



EFFECT OF CITRUS FIBERS ADDITION ON WHEAT FLOUR DOUGH RHEOLOGICAL PROPERTIES

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Abstract: Nowadays, demand for food products with high fiber content is increasing because fiber consumption improves health problems such as diabetes, cardiovascular diseases, colon cancer etc. The citrus such as orange, lemon, and grapefruit can be used as source of fiber for bread-making products. The quality of bakery products is influenced by the wheat flour dough rheological properties. The addition of different ingredients like citrus fiber affects dough rheology and dough processing as function of the fiber level addition. The effects of citrus fiber addition to wheat flour at the levels of 0, 2, 4 and 6 % on the rheological behaviour of the dough obtained were investigated using as rheological devices Farinograph and Amylograph. Dough rheological parameters measured were water absorption (WA), development time (DT), stability (ST), degree of softening (SDg), gelatinization temperature (G_t) and peak viscosity (P_V). The fiber addition has the effect of increasing Farinograph water absorption simultaneously with the increase of the addition level. An increase in development time and stability were recorded upon addition of citrus fiber ≤ 4 %. Also, the Amylograph parameter peak viscosity increased with increase of the citrus fiber level.

Keywords: citrus fibers, rheological dough parameters, wheat flour, Farinograph, Amylograph

1. Introduction

In the recent decades, dietary fiber has received great attention from researchers in food science and nutrition. The term dietary fiber comprises to major classes: soluble fiber in water such as pectin, gum and mucilage, which cannot be digested by the human digestive enzymes and water insoluble fiber, i.e. cellulose, lignin and some of the hemicelluloses to absorbable components in the upper alimentary tract [1]. Many studies dealing with the nutritional and physiological aspects of dietary fiber has led to their incorporation in food products, such as bakery, breakfast cereals, meat products, pasta and yogurts [2]. The high functional value of dietary fiber has been well studied over the years

[3-5]. A large number of studies have been reported on the physiological actions of fiber addition in foods such as, the maintenance of gastrointestinal health, reduction of intestine transit time, protection against colon cancer, lowering of total and low-density lipoprotein cholesterol in the blood serum, reduction of postprandial blood glucose levels, increase of calcium bioavailability and reinforcement of the immunological system [1], [6]. Also, the increased of food consumption with dietary fiber are associated with the prevention, reduction and treatment of some diseases, such as diverticular and coronary heart diseases [7], improves blood glucose control in diabetes, promotes regularity, aids in

weight loss, and appears to improve immune function [8].

Nowadays, demand for foods products with ingredients which contain bioactive compounds that provide additional health benefits are increasing. Bread is the most popular food consumed daily by the majority of the population and to meet this requirement, the development of enriched bread with bioactive compound such as, dietary fiber should be the best way to increase the fiber intake. From the point view of the daily intake of total fiber for adults, is recommended 38 g for men and 25 g for women [9]. Dietary fiber plays an essential role in human health not only for their nutritional properties, but also for their functional and technological properties. The functional properties of dietary fiber derived from different sources should be studied in order to obtain the individual characteristics of each one [10]. Adding different fibers in wheat flour dough, in order to improve the nutritional quality of bread will affect the rheological properties of dough. The evaluation of rheological properties of wheat flour dough is decisive for bread making technology because its provide information's regarding dough behaviour during the bread making process and the quality of the finished bakery products [11]. Bread can be enriched with many form of dietary fiber such as wheat bran, oat bran, rice bran, corn bran, carob fiber, peanut hull, sunflower hull, flaxseed [12-15] e.g. When added to bread dough, the fiber can change its consistency, texture, rheological behavior and the properties of the finished products [16-18]. Many studies have been reported on rheological properties of dough supplemented with fibers from different sources [19-25].

In recent years, dietary fiber from fruits has received increasing attention from researchers due to their considerable beneficial effects on the human body.

The citrus fiber from oranges, lemons and grapefruits constitute rich sources of dietary fiber with well-balanced proportion of soluble and insoluble fiber fractions [26]. Comparatively with the dietary fibers from other sources, such as cereals, the main advantage of citrus fiber is its higher proportion of soluble dietary fiber, about 33%, while only 7% is present in wheat bran [27], [28]. Also, citrus fibers have an additional advantage due the presence of associated bioactive compounds such as flavonoids, polyphenols, vitamina C and others [29] with antioxidant properties, which may exert further health promoting effects in addition to those of the dietary fiber itself [30]. Therefore, citrus fiber can named as antioxidant dietary fiber.

