

THE EFFECT OF ADDED WHOLE OAT FLOUR ON SOME DOUGH RHEOLOGICAL PARAMETERS

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Abstract

This paper examined the effect of the addition of whole oat flour on dough farinographical parameters. In this regard, the successive amounts of 10 to 50% of whole oat flour were added to wheat flour type 550. For each experimental variants were performed farinographical analyzes. According to our results, the optimal proportion of whole oat flour that can be added to wheat flour, without adversely affecting technological parameters of dough, was 20%. At this amount, dough parameters: Development time (DT), Stability (ST) and Farinograph Quality Number registered the best values.

Keywords: dough rheology, farinograph,, wheat flour, whole oat flour

INTRODUCTION

Diversifying sources of dietary fibers, which can become inputs for the manufacture of bread, meets consumer interest in the development of functional foods. This is due to the fact that in comparison with products derived from wheat or rye, oat products are characterized by a unique nutritional profile, able to bring significant benefits to our diet. Oat is characterized by a high content of lipids, 2-3 times more than other cereals (Butt et al., 2008; Angioloni and Collar, 2012) [1,2] and a high protein content that can be a great exogenous source of amino acids (Hahn et al., 1990, Butt et al., 2008; Gambusia et al., 2011) [2, 3, 4]. Compared to other cereals, oat contains a smaller amount of carbohydrates, being more abundant in dietary fibers (mainly glucans and pentosans). Also, oat can be a good source of vitamins, especially vitamin E and pantothenic acid. Having a high content of β -glucans, products made from oat have a positive effect on prevention of coronary heart disease. This is due to the ability to reduce serum cholesterol levels and postprandial serum glucose (Klopfenstein, 1988) [11]. Also, fibers from oat can bring important

benefits to the health of the digestive tract, due to the contribution of the increase of faecal mass.

In addition to β -glucans benefits, products derived from oat have a significant content of phenolic compounds and other antioxidants, as shown by some published works (Madhujith & Shahidi 2007; Inglett et al. 2011; or Inglett & Chen 2012) [6, 10, 18]. The effects of the addition of oat are not limited only to nutritional benefits of these kind of products.

The literature describes a whole range of other applications of the addition of oat in bakery products: reduction of fat amount and implicitly of calories (Lee et. al 2004), control of rheology and texture (Rosell et al, 2001), modification of starch gelatinisation and retrogradation (Rojas et al., 1999; Lee et al., 2005), reducing the rate of bread aging (Salehifaret al., 2006) and improving the tolerance to freezing / thawing of the bakery products (Lee et al., 2002) [12, 14, 16, 19, 20, 21].

The main problem with the use of products derived from oat, especially bakery products, refers to the degree of consumer acceptance to this addition.

In our country, the most important purchase criterion of bakery products is the volume of bread. Numerous studies have shown that the use of products derived from oat, in bread composition, have caused a drastic decrease of its volume (Litwinek et. Al., 2013) [17]. A first explanation for the occurrence of this effect is based on the fact that products derived from oat do not contain gluten. Thus, the addition of oat flour in bakery products contribute significantly to the reduction of dough gluten content, as compared to a dough made entirely of wheat flour. Therefore, worsen the rheological properties of the dough and the gas retaining capacity is reduced. This effect is accentuated with the use of products derived from oat, rich in fibers, because the gluten films are mechanical damaged. Finally, another explanation is related to the distribution of water in the dough. Water retention in fibers may cause incomplete hydration of gluten proteins and formation of short gluten networks, with altered elastic properties. This paper aims to assess the effect of the addition of whole oat flour on rheological parameters of dough by using the farinographical method.

MATERIALS AND METHODS

To achieve the researches we used two types of flour:

1. wheat flour type 550, from SC Farinsan SA (harvest 2014), having the following quality characteristics: Moisture % = 14.3; Protein content % = 13.0; Wet gluten content % = 30.2; Gluten Index = 82; Content of minerals% = 0.55; Hydration capacity = 57.8; Dough development time (min) = 2.0; dough Stability time (minutes) = 5.9; Degree of softening (UF) = 54; alveographical mechanical work (W) = 302×10^{-4} J; alveographical report Resistance/Extensibility (p/l) = 1.02;
2. whole oat standardized flour, purchased from SC Cope SA Piatra Neamt, having the following characteristics: max. Moisture % = 10; max. Ash content % = 1,2; Protein content% = 10.0; Fiber content % = 4.0; Content of carbohydrates % = 66.0, Lipid

content % = 8.0; Granularity, characterized by a particle size mean of less than 500 μ , for 97% of particles, the remaining 3% having sizes between 500 and 1,000 μ .

In order to evaluate the impact over farinographical parameters, were added successive quantities, increasingly higher, of whole oat flour to wheat flour, according to the experimental design presented in table 1.

