UDC 664.69 : 664.641.2] : 543.92

Original research paper

INSTRUMENTAL AND SENSORY PROPERTIES OF BUCKWHEAT FLOUR PASTA

Dubravka J. Jambrec*[1], Mladenka V. Pestorić[1], Đorđe B. Psodorov[1], Marijana B. Sakač[1], Nataša M. Nedeljković[1], Anamarija I. Mandić[1], Ivana J. Sedej[1]

[1]University of Novi Sad, Institute of Food Technology, Bulevar cara Lazara 1, 21000 Novi Sad, Serbia

*Corresponding author:
E-mail: dubravka.jambrec@fins.uns.ac.rs
Tel: +381 21 485 3782;
Fax: +381 21 450 728

ABSTRACT: The standard wholegrain wheat flour pasta formulation was modified using light buckwheat flour at the level of 20% to obtain a new added-value product. The control and enriched dry pasta were tested on chemical and colour properties. Cooking properties were also investigated in the pasta samples. Sensorial properties for dry and cooked pasta were evaluated using the 5-point category scale.
The obtained results suggest that the substitution of wheat with buckwheat flour in the formulation of pasta did not influence tested parameters remarkably.

Keywords: s*ensory properties, pasta, buckwheat flour, cooking quality, colour determination*

INTRODUCTION

Consumers' attention in recent years has been directed to nutritional and health aspects of foods. The application of new ingredients in the basic product formulation could result in products with higher nutritional value and new sensory quality (Šimurina et al. 2009). Pasta and pasta related products are known as frequently used food in human nutrition on a daily basis (Plavšić et al., 2010). According to UN. A. F. P. A from 2009 (http://www.pasta-unafpa.org), pasta consumption was over 3 million tonnes in the E. U., and tends to increase. Therefore, pasta is recognised as good matrix for supplementation with various health beneficial supplements.

Buckwheat (*Fagopyrum esculentum* Moench) possesses a great potential for upgrading the functional properties of foods due to its high content of proteins, starch, and vitamins. Moreover, buckwheat has been reported to possess higher antioxidant activity than the most frequently used cereals (Kreft et al. 2006). High phenolics content, especially rutin, contributes to the increased functionality of foods. Buckwheat does not contain gluten and therefore is convenient for gluten-free products (Sedej et al. 2011; Torbica et al. 2010).

The substitution of wheat flour in commonly used pasta with buckwheat flour can fortify pasta with proteins, dietary fibres, vitamins and minerals with acceptable effects on sensory and cooking quality (Schoenlechner et al. 2010).

In order to found new nutritionally perspective pasta recipe, the replacement of 20% wholegrain wheat flour with light buckwheat flour in pasta formulation was studied with the aim to

determine the effect of buckwheat addition on pasta cooking quality, colour and sensory properties.

MATERIALS AND METHODS

Samples

The standard formulation of wholegrain wheat flour pasta was modified by substitution of wheat flour with 20% of light buckwheat flour. The pasta (tagliatella shape) was produced by using Ital past Mac 60 (Parma, Italy).

Pasta cooking quality

Optimal cooking time (OCT) was determined as the time necessary to disappear white core in the middle of the pasta sample when it was pressed between two transparent plastic tiles. Pasta samples were cooked in boiling water (1000 mL) containing 0.5% (w/v) of sodium chloride.

Dry matter content of cooked pasta was determined by using a blend of water from cooking and rinsing pasta sample which was evaporated and dried 90 minutes at 130 °C. The residue was weighted and reported as a percentage of the dry matter of dry pasta sample.

The volume increase (VI) was determined as the ratio between volume of cooked and uncooked pasta sample.

Cooking loss (CL) (the amount of solid substance lost to cooking water) and the above parameters of cooking quality were determined according to natural regulation (Pravilnik o metodama fizičkih i hemijskih analiza žita, mlinskih i pekarskih proizvoda, testenina i brzo smrznutih testa ("Sl. list SFRJ", br. 74/88)).

Colour determination

The colour of dry pasta samples was measured using a Minolta Chromameter (Model CR-400, Minolta Co., Osaka, Japan), with granular attachment CR–A50, and expressed in Commission Internationale d' Eclairage *L* (*lightness), *a** (redness–greenness), *b** (yellowness–blueness) colour–space. Prior to colour measurements dry pasta samples were grounded in 1095 *Knifetec* sample mill.

