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EFFECT OF VARIOUS OAT FORMS ON THE QUALITY OF CONFECTIONERY

Małgorzata Sobczyk

Department of Food Technology, Division of Cereal Technology, Warsaw University of Life Sciences

Key words: naked and husked oat, wheat flour, wheat dough, sponge-fatty cakes

The aim of these studies was to examine the effect of addition of four oat forms on the physical properties of wheat dough and quality of sponge--fatty cakes. The research material consisted of wheat flour type 450 and the grain of two naked (Akt and Polar) and two husked (Dukat and Sprinter) oat varieties.

The physicochemical analysis was performed on wheat flour and oat grains, which was followed by the investigation into the effect of oat flour (5, 10 and 15%) on the structural rheological characteristics of wheat dough. Farinographic analyses were carried out as well. Next, sponge-fatty cakes were baked with an addition of oat flour. Then the final products were evaluated in a sensory test and their selected physicochemical properties were analysed. The contents of dietary fibre and its water soluble and insoluble fractions were examined.

The addition of different oat forms resulted in an increase in dough water absorption and development time. It also caused an increase in contents of the total dietary fiber as well as its water soluble and insoluble fractions in confectionery.

INTRODUCTION

Generally, oats have been qualified as feed grain of little value. In Polish tradition flaked oat grains are consumed as a component of curative diets and found rather in the menu of poor families [Bartnik & Rothkaehl, 1997].

In Poland, the end of the XXth century has been very successful in the field of oat cultivation. Many valuable cultivars were developed, *e.g.* cultivars adapted to the mountain conditions and the first Polish cultivar of gymnospermous (naked) oats [Spiss, 2003].

The appearance of the new, gymnospermous cultivars caused a considerable raise of interest in this form, not only among farmers but also nutritionists, dietitians and animal breeders. Its grain is devoid of a husk, which is a useless ballast in human nutrition, difficult to separate during the technological process. Compared to husked cultivars, the naked varieties are characterised by a higher content of protein, fat, β-glucans and vitamins, therefore this form of oat is often used for food production [Śniady *et al*., 1997; Wieser & Seilmeier, 1998; Gambuś *et al.*, 2003].

Both types of oat grain, with and without husks, constitute a valuable source of nutritive cellulose. This component is necessary in the rational nutrition of humans, both healthy and sick. Thus it is useful to introduce oat products, such as flour, flakes and bran, to food products (*e.g.* baker's and confectionary products, meat products) [Ötles & Cagindi, 2006]. Cellulose of oat origin may partially substitute flour or fat in confectionary. In this way such products are enriched in a valuable component and simultaneously their caloric value decreases [Anderson *et al.,* 1991; Górecka & Anioła, 1999].

The addition of oat products to wheat flour affects water absorption and rheological properties of dough. Oat products incorporated into bread may decrease its volume, however, they improve the structure of crumb together with taste, aroma and nutritive value of the final product [Gąsiorowski, 1995; Oomah & Lefkovitch, 1998]. According to Gambuś *et al*. [2003], oat bran is a more valuable supplement of wheat flour than of oat flour and its optimal addition amounts to 5%. Oat products are also used in the production of various confectioneries. Flakes, bran or oat flour may be added (20-25%) to different doughs like, yeast, sponge, short, short-crust, gingerbread, *etc*. Certain products, supplemented with processed oats, gain a pleasant "nutty" taste [Gąsiorowski, 1993]. In the biscuits production wheat flour can be totally substituted with oat flour [Ceglińska *et al*., 2003]. Mazurkiewicz & Achremowicz [1997] ascertained that in the production of biscuits it is possible to use oat extruders, however, its maximum addition should not exceed 20%, otherwise distinct oat taste and aroma may be distinguished. According to Ceglińska *et al*. [2003], oat bran may also by used for the production of such confectionary as cracknels and pretzels.

The reported research was aimed at determining the effect of addition of whole oat meal cultivars (two husked and two naked ones) on the physical properties of flour and wheat dough as well as the quality of sponge-fatty cakes.

