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THE INFLUENCE OF FLOURS FROM FOOD BY-PRODUCTS ON THE FALLING NUMBER

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Abstract: *The aim of this study is to determine the impact of flour obtained from the food waste (grape pomace and tomato waste) in amounts of 4, 6, 8 and 10% on the α-amylase activity. One of the fastest methods to provide the activity of this enzyme is to establish the falling number according to Hagberg. For its determination, it is necessary to calculate the moisture content of each mixture beforehand. Analyzes have shown that the addition of flours from food by-products (grape pomace and tomato pomace) decreased the falling number. Nevertheless, with the addition of these types of flour, α-amylase activity remaied low, which is also a desirable component when preparing these products.*

Keywords: *Falling Number, By-products, Flours, α-amylase activity*

INTRODUCTION

Flour is a product obtained by dividing grains from different cereals, milling and sowing (Vasilevski, 2011). Wheat is considered to be the most important cereal crop used for bread production, bakery, confectionery and confectionery products. It has been consumed by humans for about 5000 years (Tashkov & Kuzelov, 2012).

In bakery products (bread, cookies, biscuits, crackers, etc.), the main raw material is wheat flour. It has been proven that almost all the characteristics of bakery products depend on wheat flour (Martins, Pinho, & Ferreira, 2017). Bakery products are products consumed by the whole population and play an important role in the human nutrition (Martins et al., 2017; Nakov, Komlenić, Stamatovska, Šušak, & Jukić, 2017). Adding functional ingredients to bakery products increase their popularity and acceptability as well as the ability to reduce the risk of chronic diseases (Martins et al., 2017). The food industry produces large quantities of waste every year, and their efficient management and usage is one of the basic goals of the European Union (Nakov, Jankuloska, Dimov, & Taneva, 2019; Nakov, Jankuloska, & Georgieva-Nikolova, 2019). In the Republic of Bulgaria in 2017, the vineyards covered 51,272 ha and the wine production was 1,079,897 hectolitres (Ministry of Agriculture, Food and Forestry in Bulgaria, 2018). It is estimated that every 6 liters of wine yields produced approxitametly 1 kg of waste (Tsali & Goula, 2018). Based on the literature, in the grape pomace (GP) are included three important ingredients stalk, seeds and peel. Tomato waste (TW) is a product that remains after separating the tomato juice. In the crop fields in Bulgaria in 2018, a total of 158 762 tons of tomatoes have been produced (Ministry of Agriculture, Food and Forestry in Bulgaria, 2018).

Determination of α-amylase activity in cereals from which flour is produced has always been challenging. The level of α-amylase (EC 3.2.1.1) presented in flour had a major impact on the quality of bakery products. High levels of α-amylase in the cereal grains which, when milled passed into the flour yielding low volume products and increased levels of starch degradation.

These changes further caused the formation of a sticky product.

On the contrary, very low levels of α-amylase also have a bad effect on the end product, and because of this, flour producers very often add fungal α-amylase (Mangan, Szafranska, McKie, & McCleary, 2016).

According to the Council Regulation (EC) No 1234/2007 of 22-10-2007 in determining the quality of the grain being processed, one of the analyzes that must be taken into consideration is Hagberg's Falling Number (FN), which is determined by the ISO method 3093 : 2004 (Erlbacher, Moegele, Erlbacher, & Moegele, 2011). FN has been used for decades to evaluate the quality of wheat processed into flour, in particular the activity of the starch hydrolyzing the α-amylase enzyme. The method represented in this research is a physical test that measures the viscosity of a mixture of flour and water, which is subjected to gelatinization and hydrolysis under controlled conditions of preparation, mixing and heating of the mixture (Delwiche, Rausch, & Vinyard, 2020).

The aim of this analysis was to investigate the impact of flour obtained from food waste (GP and TW) in the amount of 4, 6, 8 and 10% on FN.

