło et al., 2020). Sprouts and microgreens are considered "functional foods" because they are rich in vitamins, minerals, and antioxidants, and their popularity has been constantly growing (Brentlinger, 2007; Choe and Wang, 2018).

Although sprouts have been a diet staple in Chinese culture for over 5,000 years, they remain relatively unpopular in other countries (Food Source Information 2022). Fortification is the incorporation of bioactive compounds within a food matrix to prevent specific nutrient deficiencies and promote population health (Dwyer et al., 2015). Therefore, a possible way to include sprouts or microgreens in human nutrition is to fortify food such as bread, pasta, noodles, and breakfast flakes with these raw materials.

The global pasta market reached about USD 25.67 billion in 2022 and is expected to reach approximately USD 31.14 billion by 2028 (EMR2023). WHO (the World Health Organization) and FAO (the Food and Agriculture Organization of the United Nations) described pasta as a healthy, sustainable, and quality food model (Bresciani et al., 2022). Clinical data suggest that pasta consumption is not directly associated with overweight or obesity in healthy children and adults (Sanders and Slavin, 2023). Cooked pasta can have a low glycaemic index, is cholesterol-free, and is low in sodium (EMR 2023).

In the last two decades, there has been much research into improving pasta nutritional value by including non-conventional ingredients (dietary fibre, fish ingredients, herbs, inulin, resistant starches, legumes, vegetables, and protein extracts). Buckwheat, amaranth, or quinoa are becoming increasingly popular as ingredients in pasta due to improving nutritional quality too (Kahlon and Chiu, 2015). However, these ingredients can affect the technological properties, such as the texture, taste, and odor of the pasta (Gao et al., 2018). Health effects with good taste, texture, and an acceptable price are essential for the consumer demand for such foods (Sissons, 2022).

This work aimed to test the possibility of pasta production with different proportions of buckwheat sprouts or microgreens and evaluate their qualitative properties

MATERIAL AND METHODS

Sprouts preparation

The common buckwheat (*Fagopyrum esculentum* Moench) achenes (500g), Jana variety from organic farming were cleaned and freed from foreign seeds and mechanically dehulled. 250 g of seeds surface-sterilized were presoaked in sterile water for 4 h. The seeds were directly placed into 40×40 cm plastic trays with two sheets of filter paper (KA 1) saturated with sterile water and incubated in the thermostat at 25±1°C under dark conditions for 96 hours. The seedlings were sprayed with water daily. The plant material was dried in a ventilated oven at 45±1°C for 48 h.

Microgreens preparation

For microgreens, the achenes were directly placed into a double-bottomed container. A hemp non-woven fabric was placed on the upper, perforated bottom of the container with 1x1 cm holes, and buckwheat achenes were placed on the fabric. The container was closed with an opaque lid for five days. Then the lid was removed. Plants were incubated in the thermostat at 25±1°C under dark conditions. Eleven days after the start of the experiments, sprouts were cut 10 mm above the surface for microgreens. The plant material was weighed and dried in a ventilated oven at 45±1°C for 48 h.

Preparation of pasta

At first, sprouts or microgreens were ground into flour. Mixtures of flour were prepared containing 0, 10, 15, and 20% of buckwheat flour from sprouts or 10% of buckwheat flour from microgreens, the remainder up to 100% by weight being durum wheat flour (semolina). Semolina flour was purchased from the firm Granoro Italy (Bari, Italy).

This was followed by kneading the dough of 100 g of a flour mixture with 48 ml of distilled water, warm at 47±1° C and kneaded for 20 minutes. Pasta with the width of 1 cm and the thickness of 2 mm was produced. These were then dried for 6 hours in a hot air oven with a maximum of 90° C (at 30°C for 30 min, at 50°C for 60 min, at 90°C for 120 min, and at 60°C for 120 min).

Individual dry pasta samples (100g) were boiled for 10 minutes in 1 liter of water at 100° C, adding 10 g of salt.

