# SPELT PASTA ENRICHED WITH $\omega$ -3 FATTY ACIDS

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ISSN 2232-755X DOI: 10.7251/GHTE1612031F DC: 664.69.016.3 Original scientific paper

In this paper the quality of spelt pasta with the addition of  $\omega$ -3 fatty acid, which is positively contributing to the functional and technological changes of the product is investigated. $\omega$ -3 fatty acids are added in the quantity of 0%, 0.2%, 0.4% and 0.6% based on farina. Concerning pasta quality addition of  $\omega$ -3 fatty acids is related to increased cooking time and cooking loss, as well as reduced pasta stickiness. Gas chromatography with mass spectrometry was used for carrying out a quantitative analysis of the liposoluble pasta extract. Pasta with 0.6%  $\omega$ -3 fatty acids contains 0.6048 g /100 fatty acids, which positively contributes to  $\omega$ -6/ $\omega$ -3 fatty acid ratio in daily meal, thus meeting values recommended by nutritionists. This type of pasta is a new product with good technological quality, improved fatty acids profile and sensory characteristics with consumer acceptability range.

*Key words:* pasta, technological quality, sensory quality, fatty acids,  $\omega$ -6/ $\omega$ -3 ratio.

#### INTRODUCTION

Pasta quality mainly depends on the properties of raw material, especially flour protein content and gluten quality [1]. Pasta is suitable for correcting eating plan because it is quick and easy to prepare, easily digestible food and it is one of the widespread foods in many countries around the world [2, 4, 5]. Due to its handling, storage and preparation properties and popularity with consumers' pasta is an excellent choice for incorporating "nutraceuticals". Nutritional and functional properties of pasta can be improved by using whole meal spelt as basic raw material for pasta preparation and by adding raw materials such as  $\omega$ -3 fatty acids [4, 6]. Normal and balanced diet recommended by nutritionists for prevention of mass non-infectious diseases consider intake of essential fatty acids and decrease of  $\omega$ - $6/\omega$ -3 fatty acids ratio [7]. Enriched pasta and other cereal products could be a good source of  $\omega$ -3 fatty acids and can contribute to achieving the recommended daily intake. ω-3 fatty acids are polyunsaturated fatty acids (PUFA) that are widely distributed in animal tissues and plants [8]. ω-3 fatty acids are becoming more familiar to consumers due to the increasing amount of research demonstrating their health benefits. New studies are identifying potential benefits for a wide range of conditions including cancer, inflammatory bowel disease and other autoimmune diseases such as lupus and rheumatoid arthritis [9,10]. The main challenges of food producers is to produce food enriched with  $\omega$ -3 fatty acids that does not reduce their current quality despite the added active ingredient [11-13]. Spelt wheat grown without use of pesticides was suitable as an organic material. Spelt cultivars have higher concentration of mineral elements Fe, Zn, Cu, Mg and P compared to Triticum Aestivum and Triticum Durum [4, 9].

The aim of this study is to produce spelt pasta enriched with  $\omega$ -3 fatty acids in order to enhance fatty acids profile of pasta, and also to quantify and inspect the effect of  $\omega$ -3 fatty acids on the technological and sensory quality of pasta.

#### **MATERIAL AND METHODS**

Spelt wheat "Nirvana" cultivar, grown in the year 2013 in Serbia at Bačko Gradište location, is used for pasta production, with the following characteristics tested: moisture, starch, protein, lipids and cellulose content of 13.0 %, 69.6% d.m., 13.1 % d.m. 2.33% d.m. and 1.3% d.m., respectively [14]. Stone milled spelt whole meal flour with particle size ranged between 200 and 300  $\mu$ m was supplied by a local producer "Jeftić"-Bačko Gradište.  $\omega$ -3 fatty acids are added during mixing, and were produced by Pharmanova, Obrenovac, Serbia. Pasta was made using the device "La Parmigiana D45" MAC 60. In a paddle mixer wholemeal moisture was adjusted to 31.5% by adding water, then the  $\omega$ -3 fatty acids are added in quantity of 0%, 0.2%, 0.4% or 0.6% based on farina and mixed for 15 min [15] into a homogeneous mass. Hydrated whole meal entered an extrusion worm which moved the loose dough forward and simultaneously compressed it into a homogeneous plastic mass prior to extrusion through a die with 1.4 mm diameter used for spaghetti. Quality of pasta was evaluated in terms of cooking characteristics (cooking time, volume increase, cooking loss and stickiness), by applying the method described by Kaluđerski and Filipović [15].