In the preparation of bread, some amount of wheat flour can be replaced with citrus fiber, but the main problem of this substitution in bread dough is the detrimental effects on dough handling due to changes in dough rheological properties. Incorporation of fiber into wheat flour interacts directly with structural elements of the three dimensional gluten network and disrupts the starch-gluten matrix, affecting the rheological behaviour of blended dough during mixing, sometime causing negative effect on the finished bread quality [31]. The effect of citrus fiber on dough and bread quality depends greatly on citrus fiber properties.

The aim of this experimental work was to assess the rheological properties of wheat flour-citrus fiber blends (0, 2, 4, and 6%, w/w of flour addition with citrus fiber) by using the rheological devices Farinograph and Amylograph. In addition, the amylase activity in the samples has been tested.

2. Materials and methods

2.1. Materials

The wheat flour used in the research are 550 type wheat flour (harvest 2012) milled at S.C. Dizing S.R.L. Brusturi, Neamț

County, Romania. As a fiber source was used commercial citrus fiber purchased from S.C. Enzymes@Derivates Romania (Costisa, Neamt, România).

2.2. Preparation of wheat flour - citrus fiber blends

Citrus fiber (CF) was added in wheat flour in different doses: 0, 2, 4 and 6 (g/100g). The wheat flour sample without fiber was considered as the control one.

2.3. Wheat flour quality evaluation

The control flour sample was analyzed from proximate composition by Near Infrared Reflectance spectroscopy (NIR) technique using Inframatic Flour Analyzers, model 9140, Perten Instruments. The determined values of its analytical characteristics are the following: moisture 14.20%, protein content 12.50%, water absorption 56.40%, Zeleny sedimentation index 40.10% and wet gluten content 29.10%. Also, the Hagberg Falling Number method (ICC method 107/1) to measure flour α -amylase activity was used.

2.4. Dough rheological properties measurement by Farinograph and Amylograph

The rheological properties of the wheat flour and various flour blends with CF were conducted using a Farinograph with a 300 g capacity (Brabender GmbH and Co. Duisburg, Germany) according to SR ISO 5530-4:2005. Water absorption (WA) is the amount of water required for dough to reach an arbitrarily chosen consistency (500 Brabender unit (BU) consistency), dough development time (DT), dough stability (ST) and the dough degree of softening (SDg) were analyzed. Wheat flour dough viscometric characteristics were carried out using an Amylograph (Brabender OGH, Duisburg, Germany) device according to SR ISO 7973:2000. Peak viscosity and gelatinization temperature were the parameters analyzed.

2.5. Statistical analysis

All analyses were performed in triplicate and the data obtained were analyzed by the statistical software SPSS 16.0 (SPSS Inc., Chicago, IL, USA). The figures plotted with SPSS shows the variation of the rheological parameters as a function of citrus fiber addition.

3. Results and Discussion

3.1. Effect of citrus fiber addition on Farinograph properties

The effect of citrus fiber addition on Farinograph parameters of wheat flour with different fiber addition is showed in Figure 1.

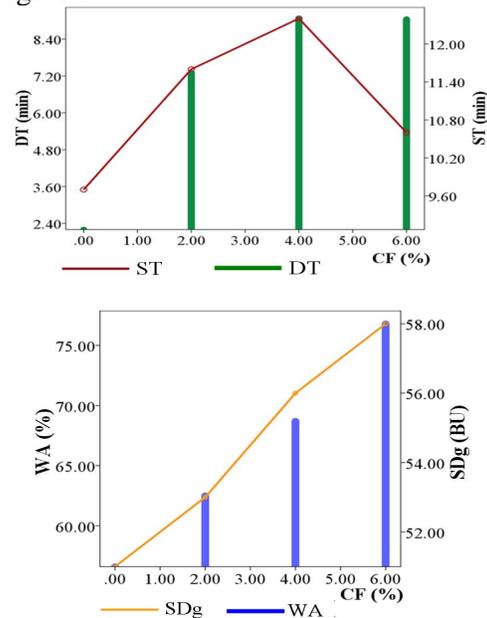


Figure 1. Farinograph characteristics of wheat flour-citrus fiber blends: ST, dough stability (min); DT, dough development time (min); SDg, softening degree of dough (BU); WA, water absorption (%).