Sensory evaluation

A panel of five assessors with experience in sensory analysis of pasta (4 females and 1 male, 30–43 years old) were selected and recruited from the Institute of Food Technology, Novi Sad, holding weekly sessions for the purpose according to ISO 8586–2 (1994).

The initial training stage of assessors involved introducing the method to assessors, and training using the real products–control samples. Six sessions were performed lasting about two hours each. The first three sessions were introduction to the sensory properties of wholemeal pasta during which the assessors were introduced to the definition of terms to be used. The remaining sessions corresponded to the evaluation of control samples used in the further study.

Sensory properties of dry and cooked pasta were evaluated by the 5–point category scale with end–points labelled from 1 to 5 as shown in Table 1 (Pestorić, 2007; Pestorić et al. 2010; Pestorić, 2011). All properties were evaluated visually, palpatory, olfactory and gustatory under laboratory condition that fulfilled requirements of ISO 8589 (2007).

All samples were identified with three random numbers and samples were presented in completely randomised order among assessors. At the start of each session assessors were given a printed response sheet with written instructions for the tests.

Dry pasta samples were presented on the plastic plates, while cooked pasta samples were presented in thermal plastic cups and served at room temperature within 20 minutes after cooking. Plain water was used for mouth rinsing before and after each sample testing.

Statistical analysis

Results were expressed as mean ± standard deviation of triplicate analyses for all measurements, except the colour determination of the samples which was performed in ten repetitions.

Analysis of variance and Duncan's multiple range test were used to compare means at 5% significance level by using statistical data analysis software system STATISTICA (StatSoft, Inc. (2008) data analysis software system, version 10.0. www.statsoft.com).

Table 1.
Scoring method for dry and cooked pasta

Sensory evaluation of dry pasta		
Visualy		
Shape	**Colour**	**Colour uniformity**
5 – Appropriate with no damage **4** – Insignificant deviation of shape **3** – Noticeable deficiencies **2** – Clearly noticeable deficiencies **1** – Highly noticeable deficiencies	**Hue:** **5** – Brown **4** – Slight differences* **3** – Noticeable differences* **2** – Clearly noticeable differences* **1** – Highly noticeable differences* ***indicate a differences** (differences refers to the lighter and darker shade with regard to the standard S4020-Y40R)	**5** – Uniform **4** – Almost uniform **3** – Slightly uniform **2** – Non–uniform **1** – Highly non–uniform
Palpatory		
Fracturability		
5 – Excellent resistance to fracture **4** – Very good resistance to fracture **3** – Good resistance to fracture **2** – Poor resistance to fracture **1** – Extremely poor resistance to fracture		

Sensory evaluation of cooked pasta			
Olfactory			
Odour			
5 – Appropriate odour, rounded, aromatic **4** – Appropriate odour, less rounded, aromatic **3** – Appropriate odour, less rounded, less aromatic **2** – Inappropriate odour, presence of foreign odour **1** – Foreign odour, unpleasant			
Palpatory			
Firmness	**Liveliness**	**Elasticity**	**Surface adhesiveness**
5 – Excellent firmness **4** – Very good firmness **3** – Good firmness **2** – Poor firmness **1** – Extremely poor firmness	**5** – Excellent liveliness **4** – Very good liveliness **3** – Good liveliness **2** – Poor liveliness **1** – Extremely poor liveliness	**5** – Excellent elasticity **4** – Very good elasticity **3** – Good elasticity **2** – Poor elasticity **1** – Extremely poor elasticity	**5** – Not sticky **4** – Insignificantly sticky **3** – Slightly sticky **2** – Sticky **1** – Extremely sticky
Gustatory			
Chewiness	**Granularity**	**Taste**	
5 – Excellent chewiness **4** – Very good chewiness **3** – Good chewiness **2** – Poor chewiness **1** – Extremely poor chewiness	**5** – Excellent granularity **4** – Very good granularity **3** – Good granularity **2** – Poor granularity **1** – Extremely poor granularity	**5** – Appropriate taste, rounded, aromatic **4** – Appropriate taste, less rounded, aromatic **3** – Appropriate taste, less rounded, less aromatic **2** – Inappropriate taste, presence of foreign taste **1** – Foreign taste, unpleasant	

RESULTS AND DISCUSSION

Chemical analysis and cooking properties of pasta

Table 2 summarizes the results of chemical analysis of dry pasta and cooking properties of pasta. The pasta samples had similar moisture content but different contents of other chemical parameters. Except starch, the content of other determined parameters was higher in the sample B because of the known structure differences between buckwheat and wheat grains (Steadman et al. 2001; Bonafaccia et al. 2003; Skrabanja et al. 2004).

