**Biblid**: 1821-4487 (2010) 14; 4; p.183-185
**UDK**: 625:074:582.665.11

Original Scientific Paper
Originalni naučni rad

# RHEOLOGICAL PROPERTIES OF DOUGH MADE FROM WHEAT-WHOLEGRAIN BUCKWHEAT FLOUR SUPPLEMENTED WITH HERBAL MIXTURE VITAPLANT®

# REOLOŠKA SVOJSTVA TESTA OD PŠENIČNOG I INTEGRALNOG HELJDINOG BRAŠNA SA BILJNOM SMEŠOM VITAPLANT®

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## ABSTRACT

*The importance of wholegrain buckwheat flour is that it is a gluten free food and it is abundant innutrients, such as proteins, essential amino acids, dietary fibers, starch, vitamins and minerals. Addition of aromatic and spice plants improves the nutritional and health potential of food, improves taste and odour and prevents its deterioration. As rheological properties have great relevance in predicting the final product quality, the effect of Vitaplant® herbal mixture addition on dough rheological properties was studied. The dough was made with wheat- wholegrain buckwheat flour mixture (70:30 w/w) and 2, 3, 5 and 7% of Vitaplant®, where the amount of wheat flour was reduced for the Vitaplant® portion. The addition of herbal mixture Vitaplant® changes the rheological properties of dough. Based on cluster analysis and Euclidean distances, in order to achieve better functional properties of food products, Vitaplant® is recommended in portion of 7%.*

***Key words:*** *wholegrain buckwheat, flour, dough, rheology, herbal mixture.*

## REZIME

*Značaj integralnog heljdinog brašna ogleda se u tome što ne sadrži gluten i što je bogato nutritivnim sastojcima kao što su proteini, esencijalne amino kiseline, dijetetna vlakna, vitamini i minerali. Kada se u prehrambenoj industriji, deo pšeničnog brašna zameni heljdinim brašnom, dobija se finalni proizvod sa manjim sadržajem glutena, obogaćen nutritivnim komponenta heljde. Primena aromatičnog bilja u prehrambenoj industriji je doživela ekspanziju poslednjih godina, kada je proizvodnja funkcionalne hrane postala trend u svetu. Dodatak aromatičnog i začinskog bilja popravlja nutritivna svojstva hrane, ima pozitivan efekat na zdravlje ljudi, menja ukus i miris hrane i sprečava njeno kvarenje. Prehrambeni proizvodi sa bezglutenskim integralnim heljdinim brašnom uz dodatak biljne smeše mogu se smatrati funkcionalnom hranom. Kako je poznavanje reoloških svojstava testa značajno u predviđanju kvaliteta finalnog proizvoda, u radu je ispitan uticaj dodatka biljne smeše Vitaplant® na reološka svojstva testa. Testo je dobijeno od smeše pšeničnog i integralnog heljdinog brašna u odnosu 70:30 m/m, sa udelom Vitaplant®-a od 2, 3, 5 i 7% m/m, pri čemu je količina pšeničnog brašna smanjena za udeo Vitaplant®-a. Reološka svojstva testa ispitana su primenom standardnih metoda ispitivanja na farinografu, ekstenzografu i amilografu. Rezultati ispitivanja pokazju da dodatak Vitaplant®-a menja reološka svojstva testa. Na osnovu klaster analize i Euklidskih rastojanja, u cilju dobijanja prehrambenih proizvoda sa boljim funkcionalnim i nutritivnim svojstvima preporučuje se upotreba Vitaplant® u udelu od 7%.*