Sensory analysis was conducted according to SRPS ISO 4121:2002 [16], by panel of six trained evaluators. Evaluators identified descriptors and scored taste using 6 point scale (0 – not detected, 5 – strong). Sensory analysis of cooked pasta included determination of colour (yellow, red, whiteness, of different colouration), taste (characteristic, non-characteristic, fatty taste, fish taste) and odour (characteristic, non-characteristic, fatty taste, fish taste). Fatty acids content was determined on dry pasta by using gas chromatography with mass spectrometry (Agilent Technologies, Palo Alto, CA, USA), according to Vujić et al. [17].

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Descriptive statistical analyses for all the obtained technological parameters were expressed as the mean values  $\pm$  standard deviation (SD). Collected data were subjected to analysis of variance (ANOVA) for the comparison of means and significant differences are calculated according to post-hoc Tukey's HSD (honestly significant differences) test at p<0.05 significant level, 95% confidence limit, using StatSoft Statistica 10.0® software.

## **RESULTS AND DISCUSSION**

Quality is the primary criterion for evaluating a food product and it has a dominant influence on the acceptance by consumers. Related to pasta quality, the addition of 0.4% and 0.6% of  $\omega$ -3 fatty acids statistically significantly increases cooking time of pasta (Table 1). Volume increase of pasta represents the ability of starch to swell, and this parameter indicates that there were no statistically significant differences in volume increase between pastas with higher amounts of  $\omega$ -3 fatty acids (0.4% and 0.6%) compared to pasta with 0%  $\omega$ -3 fatty acids. Cooking loss is also a useful parameter for cooked pasta quality evaluation. Cooking loss significantly increases with addition of  $\omega$ -3 fatty acid, which indicates that this small quantity of fatty acids does not strengthen the gluten structure of the product. Stickiness of pasta showed a significant decrease with increased  $\omega$ -3 fatty acids addition (Table 1), and the maximum was observed in pasta with 0%  $\omega$ -3 fatty acids (8.7±0.5) while the minimum stickiness of 7.2±0.4, was observed with 0.6%  $\omega$ -3 fatty acids, as confirmed by Filipović et al. [3].

Table 1. Quality of pasta with  $\omega$ -3 fatty acids Tabela 1. Kvalitet testenine sa  $\omega$ -3 masnim kiselinama

|   | Quantity of ω-3 fatty acids<br>Količina ω-3 masnih kiselina |                         |                         |                      |
|---|---|-------------------------|-------------------------|----------------------|
|   | 0%  | 0.2%                    | 0.4%                    | 0.6%                 |
| Cooking time, CT (s)<br>vreme kuvanja (s)                 | 212±12ª   | 239±8ª                  | 270±14 <sup>b</sup>     | 298±10 <sup>b</sup>  |
| Volume increase, $\alpha$<br>povećanje zapremine $\alpha$ | 3.57±0.03ª  | 3.42±0.05 <sup>b</sup>  | 3.55±0.05 <sup>ab</sup> | 3.57±0.07ª           |
| Cooking loss, (% d.m.)<br>procenat raskuvavanja, (% s.m)  | 5.98±0.07 <sup>a</sup>                                      | 6.32±0.03 <sup>ab</sup> | 6.75±0.03 <sup>b</sup>  | $7.00 \pm 0.08^{b}$  |
| Stickiness*<br>Lepljivost                                 | 8.7±0.5ª  | 8.3±0.4 <sup>ab</sup>   | 7.8±0.3 <sup>ab</sup>   | 7.2±0.4 <sup>b</sup> |