The optimal cooking time for the pasta without buckwheat flour was longer than for the pasta with added 20% light buckwheat flour. This was in accordance with Chillo et al. (2008) and Manthey et al. (2004) who showed that the addition of buckwheat flour up to 30% caused a decrease in optimal cooking time of pasta. The same authors explained this phenomenon by physical disruption of the gluten matrix and overall low density that provides a path for water absorption into pasta containing buckwheat flour which results in a shorter cooking time.

The pasta with added buckwheat flour had cooking loss value quite lower than that of the wheat pasta indicating it has acceptable cooking loss level.

Colour determination

Pasta colour is essential for assessing pasta quality. Generally, pasta consumers prefer pasta with a bright yellow colour (Debbouz et al. 1995). Flours that were used for the production of all tested pasta showed beige colour (*L** values were in the range of 82.05-83.49), which contributed to darker colouration of the final products (data not shown). Brown colour might be noticeable to attract consumers' attention on these products, because consumer normally associates the pasta rich in dietary fibre to a darker colour (Chillo et al. 2008). Table 3 shows the *L**, *a** and *b** values for pasta samples.

Decrease in pasta colour with regard to flour type was noticed. This may be related to the development of Maillard reaction products which readily occurs during pasta drying (Anese at al. 1999). Significant differences ($P < 0.05$) were detected on lightness (*L**) and redness (*a**) among the pasta samples. Buckwheat addition led to a decrease of *L** and *a** parameters (B sample was darker and less red than the sample A), but did not significantly affect *b**.

Colour scores have been calculated as (*L** + (*b** x 2))/20, giving a score range of 1–10, with 10 being the best qualification (Hareland et al. 1995). The calculated colour scores are shown in Table 3. The sample B had negligible lower value of colour score. Both pasta samples expressed the acceptable colour scores which were at the same level as durum pasta (Martinez et al. 2007).

Table 2.
Chemical characteristics of dry pasta and cooking properties of pasta

	Chemical analysis					Cooking properties		
Sample	**Moisture (% d.b.)**	**Protein (% d.b.)**	**Ash (% d.b.)**	**Cellulose (% d.b.)**	**Starch (% d.b.)**	**OCT (min)**	**CL (% d.b.)**	**VI (%)**
A	11.35±0.03	11.60±0.10	1.30±0.03	0.44±0.01	66.42±0.16	9.00±0.30	10.33±0.40	2.86±0.20
B	11.09±0.01	13.42±0.07	1.59±0.02	0.88±0.02	60.47±0.01	8.00±0.10	7.83±0.60	3.07±0.40

Abbreviations used in table: OCT– optimal cooking time; CL – cooking loss; VI – volume increase.
Values are means of three determinations ± standard deviation.

Table 3.
Dry pasta colour measurements

Sample	*L**	*a**	*b**	Colour scores (1-10)
A	75.29 ± 0.45^{b}	2.91 ± 0.17^{b}	14.77 ± 0.11^{a}	5.24
B	74.67 ± 0.45^{a}	2.61 ± 0.12^{a}	14.73 ± 0.32^{a}	5.21

Values are means of ten determinations ± standard deviation.
Values followed by a different letter within a column are significantly different ($P < 0.05$).
Colour scores: (L + (b* x 2))/20; score range: 1-10, with 10 being the best qualification.*

Sensory evaluation

Table 4.
Sensory evaluation of pasta

	Dry samples			
	Shape	**Uniformity of colour**	**Colour**	**Brittleness**
A	4.00±0.67[a]	4.40±0.52[a]	4.40±0.52[a]	3.90±0.88[a]
B	4.00±0.67[a]	4.40±0.70[a]	4.70±0.48[a]	4.30±0.67[a]

	Cooked samples							
	Odour	**Firmness**	**Liveliness**	**Elasticity**	**Surface stickiness**	**Chewiness**	**Granularity**	**Taste**
A	4.70±0.48[a]	4.50±0.53[a]	3.90±0.74[a]	3.30±0.67[a]	3.90±0.57[a]	3.70±0.67[a]	4.00±0.67[a]	4.10±0.88[a]
B	5.00±0.00[a]	4.30±0.67[a]	4.00±0.67[a]	4.00±0.67[b]	3.60±0.52[a]	4.30±0.67[a]	4.30±0.82[a]	4.60±0.52[a]

Values are means ± standard deviation of five panelists.
Values with the different superscript within a column are statistically different ($P < 0.05$).