Author's address for correspondence: dr inż. Małgorzata Sobczyk, Department of Food Technology, Division of Cereal Technology, Warsaw University of Life Sciences, ul. Nowoursynowska 159C, 02-776 Warszawa, Poland; e-mail: malgorzata_sobczyk@sggw.pl

MATERIAL AND METHODS

MATERIALS

The experimental material consisted of wheat flour type 450, four oat cultivars from the Plant Breeding Centre, Ltd. in Strzelce, harvested in 2005, including two naked (Akt and Polar) and two husked ones (Dukat and Sprinter).

The oats were ground in a laboratory grinder, type WŻ-1, produced by ZBPP o/Bydgoszcz. The grinding was conducted over a period of 3 min.

METHODS

The following analyses of oat grain were performed: moisture content [PN-93/A-74012], HL weight [PN-ISO 7971-2:1998], weight of 1000 grains, seed-coat content, total protein content according to the method by Kjeldahl's (N x 6.25), evaluation of wheat flour type 450 and mixtures containing 5%, 10% or 15% of oat whole meal flour, evaluation of dough obtained from those flours and of the ready products.

The baking value of wheat flour was evaluated on the basis of the following determinations: moisture content [PN-93/A-74012], acidity, total protein content determined by Kjeldahl's method (N x 5.7) using the Foss Tecator apparatus, type 1002 [PN-75/A-04018], wet gluten yield, its spreadability and elasticity [PN-77/A-74041].

The technological characteristics of control dough as well as dough produced with an addition of oat flour were based on a farinograph analysis, performed on a Brabender's farinograph. Interpretation of the results obtained was conducted according to Brabender's standards [PN-ISO 5530-1:1999] and the Falling Number 1400 [PN-ISO 3093/AK:1996].

Sponge cakes formula

A test laboratory baking of sponge cakes was conducted on the basis of the "traditional", cold method. Preparation of the dough consisted of aeration of the fat-and-sugar mass over a period of 15 min, mixing it with eggs for 5 min and gentle stirring in the flour for the final 2 min. Portions of dough weighing 100 g were placed in forms and baked for 30 min at a temperature of 180°C. The following recipe was used: wheat flour 125 g; margarine 125 g; sugar 125 g; eggs 120-125 g; and baking powder 2.5 g.

Sensory analysis

The sensory analysis of sponge cakes was carried out by a panel five people assigning scores for various quality attributes such as surface appearance, structure of crumbs, taste and aroma. The evaluation of cakes quality was done according to the accepted scale from 1 to 5 [PN-A-74108: 1996]. Moreover, contents of total dietary fiber and its water soluble and insoluble fractions were determined with the enzymatic method according to Asp [PN-A-79011-15] and the hardness of the cakes obtained was tested using a texture analyser type TA.XTZ. The crushing force was determined using a cylindrical pivot, 25 mm in diameter, which entered the cake (20 mm thick) 9 mm deep. The maximum force was recorded in Newtons (N).

Statistical analysis

The results obtained were subjected to a statistical analysis (Statgraphics Plus 4.1) using a single factor analysis of variance (Anova). The significance of variance between mean values at $\alpha=0.05$, depending on the effect of different factors, was verified with the Tukey's HSD test. The same test was used to calculate the least significant difference between the mean values.

RESULTS AND DISCUSSION

Results of the physicochemical analysis of oat grain are presented in Table 1.

Compared to husked varieties, the naked grains were characterised by a higher moisture and HL weight as well as a lower weight of 1000 grains. All the cultivars tested showed a high total protein content, the highest being recorded for the cultivar Polar (19.4%). This is concordant with the data found in literature, according to which the cultivar Polar is characterised by a very high total protein content, higher even than that of cultivar Akt [Leszczyńska, 2002]. On the basis of the results obtained one may state that the grain of the cultivars tested met the requirements of the Polish standard PN-R-74106, and possessed the required sensory properties.

The results of the overall characteristics of the flour tested are presented in Table 2. The flour used for testing showed good baking properties, consistent with the requirements of standard [PN-91/A–74022], and literature data [Ambroziak, 1998].

The farinograph analysis, performed on dough obtained from wheat flour 450 and on dough containing a supplement of oat flour, demonstrated good baking properties, thus confirming the chemical indicators and falling number obtained. A majority of mixtures demonstrated a higher water absorption than the control flour (Table 3). It was observed that with

TABLE 1. Physicochemical properties of grains of different oat cultivars.

