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PROPERTIES OF DOUGH AND QUALITATIVE CHARACTERISTICS OF WHEAT BREAD WITH ADDITION OF INULIN

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Key words: breadmaking, inulin, rheological properties, wheat flour

The aim of the present study was to determine the influence of inulin on physical properties of wheat dough and quality of bread. The experimental material were two commercial types of wheat flour (550 and 750) and inulin TEX of long average chain length. Inulin was added at 1, 2, 3 and 4% in relation to the weighted portion of flour. The control test were wheat flours. The properties of dough with and without addition of inulin were determined on the grounds farinograph and extensigraph diagrams. Besides there was made laboratory baking.

Wheat flours with addition of inulin appeared to have absorbed less water as compared with control test. Addition of inulin was bringing prolonged time of dough development, longer stability, less softening and increased value of the quality indexes, also higher energy.

The volume of bread with more than 2% inulin was significantly smaller than that of control loaves or enriched with 1 and 2% inulin. Bread volumes significant depend on interaction between the type of flour and the addition of inulin.

INTRODUCTION

Inulin is a polydisperse mixture of linear chains of fructose units (DP2-DP60) with mostly one terminal glucose unit, coupled by means of β (2-1) bonds. It is a soluble form of dietary fiber, numbered among products of low caloricity [Roberfroid, 1999a]. In human alimentary tract there do not occur enzymes capable of its digestion. In the small intestine inulin participates in formation of increased amount of matter, and in the large one it undergoes considerable fermentation making the medium for development of bacterial microflora which enables proper digestion. Inulin brings about, too, a slower liberation of glucose as well lowering of the cholesterol level in blood [Kopeć & Cieślik, 2005; Schneeman, 1999; Williams, 1999].

According to Van Loo *et al*. [cited after Moshfegh *et al.*, 1999], high quantities of inulin occur in the roots of chicory (41.6%) and Jerusalem artichoke (18%). Its lower quantities are found in dandelion (13.5%), garlic (12.5%), onion (4.3%) and wheat (2.5%).

Inulin can be used instead of fat. It was found out that 1 g of fat could be replaced with 0.25 g of inulin [Coussement, 1999]. Research carried out by the Orafti firm proved that inulin connected with water forms molecular gels, which after a thorough mixing give a thick, creamy structure making the products smooth and of good mild taste [Anonymous, 2001a].

Inulin can be used in meat industry as a texture-forming and water fixing agent to improve the succulence of pork-butcher's products [Makała, 2003]. The advantages of inulin make it useful in food production for diabetics, particularly as addition to cakes and sweetmeats with reduced caloricity [Remiszewski *et al.,* 2003].

Inulin contributes to development of functional food as well as its quality, in consequence to improved health of consumers. In this context inulin, as a natural product, can be a valuable addition in production of enriched food stuffs which would be favourable to human organism [Roberfroid, 1999b]. So the compound raises the interest of food producers, including those of the baking branch. The research by Filipiak-Florkiewicz & Cieślik [2001] showed that bread with addition of inulin contained more fructans as compared with standard bread (6.7-1.4%, respectively); thus, they certainly have a higher nutrition value.

Because of little information concerning the influence of inulin addition on baking properties of wheat flour, the object of the research has been to determine the influence of inulin on physical properties of wheat dough and quality of bread.

MATERIAL AND METHODS

The experimental material were two commercial types of wheat flour (550 and 750) as well as inulin TEX of long average chain length (>90% inulin, 5-10% fructose, glucose, sucrose, <0.2% ash) (country of origin – Dutch). The flour was characterized by determining the total protein content with Kjeldahl method (N x 5.7), efficiency of gluten, its deliquescence [PN 77/A 74041], sedimentation value acc. to Zeleny [PN-ISO 5529:1998] and the falling number [PN-ISO 3093:1996].

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Inulin was added at 1, 2, 3 and 4% in relation to the weighted portion of flour. The control test was wheat flour. The properties of dough with and without addition of inulin were determined on the grounds of farinographic [PN-ISO 5530-1:1999] and extensigraphic [AACC, 2000] diagrams. Baking was made with the Biskupski method as described by Karolini-Skaradzińska *et al.* [2001]. Porosity of the bread crumb was determined according to eight-point Dallmann scale. The experiments were carried out in the years 2003--2005.

Statistical analysis. The results obtained were analysed statistically. Multifactor analysis of variance was carried out with Duncan's test to determine the significance of differences (p=0.05). Use was made of Statgraphics v. 5.0 software.

RESULTS AND DISCUSSION

The wheat flour type 750 contained on the average more protein (11.8%) and gluten (31.2%) than type 550 (11.2% and 29.7% respectively). Besides, it was characterised by higher sedimentation value (34.5 mL) and activity of α-amylase (304 s) in comparison with the flour type 550 (32.7 mL and 381 s respectively). Gluten of the flour type 750 was characterized by higher deliquescence (11.2 mm) than that of type 550 (7.0 mm).