Evaluated parameters

Optimal cooking time - the time when the white cores of the strands disappeared, according to Approved Method 66-50 of AACC International.

Cooking water absorption - the determination of water content in percentage by weight the pasta was performed during cooking. The drained pasta was left in the sieve for 2 minutes and weighed. Water absorption (WA) was obtained by the following formula: WA (%) = (a – b) /b * 100

Where: a – the weight of the cooked pasta (g), b – the weight of the dry pasta (g).

Cooking yield – the percentage of increased weight of pasta during cooking.

Swelling index - the ratio volume of pasta before (100g) and after cooking, expressed as a multiple of the original volume of solution. The pasta was placed in a graduated cylinder with 700 ml of water, and the water level in ml was read.

Cooking losses - solids (g) from the cooking water were determined by concentrating the cooking water to dryness in an oven at 100 °C.

Stickness - how cooked the pasta sticks to the fork compared to the semolina pasta. Scale: 1 - does not stick to the fork at all; 2 - easily sticks to the fork; 3 - medium glues to the fork, 4 - a lot of sticks to the fork, 5 - strongly sticks to the fork.

Sensory evaluation of pasta was performed by a group of 10 people (5 women and 5 men). The evaluators were not in contact with each other and were not familiar with the composition of the pasta. The evaluation took place on a scale 1 to 5, with a rating of 1 corresponding to the best and a rating of 5 to the worst impression (1-great, 2- excellent, 3- less excellent, 4- good, 5- unsatisfactory). The overall rating was determined by the arithmetic mean. For raw pasta, the color, overall look (shape, edges), surface properties (1-smooth, 2-less smooth, 3-coarse, 4- slightly rough, 5- rough), elasticity (1-puts up resistance before it breaks, 2- puts up slight resistance before breaking, 3- it breaks easily, 4- it breaks almost immediately, 5-fragile, cannot be bent, breaks immediately), translucency (1-like semolina, 2-almost like semolina, 3-only along the edges, 4-almost none, 5-none). After cooking, it was evaluated: color, look of pasta, flavour, taste, and overall impression.

Statistical analysis

The influence of buckwheat flour portion in cookies and pasta on selected parameters was evaluated by analysis of variance with the post hoc Tukey HSD test in program Statistica 12.0.

RESULTS AND DISCUSSION

Table 1 and 2 summarizes the sensory evaluation of pasta. Most parameters differed significantly ($p < 0.05$) among samples. Higher scores of sensory characteristics of raw pasta were recorded for color and translucency that had pasta with 10% of microgreens and 20% of sprouts. There was no difference among pasta variants with the different proportions of sprouts in elasticity. Similarly, De Marco et al. (2014) found that the elasticity of pasta with different percentages of spirulina also showed no change. The translucency, overall look, and surface prop-

Table 1. *Sensory evaluation of raw pasta (mean ± standard deviation)*

	Color	Overal look	Surface properties	Elasticity	Translucency	Total mark
0% of sprouts	1 ± 0.5a	1 ± 0.4a	1 ± 0.5a	2 ± 0.5a	1 ± 0.5a	1
10% of sprouts	2 ± 0.4ab	2 ± 0.4b	2 ± 0.0b	3 ± 0.0b	2 ± 0.7a	2
15% of sprouts	3 ± 0.8ab	3 ± 0.5c	3 ± 0.5c	3 ± 0.0b	4 ± 0.0b	3
20% of sprouts	4 ± 0.8b	5 ± 0.5d	3 ± 0.5c	3 ± 0.3b	5 ± 0.0c	4
10% of microgreens	4 ± 0.8b	3 ± 0.4c	3 ± 0.4c	3 ± 0.5b	5 ± 0.4c	4

Different small letters (a–b) indicate significant differences.