Results of sensory evaluation of pasta samples are presented in Table 4. Quality category was determined in dependence of scores: unacceptable (< 2.5), good (2.5–3.5), very good (3.5–4.5) and excellent (> 4.5).

On the 5–point category scale, sensory results for the dried pasta were in the range of 3.90–4.70 indicating very good and excellent sensory quality. Scores for cooked pasta samples were in the range of 3.30–5.00. Duncan's multiple range test of dried pasta samples showed that addition of light buckwheat flour did not significantly ($P < 0.05$) affect the sensory properties, except the elasticity of cooked pasta. However, it should be noted that the addition had an impact on improving scores of colour and brittleness of buckwheat pasta. In general, the results obtained for the cooked pasta indicate that buckwheat flour addition led to an increase in sensory quality.

CONCLUSION

Wholegrain wheat pasta supplemented with 20% light buckwheat flour demonstrated good quality. The colour measurements indicated that buckwheat flour addition decreased L^* and a^* of pasta which did not affect the panel assessment. Furthermore, sensory analysis showed that dried pasta with added buckwheat flour demonstrated sensory properties fairly similar to the wholegrain wheat pasta. Buckwheat flour supplementation did not significantly affect all evaluated sensory properties except the elasticity that which was evaluated by the panel with a better score.

ACKNOWLEDGEMENTS

This work was supported by the Serbian Ministry of Education and Science (number of the project TR 31029).

REFERENCES

1. Anese, M., Nicoli, M. C., Massini, R., Lerici, C. R. (1999). Effect of drying processing on the Maillard reaction in pasta. *Food Research International, 32*, 193–199.
2. Bonafaccia, G., Marocchini, M., Kreft, I. (2003). Composition and technological properties of the flour and bran from common and tartary buckwheat. *Food Chemistry*, *80*, 9–15.
3. Chillo, S., Laverse, J., Falcone, P. M., Protopapa, A. M., Del Nobile, A. (2008). Influence of the addition of buckwheat flour and durum wheat bran on spaghetti quality. *Journal of Cereal Science, 47,* 144–152.
4. Debbouz, A., Pitz, W. J., Moore, W. R., Dappolonia, B. L. (1995). Effect of bleaching on durum- wheat and spaghetti quality. *Cereal Chemistry, 72*, 128–131.
5. Hareland, G. A., Puhr, D., Wear, J. G. And Skunberg, M. (1995). Color score: United States Department of Agriculture, Agricultural Research Service in cooperation with the ND state agricultural experiment stations, quality evaluation of durum wheat cultivars. http://wheat.pw.usda.gov/ggpages/gopher/Quality/Durum/1995/95durum.txt.html (accessed May 4, 2006).
6. International Commission on Illumination (CIE) (1976). *Colorimetry: Official Recommendation of the International Commission on Illumination.* Publication CIE No. (E–1.31) Bureau Central de la CIE, Paris, France.
7. ISO 8586–2 (1994). General guidance for the selection, training and monitoring of assessors – Part 2: Experts.
8. ISO 8589 (2007). General guidance for the design of test rooms.
9. Kreft, I., Fabjan, N., Yasumoto, K., (2006). Rutin content in buckwheat (*Fagopyrum esculentum* Moench) food materials and products. *Food Chemistry*, *98*, 508–512.
10. Manthey, F. A., Yalla, S. R., Dick, T. J., Badaruddin, M. (2004). Extrusion properties and cooking quality of spaghetti containing buckwheat bran flour. *Cereal Chemistry, 81*, 232-236.
11. Martinez, C. S., Ribotta, P. D., León, A. E., Añón M. C. (2007). Physical, sensory and che-

mical evaluation of cooked spaghetti. *Journal of Texture Studies, 38*, 666–683.