Tested feature	Unit	Oat cultivar			
		Akt	Polar	Dukat	Sprinter
Moisture	(%)	10.1 ± 0.2	10.3 ± 0.1	9.4 ± 0.2	9.7 ± 0.2
HL weight	(kg/hL)	69.3 ± 0.1	66.1 ± 0.1	54.2 ± 0.1	57.5 ± 0.2
Weight of 1000 grains	(g)	25.9 ± 0.2	24.8 ± 0.3	32.5 ± 0.2	36.6 ± 0.2
Seed-coat content	(%)	-	-	24.0 ± 0.7	20.7 ± 0.3
Total protein content	(% d. m.)	14.4 ± 0.1	19.4 ± 0.1	15.6 ± 0.2	15.0 ± 0.6

TABLE 2. Quality evaluation of wheat flour type 450.

Sample	Flour parametr	Unit	Mean values
1.	Moisture	(%)	12.8 ± 0.7
2.	Total protein content	(% d. m.)	12.0 ± 0.7
3.	Wet gluten yield	(%)	31.0 ± 1.4
4.	Gluten spreadability	(mm)	6 ± 0.7
5.	Gluten elasticity	(°elastic)	II
6.	Gluten number	–	50 ± 1.8
7.	Acidity	(°ac)	2.4 ± 0.4

TABLE 3. Farinograph and falling number analysis of wheat dough (450 type) with oat flour addition.

Oat cultivar and amount of additives (%)		Water absorption (%)	Development time of dough (min)	Stability time of dough (min)	Resistance time of dough (min)	Degree of softening of dough (FU)	Falling number (s)
Control		60.2[a]	1.9[a]	10.6[a]	12.5[a]	22[a]	306[a]
	5	60.8[b]	5.5[b]	7.0[b]	12.5[a]	36[b]	315[b]
Akt	10	61.1[c]	4.2	4.7[c]	8.9[b]	61[c]	317[b]
	15	64.6[d]	1.5[a]	4.1[d]	5.6[c]	96[d]	317[b]
	5	62.5[b]	5.4[b]	6.6[b]	12.0[a]	45[b]	300[a]
Polar	10	63.4[c]	3.2[c]	6.4[b]	9.6[b]	43[b]	289[b]
	15	63.7[d]	3.7[d]	5.6[c]	9.3[b]	52[c]	287[b]
	5	64.1[b]	3.5[b]	7.3[b]	10.8[b]	60[b]	284[b]
Dukat	10	64.9[c]	3.5[b]	6.8[c]	10.3[b]	57[c]	294[c]
	15	65.0[c]	4.0[c]	4.6[d]	8.6[c]	66[d]	301[a]
	5	64.3[b]	2.2[a]	5.7[b]	7.9[b]	63[b]	262[b]
Sprinter	10	64.7[b]	3.2[b]	5.1[c]	8.3[c]	86[c]	243[c]
	15	66.5[c]	3.8[c]	3.3[d]	7.1[d]	118[d]	226[d]

a, b, c, d, – means in the same column with different superscripts are significantly different at $\alpha = 0.05$.

the increasing addition of oat flour also water absorption of wheat dough increased. In the case of naked oat varieties (Akt and Polar) the values obtained for this trait increased from 1.0 to 7.3%, while in the case of husked varieties (Dukat and Sprinter) – from 6.5 to 10.5%, compared to the control sample. The greatest increase in water absorption was recorded when the addition of oat flour (cultivar Sprinter) amounted to 15% (Table 3).