MATERIALS AND METHODS

Materials

For the purpose of this analysis, wheat flour type 500 by SofiaMel (Sofia, Bulgaria) and flour obtained from food waste (GP and TP) were used.

Methods

Production of flour from food waste

After harvesting the red grape (variety Muscat Hamburg) and tomatoes from Razgrad, a region in Bulgaria, and separating the juice, the residue was dried for a period of 48 hours at the temperature of 60 °C in a UFE 500 oven (Memmert GmbH, 84 Schwabach, Germany). Finally, the dried material was grounded (size <0.5 mm) with an IKA MF10 grinder (IKAÆ-Werke GmbH & Co. KG, Staufen, Germany). The flours were obtained in a laboratory at the University of Ruse "Angel Kanchev" Branch - Razgrad, Bulgaria.

Determination of moisture and Falling number of a mixture of wheat flour and GP and TP flour

Moisture in the mixture of wheat flour, GP and TP flour was determined according to the ISO 6540 method. Falling number was determined according to the AACC Method 56-81B using FN 1500 apparatus. The figure illustrated bellow (Fig. 1) shows a schematic diagram for FN determination.

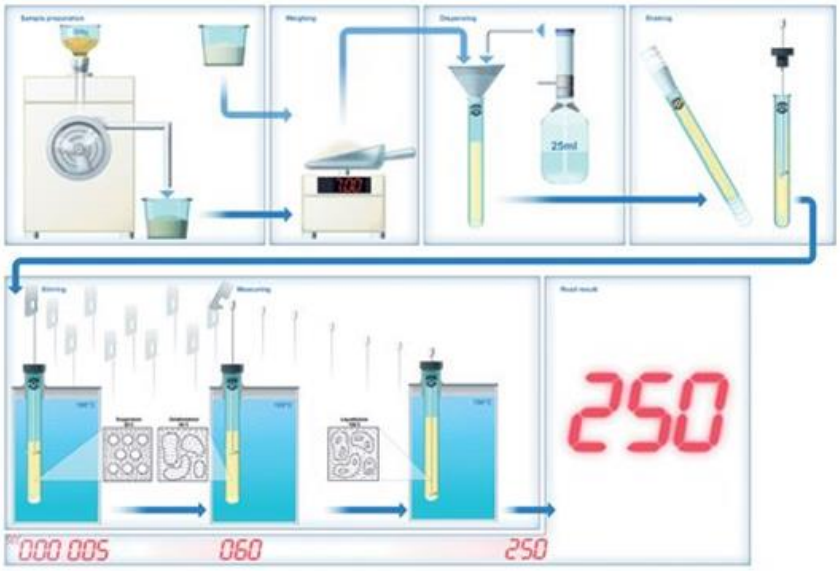

Figure 1. Scheme for measuring Falling Number (Perten, Elmer, 2020)

RESULT AND DISCUSSION

Rheological characteristics such as elasticity, viscosity and stretching are essential parameters for the milling and baking industry in view of prediction of the parameters for the processing of dough and the quality of the final products (Codina, Mironeasa, Bordei, & Leahu, 2010). The FN is the time in seconds required for the device to fall and the measured distance through a hot flour/water mixture while heat is applied. If the enzymatic activity is high, the starch is broken down (liquefied) rapidly during the process of gelatinization. Thus, the device falls through the relatively liquid pastes in a short period of time. A less viscous fluid opposing less resistance to the flow which means the FN is low. Moreover, if the activity of the enzyme is low, it takes longer for the device to cover the distance of its fall. This means the falling number is high (Baker pedia, 03/21/2020). In the table 1 is presented the moisture content of the samples analysed in this study.