\*Sensor testing, minimum score is 1, maximum score is 10 (non sticky)

\* senzorna ocena, minimalna vrednost 1, maksimalna vrednost 10 (ne lepljiva)

The results are presented as mean±SD (standard deviation);

Rezultati predstavljaju srednju vrednost±SD (standardna devijacija)

<sup>a,b</sup> Different letters within the same row indicate statistically significant differences (p<0.05), according to Tukey's test, number of repetitions: n=6,

<sup>a,b</sup>Različita slova u eksponentu vrednosti u istim redovima ukazuju na statistički značajne razlike pri nivou značajnosti od p<0,05 po Tukey, broj ponavljanja: n=6

On Figure 1 changes of descriptive sensory characteristics of pasta with different quantities of  $\omega$ -3 fatty acids are shown.

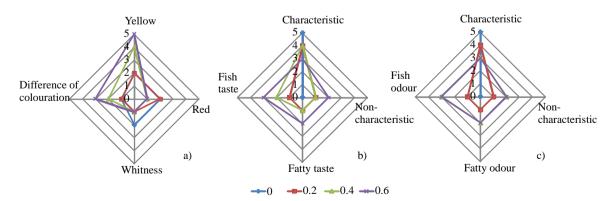


Figure 1.a-c Sensory analysis of pasta with different quantity of ω-3 fatty acids Slika 1.a-c Senzorna ocena testenine sa ω-3 masnim kiselinama

The data point out that the adding of  $\omega$ -3 fatty acids positively contributes to the increase of yellow colour and decrease of red colour (Figure 1a).  $\omega$ -3 fatty acids contribute to increased differences of colouration (the highest

descriptor, 3, was in pasta with 0.6% fatty acids and the lowest descriptor, 1, was in pasta with 0% and 0.2% fatty acids). The highest whiteness of pastas was experienced with 0% fatty acids and it was decreasing with addition of  $\omega$ -3 fatty acids. Pasta with 0%  $\omega$ -3 fatty acids had characteristic taste (descriptor was 5), while the addition of  $\omega$ -3 fatty acids (Figure 1b) had negative impact on pasta taste. Non-characteristic and fatty tastes were increased with addition of  $\omega$ -3 fatty acids. Descriptor values for fish taste, as negative component of taste, had increased with addition of  $\omega$ -3 fatty acids. The influence of different quantities (0.2%, 0.4% and 0.6%) of  $\omega$ -3 fatty acids used in pasta production had shown that  $\omega$ -3 fatty acids (Figure 1c) had negative influence on odour descriptors of pasta. Pasta sample with addition of 0.2 % of  $\omega$ -3 fatty acids had descriptor values of 1 for non-characteristic and fatty odour, while pasta samples with addition of 0.4 % and 0.6 % of  $\omega$ -3 fatty acids had descriptor values of 2 for non-characteristic and fatty odours.

The distribution of saturated, monounsaturated and polyunsaturated fatty acidin in spelt pasta with 0%, 0.2%, 0.4% and 0.6%  $\omega$ -3 fatty acids are given in table 2. Gas hromatography with mass spectrometry was used for performing a qualitative analysis of saturated, monounsaturated and polyunsaturated fatty acids. The addition of  $\omega$ -3 fatty acids in spelt pasta in the quantities of 0.2%, 0.4% and 0.6% statistically significantly increased the total fatty acid content. The addition of 0.4% and 0.6%  $\omega$ -3 fatty acids in spelt pasta statistically significantly decreased the share of palmitic and stearic acids (Table 2). There were no significant statistical differences in values of oleic acid content of pasta with different content of  $\omega$ -3 fatty acids. The spelt pasta contains 0.16 mg/100 g of total fatty acids with the shares of linoleic acid and linolenic acid of 0.096 mg/100 g and 0.0048 mg/100 g, respectively (Table 2). In pasta without addition of  $\omega$ -3 fatty acids,  $\omega$ -6 fatty acids make a share of 60% while the  $\omega$ -3 fatty acids make a share of only 3%, which is consistent with findings of Abdel et al [18] and the essential  $\omega$ -6/ $\omega$ -3 ratio is 20:1. The addition of  $\omega$ -3 fatty acids in spelt pasta values in share of linolenic acid, which results with improved  $\omega$ -6/ $\omega$ -3 ratio of 1:2, 1:4 and 1:6 for pasta with 0.2%, 0.4% and 0.6%  $\omega$ -3 fatty acids, respectively.