***Ključne reči****: integralno heljdino brašno, testo, reološka svojstva, biljna mešavina.*

## INTRODUCTION

As the nutritional value of buckwheat (*Fagopyrum esculentum* Moench) is similar to that of cereals, it is usually grouped with cereals. The integral buckwheat flour is especially abundant in nutrients, such as proteins, essential amino acids, dietary fibers, starch, vitamins B1, B2, C and E (Watanabe, 1998; Wijngaard and Arendt, 2006) and a good source of minerals (Pomeranz, 1983; Ikeda and Yamashita, 1994). Buckwheat protein is of high nutritional quality due to relatively high levels of lysine and arginine (Watanabe, 1998) and due to well-balanced amino acid composition (Pomeranz and Robbins, 1972). When part of the wheat flour is substituted with wholegrain buckwheat flour, the final product has lower gluten content and it is enriched with buckwheat components. Using aromatic herbs and spices in food purposes expanded in the last years when the functional food has become a world trend (Biliaderis, 2008). Bakery products as popular food where wheat flour is supplemented with other cereals or some specific ingredient could be used for the prevention of nutritive deficiencies. For example, such product is white wheat bread with by-product sugar beet (Lević et al., 2005). Addition of aromatic and spice plants improves the nutritional and health potential of food, enhances taste and odour. More from antiquity it is well known that aromatic herbs and spices exhibit a role of preservatives, so their addition might prevent food deterioration (Mimica-Dukić Neda, 2003).

As dough rheological properties are important in predicting the final product quality such as mixing behaviour, sheeting and baking performance (Dobraszczyk and Morgenstern, 2003), in this paper the effect of herbal mixture Vitaplant® addition on dough rheological properties was studied. Vitaplant® is a mixture of various parts of plants such as buckthorn, mentha, caraway and parsley. Buckthorn is known as laxative, vasodilator, diuretic and cardiostimulator (Huang et al., 1991; Zhou and Chen, 1988) and mentha has anti inflammatory, antimicrobial and antioxidant effects (Fuchs et al., 1999; Mimica-Dukić Neda and Božin, 2008). Caraway (Zheng and Wang, 2001; Wojdylo et al., 2007) and parsley (Wong and Kitts, 2006; Zhang and Chen, 2006) also have antioxidant effects. In order to find the optimal portion of herbal mixture Vitaplant®, in this paper the rheological properties of dough made from wheat-wholegrain buchwheat flour mixture (70:30 w/w) with different portion of Vitaplant® were investigated.

# MATERIALS AND METHODS

## Flour and herbal mixture

Wheat flour and integral buckwheat flour were bought from the local market. Flour protein content was determined by the Kjeldahl method (Nx5.95). The ash, fat and moisture contents of flour were determined according to standard test procedures. The values for samples are from triplicate analysis and followed by standard deviation.

Plants, buckthorn (*Frangulae cortex)*, mentha (*Mentha piperitae)*, caraway (*Carvi fructus)* as well as parsley (*Petroselini fructus)*, used for the herbal drugs Vitaplant® are products of the Institute for Medicinal Plant Research „Dr Josif Pančić", Belgrade. Vitaplant® is a mixture of *Frangulae cortex* (35%), *Mentha piperitae folium* (20%), *Carvi fructus* (20%) and *Petroselini fructus* (25%). All ingredients in the herbal mixture were previously controlled: identity was established, sensory properties and level of cleanliness were determined and health validity was tested (Mišan Aleksandra, 2009).

## Rheology measurement

For testing the dough rheological properties, 90 g of integral buckwheat flour, 204, 201, 195 and 189 g of wheat flour and 6, 9, 15 and 21g of Vitaplant® were used to make 300 g of dough with 2% (V2%), 3% (V3%), 5% (V5%), and 7% (V7%) (w/w) Vitaplant® portion, without adding improvers (the amount of wheat flour is reduced for the Vitaplant® portion).

The Brabender farinograph (Brabender Model 8 10 101, Duisburg, Germany) according to ISO 5530-1 test procedure, was used for water absorption values (WA value in ml), development time (DT in minutes), dough stability (DSt in minutes), degree of softening (DSf in B.U.) and farinograph quality number (QN) determination.

For extensigraph measurements, the Brabender extensigraph (Brabender, Model 8600-01, Duisburg, Germany) and test procedure ISO 5530-2 were used. The samples were prepared from flour, distilled water and salt, and data for extensigraph area (E in cm2), resistance (R in B.U.), extensibility (Ex in mm) and ratio number (R/Ex) were recorded on the extensigraph curve.

To obtain amylograph data, gelatinization temperature (Tmax in 0C and gelatinization maximum (ηmax in B.U.), the amylograph (Brabender Model PT 100, Duisburg, Germany) and ISO 7973 test procedure were used.

## Statistical analysis

Statistical analysis, correlation coefficients and cluster analysis were performed by program STATISTICA version 5.0. The cluster analysis was used in order to classify doughs made from mixture of wheat and wholegrain buckwheat flour with different Vitaplant® portions into groups on the basis of multiple variables. The Euclidean method and complete linkage was used.