Table 1. Moisture content in the examined samples

Sample	Moisture (%)
Control (White flour)	$13.32^{a} \pm 0.03$
4 %GP	$12.69^{b} \pm 0.01$
6 %GP	$12.32^{c} \pm 0.02$
8 %GP	$12.06^{d} \pm 0.08$
10 %GP	$11.93^{e} \pm 0.04$
4 % TP	$11.81^{f} \pm 0.01$
6 % TP	$11.61^{g} \pm 0.01$
8 % TP	$11.53^{h} \pm 0.00$
10 % TP	$11.44^{i} \pm 0.02$

GP – Grape pomace, TP – Tomato pomace. The values are the average of three repetitions (± standard deviation). Values in the same column with different exponents have statistically significant differences ($p < 0.05$) following Fisher's LSD test.

Analysis of variance (ANOVA) was applied to compare between treatments (not presented), and highlighted significant differences ($p < 0.05$) for moisture in the samples. The results presented in Table 1 show that the highest amount of moisture had the white wheat flour 13.32 ± 0.03% and the lowest mixture containing 10% TP (11.44 ± 0.02%). It is observed that by adding flour from food waste, the amount of moisture decreased.

Figure 2 shows the falling number of flour / water mixture. In different trials white wheat flour has been replaced with 4, 6, 8 and 10% GP.

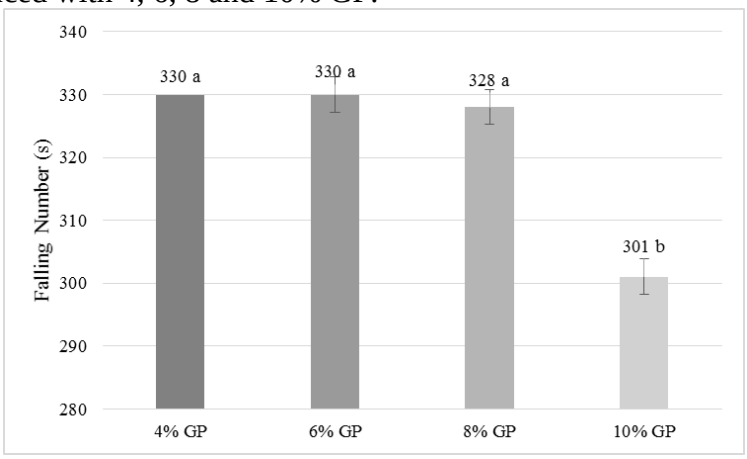

Figure 2. Falling Number in sample with GP

The results reported are the average of three repetitions; the bars represent the standard deviation. Same letters above columns indicate that data are not significantly different ($p < 0.05$) following Fisher's LSD test.

The results presented in Figure 2, show that flours containing 4% and 6% GP had the highest

FN with 330 ± 2.83 s and 330 ± 2.73 s, respectively. The lowest FN had the mixture of flour and water in which the replacement of wheat flour with GP was 10% (301 ± 7.07 s). The figure shows that by increasing the amount of GP in the mixture the FN decreased. Rašić, (2019) investigated the properties of wheat flour dough with the addition of Cabernet Sauvignon grape pomace in the range from 5 to 30%. Their studies showed that by increasing the amount of grape pomace in flour, FN declined by 10% and the GP falling number was 335 s. These results are very similar to our findings.

Figure 3 shows the FN values for the flour and water mixture. Some of the flour has been replaced with 4, 6, 8 and 10% TP.

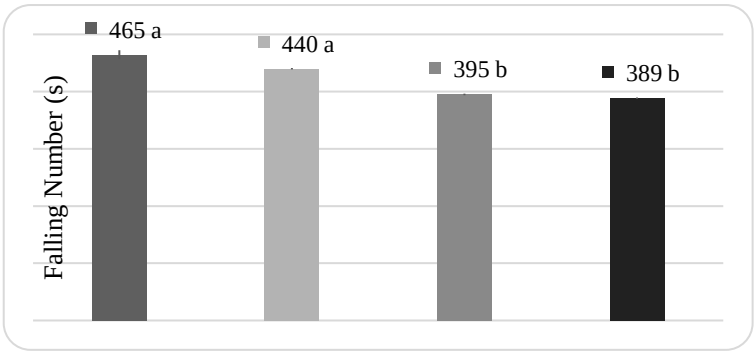

Figure 3. Falling Number in sample with TP

The results reported are the average of three repetitions; the bars represent the standard deviation. Same letters above columns indicate that data are not significantly different ($p < 0.05$) following Fisher's LSD test.

