c. LISTA PORTOFOLIULUI DE LUCRĂRI ȘTIINȚIFICE RELEVANTE

Candidat abilitare IPA: Conferențiar dr. ing. Cristina-Maria CANJA

1. **CANJA C. M.,** Maier A., Pădureanu V., Mazarel, A ; Branescu, GR; Lupu, MI; Enache, DV, 2024, *Effects of Tomato Pomace on Baking Properties of Wheat Flour and Bread Quality*, Bulletin Of University Of Agricultural Sciences And Veterinary Medicine Cluj-Napoca-Food Science And Technology, Volume 81 Issue 1 Pp. 28-37 DOI10.15835/buasvmcn-fst:2023.0029 https://www.webofscience.com/wos/woscc/full-record/WOS:001250183600003

2. BOERIU A.E., **CANJA C.M.,** *A new methodology for improving the quality of cranberry bread*, Bulletin of the Transilvania University of Braşov Series II: Forestry, Wood Industry, Agricultural Food Engineering, Vol. 13(62) No. 2, 2020 https://webbut.unitbv.ro/index.php/Series_II/article/view/37

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Effects of Tomato Pomace on Baking Properties of Wheat Flour and Bread Quality

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RESEARCH ARTICLE

Abstract

The aim of this study was to investigate the properties of tomato pomace by-products by incorporating them in powder form into new bread products to improve their properties. Tomato pomace was dried, milled and incorporated with different levels (5%, 10%, 15% and 25%) into dough and breads made from wheat white flour. The addition of tomato pomace powder (TMF) influenced farinograph characteristics by increasing water absorption and dough softening, while decreasing dough development time and stability time. However, there were no notable changes observed in the quality of the bread, including baking yield, loss, and crumb moisture. The bread with added TMF showed higher protein and lipid content compared to the control sample. Specifically, the addition of 25% TMF increased fat content by 316.7%, protein content by 43.5%, and ash content by 34.1%. The sensory evaluation revealed that higher levels of TMF (25%) negatively affected overall acceptability of the bread while the bread with medium TMF, to which 15% powder was added, received the highest mean score of 4.82 out of 5, indicating its preference among customers due to its distinctive characteristics. This finding suggests that consumers prefer a moderate amount of TMF in their bread. These results highlight the potential of vegetable by-products, specifically TMF, as beneficial food additions that can improve bread's nutritional value.

Keywords: by-products, tomato pomace, bread quality

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INTRODUCTION

The food industry and research trends aim to implement the concept of zero-waste and its policies. Although the industry is primarily concerned with the disposal of by-products from the production of vegetable food products, these by-products also present a promising source of compounds with nutritional or technological features, and they are currently being investigated as potential sources of functional compounds. A significant number of studies in the field highlight that plant residues generated by the canned vegetable and fruit industry have enormous potential for their reuse in various food products (Zarzycki et al., 2022). The management of by-products from plant food processing can be achieved through various eco-friendly methods, including composting and anaerobic digestion. Composting converts organic waste into nutrient-rich fertilizer, reduces waste volume, kills pathogens, decreases weed germination in agricultural fields, and destroys malodorous compounds (Tiwari & Khawas, 2021). Meanwhile, anaerobic digestion breaks down organic matter, such as food or plant waste, through micro-organisms in the absence of oxygen. This process produces biogas, which can serve as a source of energy, and a bio-fertilizer by-product (Dey et al., 2021). Waste can be recycled or reused by other industries. For example, food waste generated during the production process can be converted into animal feed (Tiwari & Khawas, 2021; Waste Management in the Food Processing Industry). Surplus food can also be donated to those in need (Torres-León et al., 2018).

Tomatoes (*Lycopersicon esculentum*) are the second-largest vegetable harvest in the world after potatoes. They contain lycopene, phenolics, organic acids, vitamins, and other beneficial components (Lu et al., 2019). In 2021, the total number of tomatoes produced worldwide for processing and fresh consumption was just over 189.1 million metric tonnes (mT). This is a 2% increase from the 184.8 million mT grown in 2020 and a 4% increase over the average (182.7 million mT) of the three years prior (2018-2020) (Food and Agriculture Organization (FAO)).