# RESULTS AND DISCUSSION

The wheat flour was $B_2$ quality number (QN), and had 9.86±0.3% proteins, 0.51±0.04% ash, 1.9±0.1% fat and 24.6±0.4% gluten. The protein content in the wholegrain buckwheat flour was 10.5±0.5%, ash content was 1.9±0.05% and fat content was 2.2±0.1%.

Rheological properties of four flour mixture with different Vitaplant® portions (2%-7%, w/w) obtained by farinograph, extensigraph and amylograph are presented in Table 1. Dough made with wheat and wholegrain buckwheat flour in ratio of 70:30 w/w (WIBW) was a control dough.

The results of farinograph, extensigraph and amylograph data show that the rheological properties depend on the Vitaplant® portion in the flour mixture. By rising the Vitaplant® portion in wheat-wholegrain buckwheat flour mixture, the water absorption rises, from 59.0 to 64.8%. As the main component responsible for water absorption is gluten and as buckwheat flour is gluten free, the better absorption properties are probably due to protein components such as globulin and albumin (Pomeranz and Robbins, 1972) as well as the Vitaplant® addition. These results could indicate the economic justification of the Vitaplant® use in the production of food products.

With higher Vitaplant® portion, the dough development time is longer (4.8 to 5.2 minutes instead 4.5 minutes), dough stability is slightly different and degree of softening varies, from 95 to 120 B.U. The flour quality group remains the same, and it is B2. Extensigraph data shows that the rising Vitaplant® portions in wheat- wholegrain buckwheat flour mixture decrease dough extensigraph area from 31.1 to 26.4 $cm^2$ whereas dough resistance varies from 150 to 170 B.U., and extensibility decreases from 126 to 87 B.U. By amylograph data, the gelatinization temperature decreases from 86.5 to 82.7$^oC$ and the maximal viscosity decreases from 1460 to 900 B.U.

*Table 1. The rheological properties of wheat-wholegrain buckwheat (WIBW), 70:30 w/w dough and wheat–integral buckwheat dough with 2-7% , w/w portion of Vitaplant® (V2%-V7%)*

| Farinograph data | | | | | |
|---|---|---|---|---|---|
| | WIBW | V2% | V3% | V5% | V7% |
| WA (ml) | 59.0 | 60.6 | 61.6 | 63.1 | 64.8 |
| DT (min) | 4.5 | 4.8 | 4.5 | 5.0 | 5.2 |
| DSt (min) | 0.5 | 0.5 | 0.6 | 0.7 | 0.7 |
| DSf (B.U.) | 100 | 110 | 120 | 105 | 95 |
| QN | 47.9 | 45.4 | 45.7 | 49.0 | 52.2 |
| Group | B2 | B2 | B2 | B2 | B2 |
| Extensigraph data | | | | | |
| E ($cm^2$) | 31.1 | 32.5 | 29.2 | 30.9 | 26.4 |
| R (B.U.) | 150 | 155 | 170 | 170 | 160 |
| Ex (B.U.) | 126 | 116 | 114 | 106 | 87 |
| R/Ex | 1.19 | 1.36 | 1.46 | 1.60 | 1.84 |
| Amylograph data | | | | | |
| $T_{max}$ ($^oC$) | 86.5 | 85.7 | 84.2 | 84.2 | 82.7 |
| $\eta_{max}$ (B.U.) | 1460 | 1135 | 1055 | 970 | 900 |

The correlation coefficients and significance levels between the all obtained rheological properties are presented in Table 2. The sample size was ten (N=10, five dough: dough obtained from wheat- wholegrain buckwheat flour (70:30 w/w), four wheat–wholegrain buckwheat dough with 2, 3, 5 and 7% Vitaplant® portion and two determinations). Only the correlations with absolute value above 0.8 were taken into consideration. There are 24.4% correlations, among which 8.9% were proper, and 15,5% were opposite. The proper correlations are that high value of WA goes with high DT and DSt value, high Ex value with high E and $T_{max}$ value. On the other hand, the opposite correlations are that the high WA value goes with low Ex and $T_{max}$, high DT with low E and Ex value, high DSt with low Ex and $T_{max}$ value and high DSt with low QN value.