The flours assessed differed in respect of their farinographic characteristics. The flour type 550 was characterized by less water absorbability and its dough by shorter time of development, less softening and higher quality number (Table 1).

Addition of inulin influenced a successive decrease in water absorbability of flour. The sample without addition of the inulin absorbed water at 58.1%, while with 4% inulin its capability of water absorbance got diminished to the level of 53.6%. Improved inulin Frutafit ®TEX produced by Sensus could retain two times more water than the standard types [Anonymous, 2001b]. The information concerns the inulin itself, but not the case when it participates in interactions with the components of flour. It may be supposed that inulin forms a barrier around the starch grains and thus limits the possibility of water fixation [Tudorica *et al.*, 2002].

Addition of inulin considerably prolonged time of dough development, *i.e.* from 2.3 min for the control sample to 9.9 min for flour containing 4% inulin (Table 1). Besides, the dough was getting considerably strengthened, what expressed itself by its longer stability, less softening and increased value of the quality indexes, particularly if it was with 3 and 4% addition of inulin.

Visco-elastic properties of dough made of flour type 550 were characterized by better values of extensigraphic parameters as compared with that made of flour type 750 (Table 2). Addition of inulin at 3 and 4% was bringing about strengthening of the dough. The dough was conspicuous by higher energy (143.5–148.5 cm^2) compared with the control sample (127.6 cm^2) and with that containing 1 and 2% of the dietary fibre tested (123.5–124.7 cm^2). Resistance at constant deformation (R_{50}) was higher in samples with 3 and 4% inulin (627-629 BU) than in control dough (550 BU). On the other hand, the least resistance at stretching was that of dough with 1 and 2% addition of inulin (458 and 483 BU, respectively). The research by Cavella *et al.* [2003] point to differentiated influence of inulin on the properties of dough, depending on the length of that alimentary fibre chain. Those authors proved that the resistance of dough was getting increased along with increasing addition of short–chain inulin, and decreased with use of the long–chain one. In own research the most subject to stretching appeared the dough containing 1 and 2% inulin (185 and 180 mm). The results of research by Tudorica *et al.* [2002] point to higher tenacity and strength of macaroni made with inulin, caused to the physicochemical properties of inulin fibre.

To determine the potential technological value of flour the extensigraphy coefficient is used. For flour of good baking properties it should range from 3 to 5 [Pątek, 1983]. In own research it was found that the control samples as well as those with 3 and 4% of inulin addition were characterized by similar values of the parameter (3.7, 4.3 and 4.2, respectively). On the other hand, wheat flour containing 1 and 2% inulin addition revealed lower values of the extensigraphy coefficient (2.8 and 3.0, respectively).

It should be emphasized that the changes in rheological properties of dough from both the types of wheat flour after addition of inulin were similar. Therefore, no information concerning interactions between inulin and flour properties were obtained.

Bread made of flour type 550 was conspicuous by greater overbake (47.4%), smaller volume (497 cm^3) and better poros-

TABLE 1. Mean values of farinograph traits of wheat dough with addition of inulin.

	Water absorption of flour (%)	Dough development (min)	Dough stability (min)	Dough softening (BU)	Quality number (mm)
Type of flour					
550	54.1^b	3.5^b	9.9^a	42^b	134^a
750	57.0^a	4.8^a	7.3^a	65^a	102^b
Addition of inulin (%)					
0	58.1^a	2.3^b	4.0^c	73^a	70^c
1	56.8^b	2.4^b	4.9^c	63^{ab}	77^c
2	55.2^c	2.9^b	6.9^{bc}	55^b	94^{bc}
3	54.2^d	3.2^b	11.2^b	38^c	132^b
4	53.6^e	9.9^a	16.3^a	38^c	218^a

a, b, c, d, e – homogenous groups estimated with Duncan's test (p≥0.95)

TABLE 2. Mean values of extensigraph traits of wheat dough with addition of inulin.

	Dough energy (cm²)	Resistance to extension (R_{50}) (BU)	Extensibility of dough (mm)	Extensigraphic index (BU/mm)
Type of flour				
550	147.7^{a}	623^{a}	157^{b}	4.1^{a}
750	119.3^{b}	476^{b}	190^{a}	3.1^{b}
Addition of inulin (%)				
0	127.6^{b}	550^{b}	168^{c}	3.7^{a}
1	123.5^{b}	458^{c}	185^{a}	2.8^{b}
2	124.7^{b}	483^{c}	180^{ab}	3.0^{b}
3	143.5^{a}	627^{a}	166^{c}	4.3^{a}
4	148.5^{a}	629^{a}	169^{bc}	4.2^{a}

a, b, c, – homogenous groups estimated with Duncan's test (p≥0.95).