During the industrial processing of tomatoes, large quantities of waste (bark, seeds, fibrous parts and pulp residues) are generated which make up 7 - 7.5% of the raw materials (Nour et al., 2018). Figure 3 shows that the highest FN was the mixture of flour and water containing 4% TP (465 ± 7.78 s) and the lowest FN containing 10% TP (389 ± 1.19 s). The figure also shows that by increasing the amount of TR in the mixture, the FN decreased. According to Klarić, (2017) flours with a low FN (below 220) provided products with an inelastic and moist environment and have a high capability for creating dough gases. The good examples are the medium FN flour (240 - 280) yields products with normal elasticity, good environmental hollowness and normal gaseous capability, and the high FN flour (over 300) yields products with a low volume dry and flaky environment. These flours (with an FN of over 300) have low gaseous power and therefore fermentable sugars need to be added to them. On the other hand, according to method 107 approved by the ICC (International Association for Cereal Science and Technology), FNs are given which provide information on α-amylase activity. Following this method and below 150 s, the activity of α-amylase is high; ranging from 200 to 250 s the α-amylase's activity is moderate, and more than 300 s the activity of α-amylase is low.

Figure 4 presents the statistical analysis of the mean values for FN between grape pomace and tomato pomace.

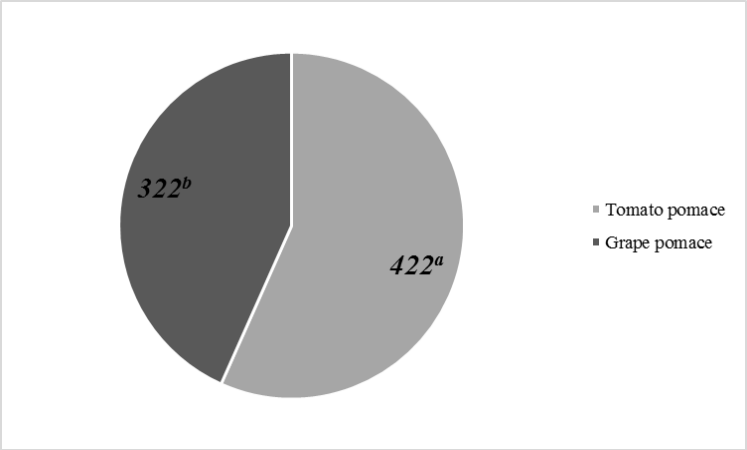

Figure 4. Falling Number in sample with GP and TP

The results reported are the average of three repetitions; the bars represent the standard deviation. Same letters above columns indicate that data are not significantly different ($p < 0.05$) following Fisher's LSD test.

Analysis of variance (ANOVA) was applied to compare between treatment (not presented) highlighted significant differences ($p < 0.05$) for falling numbers in flour with GP and TP. The values shown in Figure 4 show that the flour / water mixture containing a different amount of GP has a higher FN in comparison with the flour / water mixture containing TP.

CONCLUSION

Analyzes have shown that the addition of flour produced from food waste reduces the falling number. This means that by adding them to the wheat flour (which has a high FN), the resulting flour mixture (wheat and flour by food by products) tends towards a medium FN characterized by a normal dough elasticity, good hollowness in the middle and a normal brewing ability of gases in the dough. It has also been shown that the addition of flours from food-by-products increases the activity of α-amylase. Adding flours form food-by-products (grape pomace and tomato pomace) to wheat flour, showed low activity of α-amylase.

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