By cluster analysis, dough from wheat-wholegrain buckwheat flour, 70:30 w/w (WIBW) and wheat– wholegrain buckwheat dough with 2% (V2%), 3% (V3%), 5% (V5%) and 7% (V7%) Vitaplant® portion were classified into groups on the basis of multiple variables.

*Table 2. Correlation matrix for five dough: dough from wheat-integral buckwheat flour, 70:30 w/w, wheat–integral buckwheat dough with 2, 3, 5 and 7% Vitaplant® portion and two determinations (N=10, correlations are significant at p≤ 0.5)*

| | WA | DT | DSt | DSf | QN | E | R | Ex | $T_{max}$ |
|---|---|---|---|---|---|---|---|---|---|
| DT | 0.86 | 1 | | | | | | | |
| DSt | 0.93 | 0.72 | 1 | | | | | | |
| DSf | -0.30 | -0.57 | -0.29 | 1 | | | | | |
| QN | 0.71 | 0.79 | 0.72 | -0.84 | 1 | | | | |
| E | -0.57 | -0.83 | -0.35 | 0.75 | -0.73 | 1 | | | |
| R | 0.59 | 0.17 | 0.68 | 0.48 | 0.01 | 0.30 | 1 | | |
| Ex | -0.94 | -0.92 | -0.81 | 0.51 | -0.78 | 0.81 | -0.30 | 1 | |
| $T_{max}$ | -0.98 | -0.76 | -0.91 | 0.25 | -0.67 | 0.52 | -0.61 | 0.91 | 1 |
| $\eta_{max}$ | 0.02 | 0.04 | -0.05 | 0.39 | -0.22 | 0.07 | 0.13 | 0.04 | 0.02 |

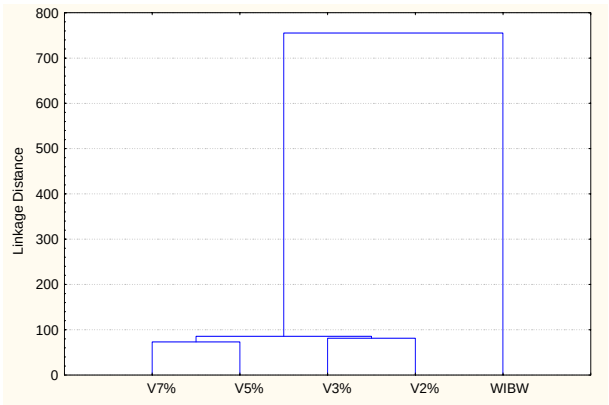


*Fig. 1. Dendrogram based on rheological properties of dough from wheat-wholegrain buckwheat flour, 70:30 w/w (WIBW) and wheat–wholegrain buckwheat dough with 2% (V2%), 3% (V3%), 5% (V5%) and 7% (V7%) Vitaplant® portion*

Number of variables was five: wheat-integral buckwheat dough and four wheat– wholegrain buckwheat dough with different portion of Vitaplant®; number of cases was six: WA, DT, DSf, Ex, $T_{max}$, and $\eta_{max}$. The obtained linkage distance are presented by dendrogram in Figure 1.

The wheat– wholegrain buckwheat dough with Vitaplant® portion of 2 and 3% (V2% and V3%) as the first group, are joined with wheat-integral buckwheat (WIBW) dough at distance level of 81 and the wheat–integral buckwheat dough with Vitaplant® portion of 5 and 7% (V5% and V7%) as the second group are joined at distance level of 73. These groups are joined each other at the distance level of 86 and with the WIBW at the distance level of 755. Based on these Euclidean distances there is no great difference between the first group (wheat–integral buckwheat dough with Vitaplant® portion of 2 and 3%) and second groups (wheat–integral buckwheat dough with Vitaplant® portion of 5 and 7%), i.e. difference in distance level is only 8, compared to the maximum distance level of 755. Based on this cluster analysis, in order to achieve better functional properties of the food products, Vitaplant® is recommended in portion of 7%.