Worldwide, there are many different ways to eat tomatoes: raw or in the form of processed foods like paste, juice, sauce, puree, and ketchup (Kaur et al., 2008). In general, when tomatoes are processed, a by-product known as tomato pomace (TP) is formed, which consists primarily of peels (40%) and seeds (60%). The peel, and seeds are rich in minerals, fatty acids, proteins, lipids, and amino acids, and they also include bioactive antioxidants like lycopene, beta-carotenoids, tocopherols, polyphenols, and terpenes (Lu et al., 2022). Tomato pomace consists of 5–10% of the fresh weight of tomatoes (Baldacchino et al., 2023).

Because industrial processing generates a huge volume of tomato pomace, the disposal or utilization of TP is an unavoidable challenge that is critical to the food sector. On the one hand, due to its high-water content and nutrient richness, TP is prone to spoilage if not properly disposed of, posing an environmental burden and wasting resources; on the other hand, rational TP utilization, to some extent, converts wastes into usable resources such as lycopene, dietary fibers, and tomato seed oil via bio-refinery (Lu et al., 2019). The resulting by-products after processing tomatoes are a rich source of nutrients and biologically active compounds: carotenoids, proteins, phenolic compounds, mineral substances and oils (Fritsch et al., 2017). To improve the nutritional, textural, and sensory qualities of the meals involved, fine powders of tomato pomace and its peel and seed components that contain significant amounts of dietary fiber, significant amounts of minerals, vitamins, proteins, polyphenols and carotenoids (lycopene, beta-carotene and lutein) can be used as functional food ingredients to be included into wheat flour-based foods, meat products, and tomato paste (Lu et al., 2019). Specialized literature suggests that reusing these by-products can benefit consumer' health by providing ways to incorporate them into their daily diets. This is particularly important for middle-aged individuals who wish to maintain their health and reduce the signs of aging (Azabou et al., 2020; Lu et al., 2022).

The increased public interest in the health benefits of food necessitates the development of new food products as well as the modification of classic recipes. These patterns are also applicable to bakery products, such as bread (Almeida et al., 2013; Badjona et al., 2019) or pasta (Lupu et al., 2023). "Functional bread" is bread that has been enhanced with food industry by-products. The addition of these by-products can improve the nutritional value of the bread while also reducing food waste (Amoah et al., 2020).

Introducing extra components to a product recipe can be a challenging task for food manufacturers. Therefore, it is crucial to evaluate the impact of these components on the final product. The present study investigates the potential use of tomato pomace powder in the bakery industry to improve the nutritional value of bread and other bakery products. The study focuses on the quality characteristics of the flour mixture and resulting bread.

MATERIALS AND METHODS

Materials

Flour and other ingredients

The commercial wheat white flour type 550 (fat: 1.3%; carbohydrates: 69%; protein: 11%; dietary fiber: 3%) was provided by a local supplier. Wheat flour type 550 (F550) is a versatile flour that can be used for a variety of baking purposes, including bread. In addition, this type of flour has a greater amount of protein, which is necessary for the development of gluten, and it also has a wet gluten content (the amount of gluten remaining after washing the dough with water to remove starch, water-soluble pentosans, and water-soluble proteins) of 28.5%, which is ideal for elastic doughs (Kulkarni et al., 1987). The ingredients for the bread - iodized salt, dry yeast - were purchased at a nearby market. The national water distribution system provided the tap water used.

Tomato pomace

The tomatoes (2 kg.) were provided by a local supplier. After washing and cleaning, the tomatoes were placed in a juicer (Gulliver O.M.A.C Italia), which extracted all the juice. The tomato pomace (peels and seeds) was dehydrated, for 12 hours at 40 degrees Celsius in the multitray dryer Klarstein. Subsequently, the pomace was shredded using the Thermomix TM5 food processor and divided into size classes using the Analysett 3 Spartan sieves. The mixtures were created based on the percentage of particles smaller than 20 nm.

Flour mixtures

The breads were obtained through the direct method with small changes in fermentation time and temperature, by varying the amount of added tomato pomace powder (TMF) to wheat flour (F550) in proportions of 5%, 10%, 15% and 25% (w/w). A control sample (CB) was also prepared without the addition of TMF.

Therefore, five loaves of bread formulations were prepared. The recipe of the control sample consists of 500 g of wheat flour, 12.5 g of salt, 15 g of compressed yeast and the amount of water needed to form a dough with optimal characteristics. The amount of water added to each formula was based on farinographic water absorption (WA) determined previously (500 Brabender units consistency). In bread recipes with added TMF, the wheat flour was replaced by a mixture of wheat flour and 25 g of tomato pomace powder, 50 g, 75 g and 125 g, respectively. The coding of the bread samples is shown in Table 1.