Table 1. The amounts of whole oat flour added to wheat flour

No.	Wheat flour type 550 (%)	Whole oat flour (%)
1	100	0
2	90	10
3	80	20
4	70	30
5	60	40
6	50	50

To determine the farinographical parameters of the 6 samples of flours, established under the scheme in table 1, it was used a Brabender Farinograph E device.

Analyses were performed in accordance with ISO 5530-1 standard.

The determined parameters were: Water absorption (WA,%); Development time (DT, min); Stability (ST, min), Degree of softening at 10 minutes after start (DS₁₀, FU) and Farinograph® quality number (FQN).

RESULTS AND DISCUSSIONS

In table 2 are shown the farinographical tests results concerning mixtures of wheat flour and oat flour.

As seen from table 2, farinographical parameters of flour control (0% added whole oat flour) described a bakery flour with optimal characteristics.

Addition of whole oat flour determined significant changes in all parameters. In figure 1 we presented the corresponding farinograms of control flour and of the mixtures of control flour and oat flour, overlapped.

Mixed flours Hydration capacity changed significantly compared to flour control, being the higher, as the amount of added oat flour increased.

Table 2. Farinographical parameters for mixtures of wheat and oat flours

Oat flour (%)	WA(%)	DT	ST	DS ₁₀	FQN
0	57.8	2	5.9	44	42
10	58.3	1.9	8.7	35	96
20	58.7	7	9.7	19	112
30	61.1	6.3	6.9	43	89
40	64.3	6.4	4.8	38	94
50	66.6	10.7	5.6	6	132

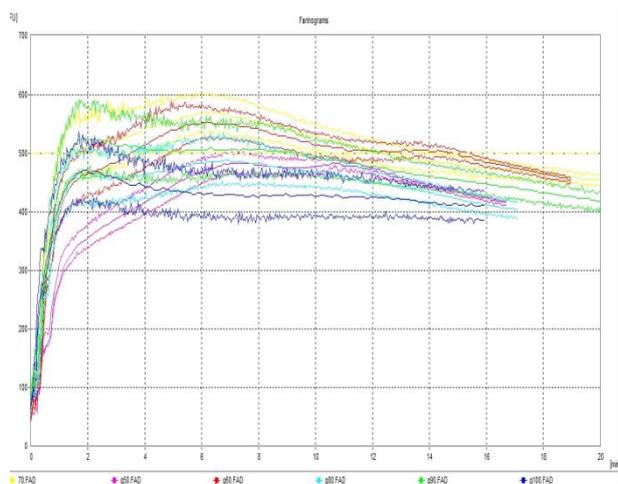


Fig.1. Control flour and mixtures of wheat and oat flours farinograms

Each fraction of 10% whole oat flour determined the increase of Hydration capacity by about 1.8% compared to control (figure 2). Increase of wheat flour Hydration capacity is explained by the additional intake of fibers, which whole oat flour brought in the dough. Oat flour used had a content of about 4% fibers, compared to wheat flour which had a fibers content of about 2%.

Increase of the Hydration capacity of the flours can be a major economic advantage, as causes higher yield in bread.

Addition of whole oat flour caused significant changes of the following parameters: Dough development time (DT) and Stability (ST).

Dough development time, associated with the time required for the homogenization of all ingredients and their integration into a stable structure in terms of viscosity, did not vary linearly with increase of oat flour addition.

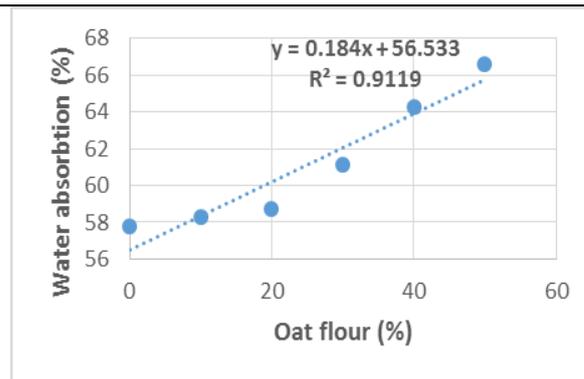


Fig.2. Hydration capacity (water absorption) of dough for various percentages of whole oat flour

Thus, in the case of the addition of 10% oat flour, there were no significant changes in Dough development time. In contrast, larger additions of whole oat flour, significantly changed the Dough development time, which reached values of up to 5 times higher, compared with control flours.

Also, the increase of Dough development time was correlated, up to 20% added whole oat flour, with the increase of dough Stability. Thus, the dough Stability was maximum at 20% added of whole oat flour, then tended to decrease. By the additions of more than 30% whole oat flour, doughs Stability was under the control flour (4.8 minutes with 40% oat flour and 5.6 minutes with 50% oat flour, versus 5.9 minutes).

This is explained by the limited capacity of the gluten network, formed in dough, to immobilize fibers. Basically, at some point, additional fibers cause mechanical damages of glutenic films with significant effects in lowering dough Stability.

Since Stability is generally correlated with dough tolerance to kneading, fermentation and even with the volume of finished products, the evolution of this parameter can be used to determine the optimal amount of oat flour, which can be added in manufacturing recipes (figure 3).