12. Pestorić, M., Pojić, M., Sakač, M., Mastilović, J., Šimurina, O., Filipčev, B., Živančev, J. (2010). Selection of optimal sensory properties for the recognition of wholemeal bread. *International Journal of Food Properties (accepted for publication)*.
13. Pestorić, M. (2007). *The definition and evaluation of the external profile of industrially produced pasta*. MSc thesis, Faculty of Technology, University of Novi sad, Serbia.
14. Pestorić, M. (2011). *Development and evaluation of sensory and instrumental methods for assessment of textural properties of pasta.* PhD Thesis, Faculty of Technology, University of Novi Sad, Serbia.
15. Plavšić, D., Psodorov, Đ., Kalenjuk, B., Tešanović, D., Šarić, Lj., Čabarkapa, I., Filipović, J. (2010). Comparison of microbiological safety of pasta and pasta related products depending on the conditions of production. *Food and Feed Research, 37,* 51–59.
16. Schoenlechner, R., Drausinger, J., Ottenschlaeger, V., Jurackova, K., & Berghofer, E. (2010). Functional properties of gluten-free pasta produced from amaranth, quinoa and buckwheat. *Plant Foods for Human Nutrition, 65*, 339–349.
17. Sedej, I., Sakač, M., Mandić, A., Mišan, A., Pestorić, M., Šimurina, O., Čanadanović–Brunet, J. (2011). Quality assessment of gluten-free crackers based on buckwheat flour. *LWT-Food Science and Technology*, *44*, 694–699.
18. Šimurina, O., Sedej, I., Sakač, M., Hadnađev, M., Filipčev, B., Pestorić, M., Pribiš, V. (2009). Buckweat in the whole grain cracker production. *PTEP 13*, 153–156.
19. Skrabanja, V., Kreft, I., Golob, T., Modic, M., Ikeda, S., Ikeda, K., Kreft, S., Bonafaccia, G., Knapp, M., Kosmelj, K. (2004). Nutrient content in buckwheat milling fractions. *Cereal Chemistry, 81*, 172-176.
20. Pravilnik o metodama fizičkih i hemijskih analiza žita, mlinskih i pekarskih proizvoda, testenina i brzo smrznutih testa (1988). *Službeni list SFRJ,* br. 74.
21. STATISTICA (Data Analysis Software System) (2008). v. 10.0., Stat–Soft, Inc., USA *(www.statsoft.com)*.
22. Steadman, K. J., Burgoon, M. S., Lewis, B. A., Edwardson, S. E., Obendorf, R. L. (2001). Buckwheat seed milling fractions: description, macronutrient composition and dietary fibre. *Journal of Cereal Science, 33*, 271–278.
23. Torbica, A., Hadnađev, M., Dapčević, T. (2010). Rheological, textural and sensory properties of gluten–free bread formulations based on rice and buckwheat flour. *Food Hydrocolloids, 24,* 626–632.
24. Union of Organizations of Manufactures of Pasta Products of the E. U. (http://www.pasta-unafpa.org).

ИНСТРУМЕНТАЛНА И СЕНЗОРСКА СВОЈСТВА ТЕСТЕНИНЕ СА ХЕЉДОМ

Дубравка Ј. Јамбрец*[1], Младенка В. Пестoрић[1], Ђорђе Б. Псодоров[1], Маријана Б. Сакач[1], Наташа М. Недељковић[1], Анамарија И. Мандић[1], Ивана Ј. Седеј[1]

[1]Универзитет у Новом Саду, Институт за прехрамбене технологије у Новом Саду, Булевар цара Лазара 1, 21000 Нови Сад, Србија

Сажетак: Стандардна формулација тестенине од интегралног пшеничног брашна је измењена супституисањем 20% интегралног пшеничног брашна белим хељдиним брашном, како би се добио нови производ са побољшаним функционалним својствима. Хемијски састав и боја, одређени су за суву контролну и обогаћену тестенину. Такође, за оба узорка тестенине одређен је квалитет при кувању. Сензорске особине куване и некуване тестенине, одређене су применом бод система са 5 бодова. Добијени резултати указују да замена интегралног пшеничног брашна белим хељдиним брашном у формулацији за тестенину не утиче значајно на испитиване параметре.

Кључне речи: *сензорска својства, тестенина, хељдино брашно, одређивање боје, квалитет при кувању*

Recieved: 16 September 2011

Accepted: 10 October 2011