Table 1. Sample coding

Type	Coding	Wheat flour (g)	TMF (g)
Control sample	CB	500	-
Sample with 5% TMF	BTMF5	475	25
Sample with 10% TMF	BTMF10	450	50
Sample with 15% TMF	BTMF15	425	75
Sample with 25% TMF	BTMF25	375	125

Note: Tomato pomace powder (TMF)

Methods

Breadmaking procedure

The dough was prepared using the Kitchen Aid Artisan 5KSM7580XEER laboratory mixer. All ingredients were accurately measured and mixed for 5 minutes at speed 1. The mixing arm speed was then increased to 8, and kneading continued for 10 minutes to form and fully develop the gluten network. The resulting dough was left to ferment for 60 minutes at 38°C. After 60 minutes, a brief mixing was performed for 30 seconds, followed by manual division of the dough into pieces weighing 250g±5g.

The samples were formed, placed into rectangular baking molds (18x7.5x7cm) and allowed to finish leavening for 30 minutes at 30 °C. The baking process was carried out in a Whirlpool 6th Sense convection oven at a temperature of 220°C for a duration of 30 minutes. The humidity in the baking room was 70-75% during the first 10 minutes and decreased to 60% by the end of baking. The breads were weighed and cooled to room temperature before measuring all parameters. After cooling, the loaves were placed in special bread packaging and stored at 20ºC prior to testing after 24 and 72 hours.

Farinograph analysis

The Farinograph-E (Brabender, Farinograph-AT, model 8110142, Duisburg model 8110142, Germany) equipped with a 50-g bowl was used to determine the water absorption (WA), dough development time (DDT), stability time (ST), and dough softening (DS) of wheat flour and wheat flour with added TMF dough. The American Association of Cereal Chemistry (AACC) Method 54–21 was employed for the determinations of farinograph parameters (AACC International, 2010).

Determination of bread physicochemical properties

The yield of bread (BY) was calculated as the amount of bread that could be produced from a given weight of flour (Zarzycki et al., 2022). The baking loss (BL) was calculated as the difference between the weight of the dough and the weight of the baked bread. The weight of the samples was measured using a balance (Radwag, model WLC 2/A2, Poland) (Miller et al., 2008).

Bread volume (BV) was determined using the rapeseed displacement method according to AACC Method 10.05-01 after cooling the loaves for two hours at room temperature (AACC International, 2010), and specific volume (cm^3/g) was determined through calculation of the bread volume/bread mass ratio.

The moisture content of the samples was determined by AACC Method 44–15.02. The samples were analyzed 24 h and additionally 72 h after baking (AACC International, 2010).

Samples of length, width, and height measuring 1.5 x 1.5 x 1.5 cm from the geometric center of the crumb were obtained for each type of bread in order to determine the porosity (Tsatsaragkou et al., 2012). Helium was used as the displacement fluid for the gas pycnometer (Stereopycnometer SPY-3, Quantachrome, Syosset, N.Y., USA) in order to estimate the volume of solids (V_S, m^3). The formula for expressing the solid density (kg/m^3), which is the ratio of dry solids' mass to volume, is as follows: $\rho_s = m_s/V_s$. The following formula was used to estimate the bulk density from the measurement of the real geometrical properties of the bead sample: $\rho_b = m_s/V_b$. The porosity was calculated from the following equation: P (%) =1- ρ_s/ρ_b.

Protein, lipids, and ash content were measured using AACC-approved procedures, such as AACC 46-11.02 (using the Kjeldahl method; total nitrogen multiplied by 5.7 protein conversion factor), AACC 30-25.01, and AACC 08-01.01, respectively (AACC International, 2010).

Sensory analysis

To determine consumer preference for the examined bread formula, 40 evaluators (males and females, ages 21-60) were asked to rate the bread on a 5-point hedonic scale from least liked (1- "dislike very much") to most preferred (5- "like very much"). Shape, crust and crumb color, crust thinness, smell, taste, elasticity, porosity, aftertaste, attractiveness and overall acceptability were considered. The bread samples were coded and distributed in a random order. Each participant rated two replications of each bread recipe. A loaf of bread (uncut) was provided for each formula to evaluate shape. Water was offered to clean the palette between bread samples. The sensory examination was conducted in a laboratory with LED lighting and at room temperature. Staff and students of Transilvania University of Brașov were recruited as evaluators.