Table 2. *Sensory evaluation of cooked pasta (mean ± standard deviation)*

Fortification	Color	Overal look	Flavour	Taste	Overal impression	Total mark
0% of sprouts	1 ± 0a	1 ± 0a	2 ± 0.7a	1 ± 0.5a	1 ± 1.1a	1
10% of sprouts	3 ± 0.5b	2 ± 0.5b	3 ± 0.5ab	3 ± 0.8b	3 ± 0b	3
15% of sprouts	3 ± 0.5b	3 ± 0.8b	3 ± 0.5ab	3 ± 0.6b	3 ± 0b	3
20% of sprouts	5 ± 0.3c	5 ± 0.5c	5 ± 0.5b	4 ± 0.5b	4 ± 0.5c	5
10% of microgreens	4 ± 0.7bc	4 ± 0.5bc	3 ± 0.7ab	4 ± 0.3b	4 ± 0.5c	4

Different small letters (a–b) indicate significant differences.

erties of row pasta were found to be the best in control pasta without buckwheat sprouts and for pasta with 10% of buckwheat sprouts.

During cooking, the starch granules swell and partly solubilize, while the protein becomes insoluble and coagulate (Hager et al., 2012). The presence of gluten positively influences the texture of cooked pasta. Higher scores of sensory properties (color, overall appearance, flavour, taste, overall impression, and also overall marker) for cooked pasta are related to 20% sprouts and 10% microgreens in pasta. Pasta with 15% sprouts was evaluated as less favourable in all characteristics. The higher level of buckwheat sprouts in pasta, the more bitterness was observed. This unpleasant taste was most noticeable in pasta with microgreens. Similarly, Bokić et al. (2022) found that the addition of broccoli sprouts significantly influenced odor and taste of cooked pasta.

The optimal cooking time of pasta with microgreens was significantly higher (18 min) than in pasta from semolina (0% buckwheat sprouts) and pasta with buckwheat sprouts (Table 3). While the lowest (10 min) cooking time was recorded in pasta with 20% of buckwheat sprouts. The increasing proportion of buckwheat sprout flour in the pasta reduced their cooking time. Bokić et al. (2022) observed that optimum cooking time also decreased with the addition of broccoli sprouts. On the other hand, De Marco et al. (2014) found that increasing amounts of spirulina in pasta decreased optimum cooking time. It was similar in our study when microgreens were added to pasta. According to Fardet et al. (1998), the protein network limits water penetration into the center of the pasta during cooking, so a weaker protein network reduces the cooking time.

The highest swelling (40 ml) and also the highest swelling index (1.59) were observed in pasta with 0% portion of sprouts (the control variant). The lowest swelling (30 and 32 ml) and the lowest swelling index (1.39) was recorded in pasta with 15% of sprouts and 10% of microgreens. There were no significant differences among pasta with different portions of sprouts or microgreens in swelling and swelling index (Table 3).

The cooking water absorption is the amount of water in weight percent that the pasta is taken by cooking. In case of insufficient binding, the cooked pasta is hard

Table 3. *Evaluation of cooked pasta (mean± standard deviation)*

Fortification	Cook. time (min)	Swelling (ml)	Swelling index	Water absorbtion (%)	Cooking yield (%)	Cooking losses (g)	Stickness
0% sprouts	12±1ab	40 ± 0.6b	1.58b	154±2.4b	254±2.6b	1.8±0.2a	1
10% sprouts	15±2ab	34 ± 0.5a	1.48a	118±2.7ab	218 ±2.8a	3.2±0.4c	1
15% sprouts	13±1ab	30 ± 4.6a	1.39a	120±4.7ab	216 ± 5.6a	3.4±0.6c	1
20% sprouts	10±1a	35 ± 0.8a	1.49a	126± 5.8ab	226 ± 7.9a	4.5±0.2d	1
10% microgreens	18±2b	32 ±2.7a	1.39a	108 ± 5.7a	208 ± 5.1a	2.3±0.1b	1

Different small letters (a–b) indicate significant differences.

