Effect of the addition of Psyllium fiber on wheat flour dough rheological properties

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Abstract: - The aim of this work was to quantify the effects of psyllium fiber addition to wheat flour at the levels of 0, 1, 2, 3 and 4% on the rheological behavior of the dough. The rheological properties of the dough were investigated using the rheological device, Farinograph. Upon the addition of psyllium fiber, a significant increase in Farinograph water absorption, simultaneously with the increase of the addition level, was recorded. The psyllium fiber addition has the effect of increasing development time and stability upon to ≤ 2 %. Also, the degree of softening of the dough increased with the increase of the psyllium fiber upon at level of ≤ 3 %. Psyllium fiber added in wheat flour up to 4% increased the falling number (FN) index. Therefore, using psyllium fiber at an optimal level, allows an increase of the daily intake of fiber without promoting negative effects on the rheological properties of the dough.

Key words: - wheat flour, Psyllium fiber, rheological dough properties, Farinograph

1 Introduction

Dietary fiber (DF) is a class of compounds that include soluble dietary fiber and insoluble dietary fiber [1] and has it is perceived as an important ingredient in the development of functional foods. The main components of dietary fiber are cellulose and lignin, but also hemicelluloses, pectic substance, gums resistant starch, inulin, lignin and other non-carbohydrate components (polyphenols, waxes, resistant protein) [2].

Interest in the role of dietary fibers (DF) in health and nutrition has prompted a wide range of research due to the beneficial effects on the diseases. Extensive research has been carried out into the physiological effects of dietary fiber and there is evidence that intake of fiber may be associated with maintenance of gastrointestinal health, reduction of intestine transit time, lowering of total and low-density lipoprotein cholesterol in the blood serum, reduction of coronary heart-related diseases, gut neoplasia [3-10]. Several authors have reviewed the role of dietary fiber in nutrition and health [11, 12].

The interest in fiber-rich foods has increased in the recent years. More fiber in food is one of the consumer demands for a healthier diet [13]. Recently many researchers have been performing studies in order to improve the technological knowledge regarding functional food as well as the development of fiber-enriched food, especially cereal based products.

Bread, a commonly consumed type of food, can be enriched with bioactive compounds such as dietary fiber [14]. Dietary fiber has received increased attention from researchers due to their functional and technological properties. The functional properties of dietary fiber, such as water holding, oil holding, swelling capacity, viscosity, derived from different sources: cereals, fruits and vegetables should be studied in order to obtain the individual characteristics of each one [15].

Incorporation of dietary fiber into wheat flour dough will affect the rheological behavior of dough. The assessing of the rheological properties of wheat flour dough is decisive for bread making and has been the focus of many studies, and results have been well documented

[16, 17]. Several studies have been reported on rheological properties of dough's supplemented with many forms of dietary fiber [18-22] from various sources, such as cereals and cereals co-products (wheat, oat, barley, rice), non-cereal sources (nuts, pea, orange, sugar beet, peach, mango, potato, apple). One of these sources is the seeds of psyllium from the plants of the *Plantago* genus that present different species [23]. Psyllium, known as a medicinally active natural polysaccharide, is as source of the soluble (70%) and insoluble (17%) fiber. The addition of psyllium fiber in diet has been associated with the regulation of large bowel function [24], to lower blood cholesterol levels [25], reducing the risk for heart diseases [26] and serum total cholesterol and LDL-cholesterol [27-29].

The main purpose of the present study was to assess the rheological properties of wheat flour-psyllium fiber blend (0, 2, 4, and 6%, w/w of flour addition with psyllium fiber) by using the rheological device Farinograph. The amylase activity in the samples was also investigated.

2 Problem Formulation

As raw material, commercial wheat flour (harvest 2012) milled on S.C. Dizing S.R.L. Brusturi (Neamț County, Romania) and commercial psyllium fiber, provided by S.C. Enzymes@Derivates Romania (Costisa, Neamt, Romania) was used. Deionised water was used in all experiments.

The effect of psyllium was evaluated by the addition of 0, 1%, 2%, 3% and 4% related to the flour weight. Wheat flour without fibre addition was used as control sample.

The analytical characteristics of the flour was determined according to Romanian or international standard methods: moisture (SR EN ISO 712:2010), wet gluten content (SR EN ISO 21415-1:2007), protein content (ICC Standard No. 202), and falling number (SR EN ISO 3093:2010).

The rheological properties of the dough were determined using a Farinograph with a 300 g capacity (Brabender GmbH and Co. Duisburg, Germany) according to SR ISO 5530-1:1999, Romanian method. The parameters determined by Farinograph device were: water absorption (WA), development time (DT), stability (ST) and degree of softening (SDg), which provide information on the behavior of the dough during the mixing stage [30].

All the measurements were performed in triplicates and data was reported as mean ± standard deviation. Data was analyzed by the Statistical Package for Social Sciences (v.16, SPSS Inc., Chicago, IL, USA).

3 Problem Solution

The mean value for the analytical characteristics of the wheat flour used in the experiment is shown in Table 1.

Table 1. Flour analytical characteristics

Parameters	Average value	Standard deviation
Moisture content (%)	14.20	0.20
Protein content (%)	12.50	0.20
Wet gluten content (%)	29.10	0.40
Falling Number index (s)	351.00	2.00

The effect of psyllium fiber addition on the Farinograph characteristics, water absorption and the softening degree of dough are illustrated in Fig.1. It can be noticed that the water absorption increased with increasing the amount of psyllium fiber. This increase is a function of the structure of the fibers [31].