TABLE 3. Mean values of baking traits of wheat bread with addition of inulin.

	Bread overbake (%)	Bread loaf volume from 100 g flour (cm³)	Crumb porosity by Dallmann's scale (points)
Type of flour			
550	47.4^{a}	497^{b}	6.2^{a}
750	42.3^{b}	526^{a}	4.3^{b}
Addition of inulin (%)			
0	44.3^{a}	534^{a}	4.5^{b}
1	45.1^{a}	520^{b}	5.5^{ab}
2	45.1^{a}	522^{ab}	5.0^{b}
3	44.9^{a}	503^{c}	5.0^{b}
4	45.0^{a}	480^{d}	6.3^{a}

a, b, c, d – homogenous groups estimated with Duncan's test (p≥0.95)

TABLE 4. Mean values of bread loaf volume for interaction between the type of flour and the addition of inulin.

Addition of inulin (%)	Type of flour	
	550	750
0	522^{a}	545^{a}
1	515^{ab}	525^{b}
2	499^{bc}	546^{a}
3	494^{c}	513^{bc}
4	456^{d}	503^{c}

a, b, c, d – homogenous groups estimated with Duncan's test (p≥0.95)

ity of crumb (6.2 points) as compared with that made of flour type 750 (42.3%, 526 cm³ and 4.3 points, respectively (Table 3). Inulin added to flour did not differentiate the bread in respect of overbake. The values of this quality ranged from 44.3% in the control bread to 45.1% in that with addition of 1 and 2% inulin. The greatest was the volume of control loaves (534 cm³, while the bread with addition of 1 and 2% inulin had lower values of that quality (520 and 522 cm³, respectively). The smallest volume was that of loaves with 4% addition of inulin (480 cm³).

As for volume of bread, there was found the existence of interaction between the type of flour and the addition of inulin (Table 4). Its 1% addition was not bringing about differences in the volume of bread made of either type of flour. However, the values of that quality, with addition of 0, 2, 3 and 4% inulin, were higher in bread made of 750 than 550 type flour. The volume of control bread and that with addition of 1% inulin to flour type 550 was the greatest, having been 522 and 515 cm³, respectively. The volumes of bread made of flour type 750 were the greatest in control loaves and in those baked with 2% inulin addition (545 and 546 cm³, respectively). It is worth-while noticing that differences in bread volume between control samples and those with 4% inulin were less with flour type 750 (42 cm³) than type 550 (66 cm³).

Górecka *et al.* [2001] proved that the presence of inulin would prolong the freshness of confectionery. They found out that fatty-sponge cake made with inulin used as partial interchanger of fat had better sensorial properties. The structure of crumb as well as its colour and elasticity are significant for sensorial assessment of bread. The pores of crumb should be minute regular and thin-walled. In this respect there was observed a favourable influence of inulin, the porosity of crumb with its 4% addition having been most minute and more delicate. However, with increasing addition of inulin the crumb was getting harder. The most perceptible change in crumb was found with 4% addition of inulin.

CONCLUSIONS

1. The addition of inulin was bringing about a decrease in water absorbability of flour.
2. Inulin influenced positively the rheological qualities of dough, bringing about its strengthening.
3. Under the influence of inulin the bread volume was decreasing, while the porosity of bread crumb was getting improved.

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WŁAŚCIWOŚCI CIASTA I CECHY JAKOŚCIOWE PIECZYWA PSZENNEGO Z DODATKIEM INULINY

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Celem pracy było określenie wpływu inuliny na fizyczne właściwości ciasta pszennego i jakość pieczywa.

Materiałem badawczym były 2 handlowe mąki pszenne (typ 550 i 750) oraz holenderska inulina TEX o średnio-długich łańcuchach fruktanowych. Inulinę dodawano w ilości 1, 2, 3 i 4% w stosunku do naważki mąki. Próbę kontrolną stanowiły mąki pszenne. Właściwości ciasta bez i z dodatkiem inuliny określono na podstawie wykresów farinograficznych i ekstensograficznych. Wykonano wypieki laboratoryjne.

Mąki pszenne z dodatkiem inuliny chłonęły mniej wody w porównaniu z próbą kontrolną. Dodatek inuliny powodował wydłużenie rozwoju ciasta oraz jego wzmocnienie wyrażające się dłuższą stałością, mniejszym rozmiękczeniem oraz zwiększeniem wartości liczby jakości (tab. 1), a także większą energią (tab.2). Objętość pieczywa z udziałem powyżej 2% inuliny była istotnie mniejsza niż bochenków chleba kontrolnego oraz wzbogaconego 1 i 2% inuliny (tab. 3). Na objętość pieczywa miała wpływ interakcja pomiędzy typem mąki a dodatkiem inuliny (tab. 4).