By consuming 100 g of pasta with 0.6%  $\omega$ -3 fatty acids the  $\omega$ -3 fatty acids intake is around 0.6048 g, which contributes to the improvement of  $\omega$ -6/ $\omega$ -3 fatty acids ratio in the daily diet (1:6) (Table 2). Daily needs in  $\omega$ -3 fatty acids recommended by the International Society for the Study of Fatty acids and Lipid's (ISSFAL) [12,13] could be met by consuming 160 g pasta with 0.4%  $\omega$ -3 fatty acids, 317 g pasta with 0.2%  $\omega$ -3 fatty acids and 13541 g with 0%  $\omega$ -3 fatty acids, with recommended dietary intake of 0.65 g/day of EPA (eicosapentaenoic) and DHA (docosahexanoic) [12,13].

|                                       | Quantity of added ω-3 fatty acids<br>Količina dodatih ω-3 masnih kiselina |                           |                            |                          |  |
|---------------------------------------|---|---------------------------|----------------------------|--------------------------|--|
| _                                     | 0%  | 0.2%                      | 0.4%                       | 0.6%                     |  |
| FAC (g/100g)<br>Masne kiseline        |   |                           |                            |                          |  |
| TFAC(g/100g)<br>Ukupne masne kiseline | 0.16±0.02ª  | 0.30±0.03 <sup>b</sup>    | 0.54±0.03 <sup>c</sup>     | 0.70±0.04 <sup>d</sup>   |  |
| SAFA<br>Zasićene masne kiseline       |   |                           |                            |                          |  |
| C 16:0 (g/100g)                       | 0.028±0.002ª  | $0.025 \pm 0.001^{ab}$    | 0.022±0.002 <sup>b</sup>   | 0.020±0.003 <sup>b</sup> |  |
| C 18:0 (g/100g)                       | 0.002±0.0001 <sup>a</sup>   | 0.002±0.0002 <sup>a</sup> | $0.001 \pm 0.0001^{b}$     | $0.001 \pm 0.0001^{b}$   |  |
| MUFA<br>Mononezasićene masne kiseline |   |                           |                            |                          |  |
| C 1:18 (g/100g)                       | 0.023±0.002ª  | 0.022±0.001ª              | 0.023±0.003ª               | 0.021±0.002ª             |  |
| PUFA<br>Polinezasićene masne kiseline |   |                           |                            |                          |  |
| C 18:2N (g/100g)                      | 0.096±0.010 <sup>a</sup>  | 0.096±0.009ª              | 0.095±0.008ª               | 0.094±0.010 <sup>a</sup> |  |
| C 18:3N (g/100g)                      | 0.0048±0.001ª   | 0.2048±0.009 <sup>b</sup> | $0.4048 \pm 0.011^{\circ}$ | $0.6048 \pm 0.015^{d}$   |  |
| Ratio ω-6/ω-3<br>Odnos ω-6/ω-3        | 20:1  | 1:2                       | 1:4                        | 1:6                      |  |

| Table 2. Content of fatty acids in pasta with $\omega$ -3 fatty acids |
|---|
| Tabela 2. Sastav masnih kiselina u testenini sa ω-3 masnim kiselinama |

The results are presented as mean±SD (standard deviation);

Rezultati predstavljaju srednju vrednost±SD (standardna devijacija);

 $^{a,b,c}$ Različita slova u eksponentu vrednosti u istim redovima ukazuju na statistički značajne razlike pri nivou značajnosti od p<0,05 po Tukey, broj ponavljanja: n=6. C16:0-palmitinska kiselina, C18:0-stearinska kiselina, C1:18-oleinska kiselina, C18:2N-linolna kiselina  $\omega$ -6,C18:3N-linoleinska kiselina  $\omega$ -3.