Kawka & Gąsiorowski [1995] demonstrated that water absorption of a wheat-and-oat mixture increased with the increasing share of oat bran. This product shows a higher water binding ability than wheat flour, as it contains more non-cellulose polysaccharides (β-glucans and pentozanes) but a similar amount of protein. In a majority of cases the addition of oats resulted in a prolongation (Table 3) of the dough development time. A 5% addition of flour from naked oat cultivars (Akt and Polar) resulted in a considerable increase in the dough development time (almost 3 times higher than that recorded for the control dough). When flour from husked oat cultivars (Dukat and Sprinter) was added, the values of this trait increased proportionally to the quantity of oat flour (from 15.8 to 110.5% in relation to the control sample). Only in the case of a 15% addition of oat flour from naked cultivar Akt was there observed a decrease (by 21% in relation to the control sample) of the water binding ability. Unfavourable changes were observed also in relation to the wheat dough – shortening of the stability and resistance time of dough and increase in the degree of softening of the dough. The shortening of the stability and resistance time of dough was very high (from 31.1 to 68.9%, in relation to the control sample) and proportional to the addition of oat flour (Table 3).

The falling number enables determining the activity of amylolytic enzymes in the flour. According to Gąsiorowski [1994], its value is affected by water binding ability by pentozans and also the degree of grain milling and flour granulation. The addition of flour from oat cultivars Polar, Dukat and Sprinter resulted in a decrease of the falling number (Table 3). This was favourable, as it led to an increase in the activity of α-amylase. In the case of cultivars Polar and Sprinter, the falling number decreased with the increasing share of oat flour and when the supplement reached 15% its values were lower by 6.2 and 26.1%, respectively, than those recorded for the control sample. An addition of 10 or 15% of flour from oat cultivar Akt resulted in a slight increase of the falling number – by 3.6% in relation to the control samples.

Hardness is an important trait determining the storage time of confectionery and bread. The changes in hardness of confectionery, caused by various additions of oat flour were highly differentiated, statistically significant and difficult to interpret, as the hardness of the ready product may be affected both by the varieties of oat and of wheat flour (Figure 1). In a majority of cases, an addition of oat flour led to a decrease of the hardness of cakes from 0.3 to 42.4%, in relation to the control sample (Figure 1) and those differences were statistically significant ($p<0.05$). The lowest values of the trait discussed were recorded for cakes containing 5% of flour of the Akt oat cultivar. The hardness of cakes in-

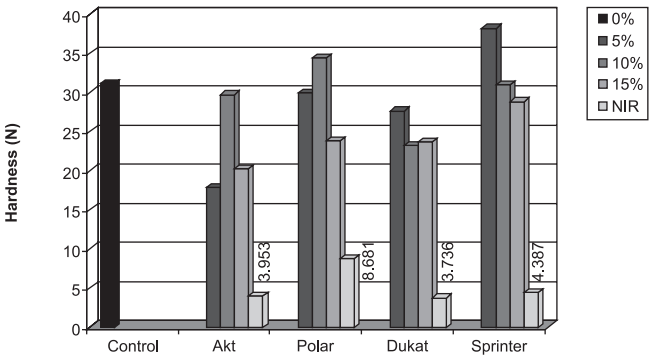

FIGURE 1. The effect of addition of oat flour on the hardness of the sponge – fatty cakes.

creased when the dough was prepared with an addition of 10% of flour from oat cultivar Polar (by 10.6%) or 5% of flour from oat cultivar Sprinter (by 22.8%).

The relations recorded were not proportional to the percentage of oat flour used (irrespectively of the cultivar).

Contents of total dietary fiber as well as its water soluble or insoluble fractions were analysed in control cakes and cakes obtained with an addition of 10% of flour from four oat cultivars. In all the tests the addition of oat flour resulted in an increase in the total dietary fiber content as well as of its soluble and insoluble fractions (Table 4). This increase proved to be statistically significant ($p<0.05$). The highest increase in the total dietary fiber content (Table 4) was observed when the flour added originated from oat cultivar Dukat (by 92.5% compared to the control cake), while the lowest when adding flour from oat cultivar Akt (by 20% compared to the control cake).

Compared to the control cake, the increase of the water soluble dietary fiber fraction was observed (Table 4) when the oat flour added originated from cultivar Polar (by 86.2%), while the addition of flour from oat cultivar Sprinter led to a decrease in the content of this fraction (by 6.7%). Those differences were, however, not statistically significant.