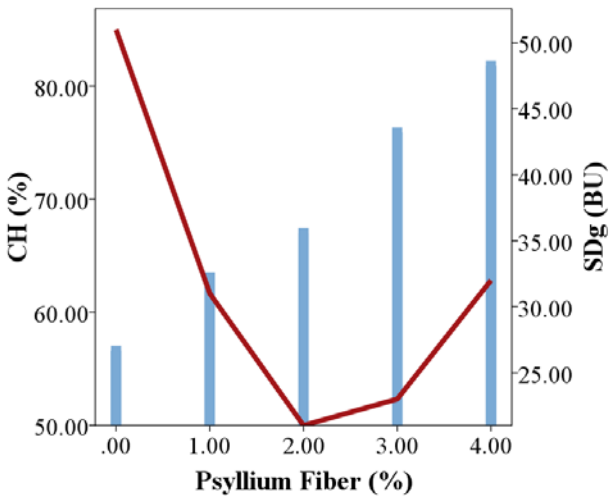

Fig. 1 Effects of different levels of psyllium fiber addition on the water absorption, CH (%) and softening degree of dough, SDg (BU)

The water absorption (CH) of control sample was 56.6% which gradually increased to 81.8 % for the sample with 4 % psyllium fiber incorporated. This behavior is attributed to the ability of psyllium fiber to retain water within its matrix. Similar results were obtained in the many studies made on various fibers added in wheat flour dough [20, 33].

The addition of psyllium fibres modified the dough development time (DT) and stability (ST), Fig. 2.

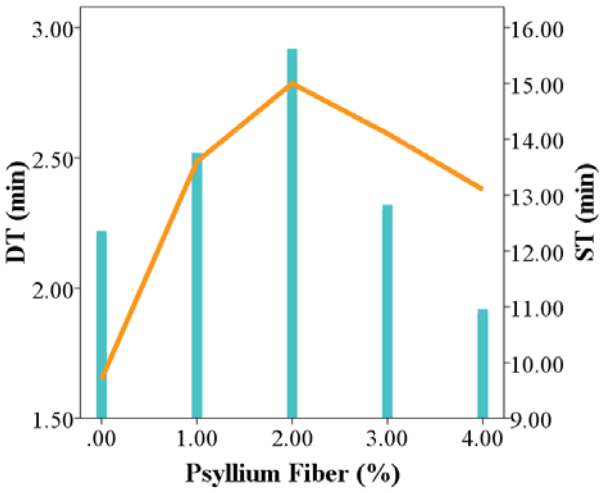

Fig. 2 Effects of the different levels of psyllium fiber addition on the dough development time, DT (min) and dough stability, ST (min)

Addition of psyllium fiber at 2% dose increased dough development time and stability, suggesting stronger dough [32], because an increase of these Farinograph parameters being is an indicator of the strength. An increase in the dough development time simultaneously with the increase of psyllium fiber content up to 2% has slowed the rate of hydration and development of gluten as reported by Sudha et al., 2007. A decreased development time and stability values were recorded for dough containing 3 % and 4% psyllium fiber. Stability of the samples containing 4% psyllium fiber was higher than those of the samples without fibre addition.

The softening degree of the dough (SDg) decreases simultaneously with the increased dose of the psyllium fiber as a result of the interference of the psyllium fiber with the gluten network in the wheat flour dough, leading to stricter dough. But the highest softening degree value was obtained in the control sample.

The effect of psyllium fiber on the amylase activity and consequently on dough viscosity is shown in Fig. 3. With the increase dose of psyllium fiber content to 4%, the falling number (FN) index increased from 351s to 1453 s. The higher FN value at higher doses of psyllium fiber added in wheat flour indicates that the α-amylase activity is lowest. This may be due to the ability of the starch granule and of the psyllium fiber to retain water and swell freely, transforming into a mass with increasing viscosity.

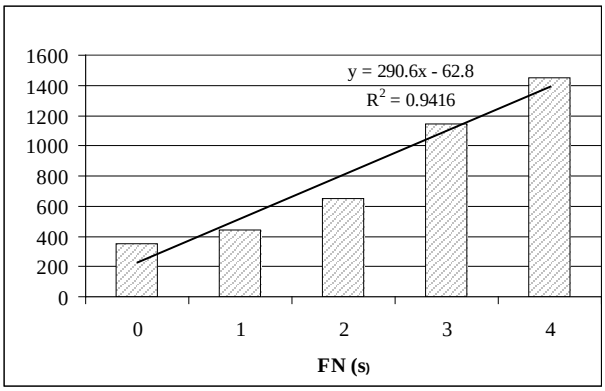

Fig. 3 Effects of different levels of psyllium fiber addition on the falling number (FN) index

4 Conclusions

The addition of psyllium fiber to wheat flour affects the rheological characteristics in various ways. It clearly indicates that incorporating psyllium fiber in wheat flour dough leads to an increase of water absorption. A level of addition above 2% has a negative impact on the dough development time, stability and softening degree of the dough. Regarding the falling number index, psyllium fiber addition leads to a decrease of α-amylase activity.

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