<sup>&</sup>lt;sup>a,b,c</sup> Different letters within the same row indicate statistically significant differences (p<0.05): according to Tukey's test, number of repetitions: n=6. FAC-fatty acid content, TFAC-total fatty acid content SAFA-saturated fatty acids, MUFA-monounsaturated fatty acids, PUFA-polyunsaturated fatty acids, C16:0- palmitic acid, C18:0-stearic acid, C1:18-oleic acid, C18:2N-linoleic acid  $\omega$ -6,C18:3N-linolenic acid  $\omega$ -3.

### CONCLUSION

Based on the obtained results of the effects of  $\omega$ -3 fatty acids addition on pasta properties, it can be concluded that added  $\omega$ -3 fatty acids increase cooking time and cooking loss. Volume is not significantly affected, while stickiness of cooked pasta is reduced.

The addition of  $\omega$ -3 fatty acids contributes to decreasing characteristic taste and increasing non-characteristic taste, fatty taste and fish taste. This research points to pasta with  $\omega$ -3 fatty acids used for production of functional pasta product, stressing that sensory characteristics are within consumer acceptability range. The addition of  $\omega$ -3 fatty acids in spelt pasta in quantities of 0.2% significantly increases the share of  $\omega$ -3 fatty acids, which results in improved ratio of  $\omega$ -6/ $\omega$ -3 to 1:2. Consumption of 100 g of pasta with 0.6%  $\omega$ -3 fatty acids means the intake of 0.6048 g of essential fatty acids per day. Pasta enriched with  $\omega$ -3 fatty acids represents a new functional product with good technological quality and improved fatty acids profile.

#### Acknowledgement

These results are part of the project supported by the Ministry of Education and Science of the Republic of Serbia, III 46005, TR 31029.

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# TESTENINA OD SPELTE OBOGAĆENA Ω-3 MASNIM KISELINAMA

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U ovom radu je ispitan uticaj dodatka  $\omega$ -3 masne kiseline na kvalitet testenine od spelte i poboljšanje funkcionalnih osobina testenine.  $\omega$ -3 masne kiseline su dodavane u uzorke testenine u količini 0%, 0,2%, 0,4% i 0,6%. Dodatak  $\omega$ -3 masne kiseline utiče na povećanje vremena kuvanja i procenta raskuvavanja, zapremina se ne menja značajno, dok se smanjuje lepljivost. Za kvantitativno određivanje sadržaja masnih kiselina koriščena je gasna hromatografija sa masenom spektroskopijom. Testenina sa dodatkom 0,6%  $\omega$ -3 masnih kiselina sadrži 0,6048 g  $\omega$ -3 masnih kiselina što doprinosi poboljšanju odnosa  $\omega$ -6/ $\omega$ -3 masnih kiselina u dnevnom obroku, što se preporučuje od strane nutricionista. Konzumiranjem 100 g testenine sa dodatkom 0,6%  $\omega$ -3 masnih kiselina dnevno, unosi se 0,6048 g esencijalnih masnih kiselina dnevno. Testenina obogaćena sa  $\omega$ -3 masnim kiselinama je nov proizvod sa dobrim tehnološkim karakteristikama, poboljšanim sastavom masnih kiselina i prihvatljivim senzornim ocenama za potrošače.

Ključne reči: kvalitet testenine, senzorne osobine, masne kiseline, odnos  $\omega$ -6/ $\omega$ -3

Rad primljen: 07. 04. 2016. Rad prihvaćen: 17. 06. 2016.