The introduction of oat flour resulted also in an increase in the content of the insoluble dietary fiber fraction (Table 4). The addition of flour from oat cultivar Akt constituted the only exception, as the final product demonstrated a lower content of the insoluble fraction (9.1% in comparison to the control cake). An addition of flour from husked oat cultivars resulted in a considerable increase in the content of the insoluble fraction (by 63.6% for cultivar Sprinter and 118.2% for cultivar Dukat), which is due to the fact that the oat husk contains almost exclusively insoluble compounds [Bartnik & Rothkaehl, 1997].

The sensory evaluation of the cakes obtained included such traits as: taste and aroma, appearance and the structure of crumbs. The evaluation was conducted by five persons on the basis of a five-point score. The results are presented in Table 5. The addition of oat flour did not have a significant effect on the taste nor aroma of cakes. The products with the highest share of oat flour could be distinguished by the characteristic "nutty" taste. However, this did not have a significant effect on their evaluation.

TABLE 4. Dietary fiber content in sponge cakes.

Oat cultivar	Addition of flour oat (%)	Dietary fiber content (% d.m.)		
		Soluble dietary fiber	Insoluble dietary fiber	Total dietary fiber
Control		2.9 [a]	1.1	4.0
Akt	10	3.8 [b]	1.0	4.8
NIR (α=0.05)		0.608	r. n.	r. n.
Polar	10	5.4 [b]	1.2	6.6
NIR (α=0.05)		1.774	r. n.	1.361
Dukat	10	5.3 [b]	2.4 [b]	7.7 [b]
NIR (α=0.05)		0.962	0.481	0.962
Sprinter	10	3.1	1.8 [b]	4.9
NIR (α=0.05)		r. n.	0.354	r. n.

[a], [b],– means in the same column with different superscripts are significantly different at $\alpha = 0.05$; r.n. – differences not significant at $\alpha = 0.05$.

TABLE 5. Results of sensory evaluation of sponge cakes (scores).

Oat cultivar and amount of additives (%)		Sensory trait			Sum of scores
		Appearance	Taste and aroma	Structure of crumbs	
Control		4.0	5.0	2.5	11.5
Akt	5	3.5	5.0	2.5	11.0
	10	4.0	4.5	2.5	11.0
	15	4.0	4.5	2.0	10.5
Polar	5	4.0	5.0	2.5	11.5
	10	3.5	5.0	2.0	10.5
	15	4.0	4.5	2.0	10.5
Dukat	5	4.0	4.5	2.0	10.5
	10	3.5	4.5	2.0	10.0
	15	3.5	4.0	2.0	9.5
Sprinter	5	3.5	5.0	2.5	11.0
	10	3.5	4.5	2.0	10.0
	15	3.0	4.0	2.0	9.0

All the products were similar in shape. However, it was observed that, compared to the control sample, cakes produced with a share of oat flour showed a greater tendency to "overflow" from the forms during baking. Cakes containing a share of flour obtained from the husked cultivars were characterised by somewhat darker colour of crumbs and surface. This was caused by the presence of the husks, fragments of which were visible, especially when the addition of oat flour reached 10 and 15%.

The low score (from 2.0 to 2.5) obtained for structure resulted from the fact that all the cakes were slack-baked. The crumbs were characterised by a small sponge and low porosity.

Taking into consideration the total score, the addition of oat flour may be claimed not to have any significant effect on the sensory properties of sponge-fatty cakes. The lowest score was ranked to cakes with the highest addition of oat flour obtained from husked cultivars. In the case of naked cultivars, all supplement levels proved acceptable (5, 10 and 15%), which is consistent with literature data [Gąsiorowski, 1998].

CONCLUSIONS

The oat cultivars tested demonstrated a high nutritive value due to the high content of total protein (from 14.4 to 19.4%). The addition of oat flour led to a water absorption higher by 10.5% and had a negative effect on the other physical properties of cakes, which was expressed by: shortened stability time, lowered resistance time, and increased degree of softening after 10 min. The addition of oat flour led to increased contents of total dietary fiber content (from 20.0 to 30.8%) and of its water soluble fraction (from 6.9 to 86.2%). In the case of husked cultivars (Dukat and Spriter), a considerable increase was also observed for the insoluble fraction. The conducted studies

demonstrated that the addition of oat flour to confectionery products was justified as it enriched the products with cellulose, protein and other, valuable nutrients.

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