## CONCLUSIONS

Rheological properties depend on the Vitaplant® portion in the wheat-wholegrain buckwheat flour mixture, 70:30 w/w. By rising the Vitaplant® portion in the wheat-integral buckwheat flour mixture, the water absorption rises, dough development time is longer and dough extensigraph area and extensibility decrease. The flour quality group remains the same, and it is B2. Based on the cluster analysis and small difference in the Euclidean distance level between wheat–wholegrain buckwheat dough with various doses of Vitaplant®, in order to achieve better functional properties of the final food products, the herbal mixture Vitaplant® is recommended in portion of 7%.

***ACKNOWLEDGEMENTS:****This work was supported under the project No 20068 by the Ministry of Science and Technology of the Republic of Serbia.*

## REFERENCES

Biliaderis C.G. (2008). Functional foods: Trends, prospects and challenges for the food industry. Journal on processing and energy in Agriculture, 12(3), 97-100.

Dobraszczyk, B.J., Morgenstern, M.P. (2003). Rheology and bread making process. Journal of Cereal Science, 38, 229-245.

Fuchs, S., Beck, T., Bukardt, S., Sandvoss, M., Mosandl A. (1999). Biogenetic studies in *Mentha x piperita* L. Deuterium-labeled monoterpene ketones: synthesis and stereoselective analysis. Journal of Agricultural and Food Chemistry, 47, 3053-3057.

Huang, H.C., Chu, S.H., Chao-Lee, P.D. (1991). Vasorelaxants from Chinese herbs, emodin and scoparone, process imunoppressive properties. European Journal of Pharmacology, 198, 211-213.

Ikeda, S., Yamashita, Y. (1994). Buckwheat as a dietary source of cinc, copper and manganese. Fagopyrum, 1, 29-34.

Lević, Lj., Filipčev Bojana, Šimurina Olivera, Kuljanin Tatjana (2005). Dough rheology and qualitative attributes of wheat bread supplemented with sugar beet. Journal on processing and energy in Agriculture, 9(5), 129-131.

Mimica-Dukić, Neda (2003). Aromatics plants as dietary supplements in human health. La Phytotherapie Europeenne, 14, 13-18.

Mimica-Dukić, Neda, Božin, B. (2008). Mentha L. species (Lamiaceae) as promising sources of bioactive secondary metabolites. Current Pharmaceutical Design, 14, 3141-3150.

Mišan, Aleksandra. (2009). Antioksidantna svojstva lekovitog bilja u hrani, PhD Thesis, Prirodno-matematički fakultet, Univerzitet u Novom Sadu, Serbia, pp. 63.

Pomeranz, Y., Robbins, G.S. (1972). Amino acids composition of buckwheat Buckwheat: Structure, composition, and utilization. Journal of Agricultural and Food Chemistry, 20, 270-274.

Pomeranz, Y. (1983). Buckwheat: Structure, composition and utilization. Critical Reviews in Food Science and Nutrition, 19, 213-258.

Watanabe, M. (1998). Catechins as antioxidans from buckwheat *(Fagopyrum esculentum Möench)* groats. Journal of Agricultural and Food Chemistry, 46 (3), 839-845.

Wijngaard, H.H., Arendt, E.K. (2006). Buckwheat. *Cereal Chemistry, 83(4)*, 391-401.

Wojdylo, A., Oszmianski, J., Czemerys, R. (2007). Antioxidant capacity and phenolic compounds in 32 selected herbs. Food Chemistry, 105, 940-949.

Wong, P., Kitts, D. (2006). Studies on the dual antioxidant and antibacterial properties of parsley (*Petroselinum crispum*) and cilantro (*Coriandrum sativum*) extracts. Food Chemistry, 97, 505-515.

Zhang, H., Chen, F., Wang, X. (2006). Evaluation of antioxidant capacity of parsley (Petroselinum crispum) oil and identification of its antioxidant constituents. Food Research International, 39, 833-839.

Zheng, W., Wang, S.Y., (2001). Antioxidant capacity and phenolic compounds in selected herbs. Journal of Agricultural and food Chemistry, 49 (11), 51265-5170.

Zhou, X.M., Chen, Q.H. (1988). Biochemical study of Chinese rhubarb XXII. Inhibitory effect of anthraquinone derivates on sodium-potassum-ATPase of a rabbit renal medulla and their diuretic action. Acta Pharmacologica Sinica, 23, 17-20.

Received:04.11.2010. Accepted:25.11.2010.