and rough. On the contrary, with high binding, the pasta is too soft and sticky. The highest cooking water absorption of pasta (154%) was observed in the control variant (0% sprouts), and the lowest cooking water absorption (108%) was recorded in pasta with buckwheat microgreens. The higher cooking water absorption increase was noticed in the pasta with sprouts than in the pasta with microgreens. There was no statistically significant difference between pasta varieties with a different proportion of sprouts in the cooking water absorption (Table 3). Water absorption should be at least 100% of the mass of dry pasta (MSZ 20500/1–1985). All samples met this requirement. Bokić et al. (2022) found that fortification of pasta with broccoli sprouts reduced swelling index but volume (swelling) increased.

The highest cooking yield of pasta (245%) was observed in the control variant (0% of sprouts), and the lowest cooking yield (208%) was recorded in pasta with buckwheat microgreens. The higher cooking yield was noted in the pasta with sprouts than that pasta with microgreens. There was no statistically significant difference between pasta variants with the different proportions of sprouts in the cooking yield.

Cooking losses are defined as the weight of the total solids lost in the cooking water. When pasta is fortified, gluten is diluted by replacing wheat flour with buckwheat sprouts or microgreens, and the protein network is weakened, which facilitates the leakage of amylose into the cooking water (De Marco et al., 2014). The higher portion of the solids lost is, the cooking losses are higher. Replacement of wheat flour by buckwheat sprouts or microgreens significantly ($p < 0.05$) increased the cooking losses. There was a statistically significant difference between pasta variants with different proportions of sprouts. The pasta prepared from flour with 10% of buckwheat microgreens had the most similar cooking losses of the control sample. The highest cooking losses were observed when the pasta was prepared with 20 % of buckwheat sprouts (Table 3). Similarly, Bokić et al. (2022) established that cooking losses increased with the level of broccoli sprouts in pasta. Pasta should exhibit low cooking losses. All pasta samples had acceptable quality because good pasta has cooking losses <8 g/100 g (Dick and Youngs, 1988).

Stickiness (adhesiveness) is another essential property of pasta. Pasta should exhibit an absence of stickiness. If the pasta sticks, it worsens their consumption. The stickiness of the pasta was tested as adhesion to a fork. Although according to Marchylo et al. (2004), the higher strength and lower.

CONCLUSION

Evaluation of pasta prepared with the addition of buckwheat sprouts flour to wheat flour confirmed that the pasta cooking time, the binding of water during pasta cooking, and the proportion of cooking losses confirmed satisfactory values of these parameters. However, the 10% addition of buckwheat sprouts is acceptable to consumers in terms of look and taste. At the same time, it will positively affect the nutritional quality of the pasta. Based on the obtained results, common buckwheat sprouts can be recommended as an ingredient in pasta. The application of buckwheat to pasta can have an essential role in human nutrition because the consumption of pasta has a long-term upward trend in the population.

As a result of the sensory evaluation, the addition of 20% buckwheat sprouts may adversely affect color and sensory properties. The addition of sprouts than microgreens can be recommended for the fortification of pasta.

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IZVLEČEK

Kakovost testenin z dodatkom ajdovih kalic in mikrozelenja

Kalice in mikrozelenje so pomembna funkcionalna živila, ki jih uporabljajo za prehranska dopolnila. Namen dela je bil preizkusiti možnost izdelave testenin z različnimi deleži ajdovih kalic in ovrednotiti njihove izbrane kvalitativne lastnosti. Pripravljene so bile testenine iz zdroba semoline (durum pšenice) z različnimi deleži moke iz ajdovih kalic (10-20 %) in ajdovega mikrozelenja (10 %). Ocenjevali so optimalen čas kuhanja, vpijanje vode pri kuhanju, nabrekanje, izgubo pri kuhanju, oprijemljivost, barvo, splošni videz, površino, prožnost, prosojnost, aromo, okus in splošni vtis. Za izdelavo testenin se priporoča moka iz ajdovih kalic v deležu do 10 %.