The results show that the addition of CF significantly influenced all the wheat flour dough rheological properties as measured by the Farinograph. As the amount of citrus fiber increased, the water absorption

increase for all the samples with citrus fiber added.

The water absorption (WA) of the blended dough increased as function of citrus fiber concentration and followed a linear relationship (1):

$$WA = 3.34 \cdot CF + 56.13; R^2 = 0.99 \quad (1)$$

The WA of control sample was 56.6 % which gradually increased to 76.8 % for the sample with 6 g/100g CF incorporated. The increased is due to probably of a great number of hydroxyl groups existing in the fiber structure, which allow more water interactions through hydrogen bonding [32], [33]. This behaviour is attributed to citrus fiber ability to retain water within its matrix. These results are in agreement with the results obtained by many studies made on various fiber added in wheat flour doughs [34-36].

Highest values in the Farinograph parameters development time (DT) and dough stability (ST) were observed in wheat flour dough in were was incorporated 4% CF. Addition of citrus fiber above a dose of 4% decreased dough development time and stability. Softening degree of dough was also found to increase with the addition of the citrus fiber. These results may be explained by the fact that citrus fiber addition reduces the wheat flour gluten network formation rate. Similar results on the effect of addition of dietary fibres on the farinographic properties of wheat flour were reported by Almeida, Chang & Steel (2010).

3.2. Effect of citrus fiber addition on Amylograph properties

Incorporation of citrus fiber at 0%, 2%, 4% and 6% levels showed differences on the dough pasting properties as measured by Amylograph. The results are indicated in Figure 2. The presence of the citrus fiber

significantly affected the pasting properties of the flour blends.

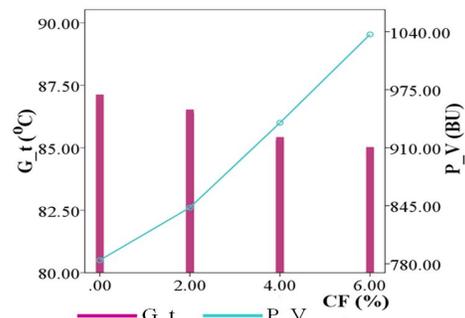


Figure 2. Amylograph characteristics of wheat flour-citrus fiber blends: G_t, gelatinization temperature (°C); P_V, peak viscosity (BU).

The results show that the increasing addition level of CF reduced the gelatinization temperature (G_t), the lowest gelatinization temperature values being recorded to a 6% dose of citrus fiber addition. Also, the peak viscosity (P_V) increased simultaneously with the increase dose of citrus fiber addition in wheat flour dough. These fact may be attributed to a more quickly starch gelatinization due to a higher water level in the dough samples with a higher fiber content incorporated.

3.3. Effect of citrus fiber addition on Falling Number index value

Effect of citrus fiber on the amylase activity and consequently on dough viscosity are illustrated in Figure 3.

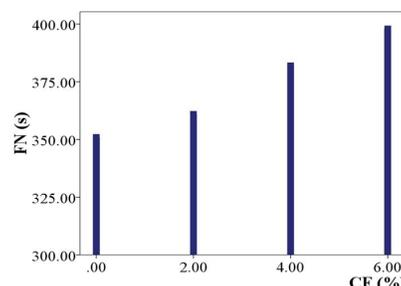


Figure 3. Falling Number index (FN) as a function of citrus fiber (CF) addition.

With the increase dose of citrus fiber content to 6%, the FN index increased from 351 to 398 s. Therefore, an increase in FN index indicates that an increase in citrus fiber content in the wheat flour dough has decreased its α -amylase activity.

This may be due to the ability of the starch granule and of the citrus fiber fraction to retain water and swell freely, transforming into a mass with increasing viscosity.

4. Conclusions

Citrus fiber additions had significant effects on dough rheological behavior, increasing the Farinograph parameter water absorption capacity. The Farinograph parameters of fiber-enriched dough provided useful information on the suitability of citrus fiber incorporation levels, from its parameters development time, dough stability and degree of softening. It clearly indicates that citrus fiber incorporation above 4g/100g has negative impact on dough development time and dough stability. Incorporation of citrus fiber did also influence the Amylograph parameters gelatinization temperature and peak viscosity, showing a decrease in α -amylase activity. The results obtained showed the fact that citrus fiber can be added to wheat flour at a level of 4% without negative influence on rheological properties of the wheat flour dough.

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