Similar observations can be made in terms of the evolution of Dough softening degree parameter. It characterizes the state of dough colloidal systems, at certain times of kneading, considering the loss of viscosity of the entire system.

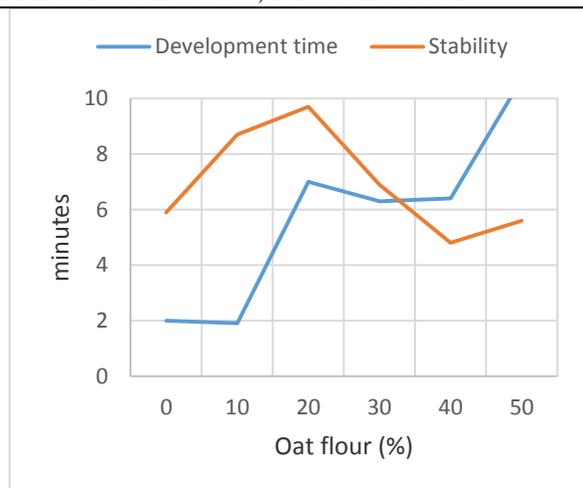


Fig.3. Dough Development time (DT) and Stability (ST) with different additions of whole oat flour

Thus, a higher value of Dough softening degree indicates a degraded dough, where the majority links, which stabilize the dough, are broken and the water is released from the system. From figure 4 it is observed that the addition of oat flour decreased the degree of Dough softening, but the decrease rate was not constant. Maximum decreased were recorded in the case of 50% added whole oat flour (6 FU), respectively in the case of 20% added oat flour (UF 19). Theoretically, additional intake of fibers in oat flour made a better water link in dough, with a corresponding effect on the degree of softening.

Farinograph Quality Number parameter increased significantly with the addition of oat flour. The most significant increases were observed in samples to which was added 50% and 20% oat flour.

Farinograph quality number describes the length, along the time axis, between the point of the addition of water to flour and the point where the height of the centre of the farinographical curve has decreased by 30 FU, compared to the height of the centre of the farinographical curve in the point where the dough development is finished. Theoretically, this is a synthetical indicator that provides informations about the quality of dough, comprising elements regarding dough Development time, Stability and Degree of softening. The higher its value is, the technological performances of flour are supposed to be better.

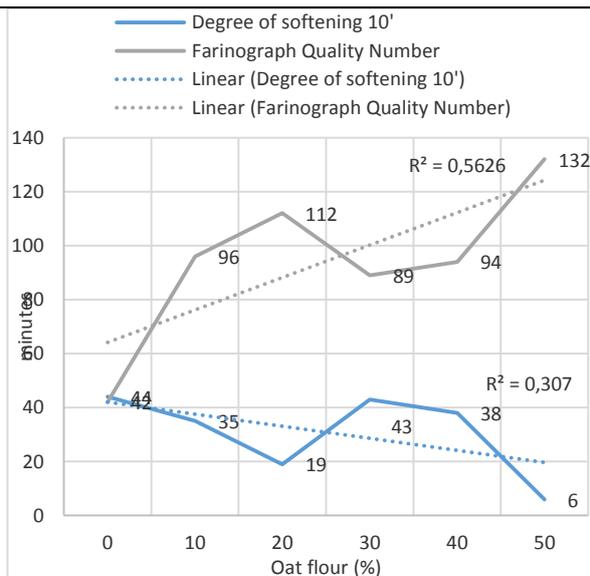


Fig.4. The degree of Dough softening at 10 minutes (DS10) and Farinograph Quality Number (FQN) of dough, with different additions of whole oat flour

The optimal amount of whole oat flour that can be added to wheat flour, without adversely affecting technological parameters of dough was, according to our results, 20%.

For 20% added oat flour, the parameters: Development time (DT), Stability (ST) and Farinograph Quality Number of dough, had the best values compared to the control flour.

CONCLUSIONS

Flours Hydration capacity changed significantly compared to flour control, being the higher, the amount of added oat flour increased. Each fraction of 10% oat flour, increased Hydration capacity by about 1.8%, compared to control sample.

Addition of whole oat flour caused significant changes of: Dough development time (DT) and Stability (ST) parameters. Dough Development time increased in all experimental variants, compared to control flour.

The dough Stability, by the addition of whole oat flour, was higher compared to the control flour, until 20% added oat flour, then decreased for 30% and 40% added oat flour.

The addition of oat flour decreased the degree of Dough softening, but the rate of decrease was not constant. Maximum decreases were recorded in the case of 50% added oat flour (6 FU), respectively in the case of 20% added

oat flour (19 FU).

The optimal amount of oat flour that can be added to wheat flour, without adversely affecting technological parameters of dough was 20%, according to our results. At this value, the parameters Dough development (DT), Stability (ST) and Farinograph Quality Number were the best, compared to control flour.

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