Statistical analysis

Each bread sample was tested in triplicate and results were collected from three separate tests. All data are presented as the mean of the three replicates followed by the standard deviation (SD). The significance of mean differences was assessed by one-way ANOVA. Tukey's test ($p \leq 0.05$) was used to compare mean differences (JASP Team, 2022).

RESULTS AND DISCUSSIONS

The examination of farinograph curves can yield valuable insights into how TMF affects the dough's mixing properties and water absorption (Table 2).

Table 2. Farinograph analysis of wheat dough with TMF addition

Sample Code	WA [%]	DDT [min]	ST [min]	DS [FU]
CB	58.8 ± 0.5^{c}	2.8 ± 0.3^{a}	13.2 ± 0.3^{a}	29.2 ± 2.1^{c}
BTMF5	59.9 ± 0.5^{c}	2.6 ± 0.3^{a}	12.1 ± 0.1^{b}	52.5 ± 5.6^{ab}
BTMF10	61.2 ± 0.5^{b}	2.55 ± 0.5^{a}	11.7 ± 0.1^{b}	58.3 ± 3.2^{a}
BTMF15	62.2 ± 0.4^{a}	2.65 ± 0.3^{a}	$10.\pm0.2^{c}$	60.2 ± 3.2^{a}
BTMF25	62.8 ± 0.3^{a}	2.65 ± 0.5^{a}	10.5 ± 0.3^{c}	58.8 ± 4.0^{b}

Note: Control sample (CB); Bread with 5% tomato pomace powder (BTMF5); Bread with 10% tomato pomace powder (BTMF10); Bread with 15% tomato pomace powder (BTMF15); Bread with 25% tomato pomace powder (BTMF25); Water adsorption (WA); Dough development time (DDT); Stability time (ST); Dough softening (SD); Values are means ± SD of triplicate determinations.; different letters in superscript within the same column indicate significant differences (Tukey test, $p \leq 0.05$).

The data presented in Table 2 provide information on the effect that the addition of tomato pomace has on the water absorption capacity of the dough and, implicitly on the dough forming capacity. As can be seen, the WA value ranges from 58.8 % to 62.8 %, with no significant ($p>0.05$) variation in BTMF5 (59.9 %), but with significant ($p\leq0.05$) variations in BTMF10 (61.2), BTMF15 (62.2) and BTMF25 (62.8) compared to the control sample (58.8 %). According to previous studies the high concentration of dietary fiber that tomato pomace brings to the dough significantly ($p\leq0.05$) increases the hydration capacity of the flour and, implicitly, the quality of the dough and its baking properties (Wang et al., 2002). Moreover, good baking performance is generally indicated by significant water absorption (Zečević et al., 2013).

The analysis of the presented data showed that the strength of the dough is given by indicators such as DDT and ST, which that indicate more tenacious doughs at variance values. The tenacity of the dough increased progressively with the amount of tomato pomace powder added, but the stability of the dough over time suffered slightly. The results of this study, summarized as values in Table 1, indicates that the addition of tomato pomace powder does not have a significant ($p>0.05$) effect on the DDT and ST values. The only exception is observed in the case of 25 % TMF addition, when the ST value decreases to 10.5 min. A minimum DDT of 2.65 min. as the amount of TMF added increases can be explained, according to studies by (Dima Gheonea, 2021), by the reduction /dilution of the gluten content in the studied flour mixtures.

In terms of ST, most types of flour on the market have an ST value less than or equal to 10 min. (Mohamed et al., 2006). In the case of this study, this value varies between 10.5 min. and 13.2 min. and is inversely proportional to the amount of tomato pomace added. The lowest value (10.5 min.) was obtained with the highest percentage of TMF added (25 %). The same trend of decreasing the stability over time of doughs with added dietary fiber has been reported by other authors (Codină et al., 2019; Liu et al., 2018).

In our investigation, compared to the control, the addition of TMF increased the degree of dough softening (Table 2). Nawroka's (Nawrocka et al., 2016) addition of carob fiber to the dough resulted in an increase in the degree of softening, which is consistent with the current investigations.

The results mentioned above can be partially explained by the interaction between added dietary fiber and gluten found in flour. In the first phase, dietary fiber absorbs water, preventing the complete hydration of proteins. This leads to incomplete and delayed formation of the gluten network during the dough mixing process (Liu et al., 2018).

Table 3 displays the results of the physical characteristics of the tested bread recipes. All bread samples exhibited good production and acceptable baking loss, consistent with previously reported data in the literature (Dziki et al., 2019; Wirkijowska et al., 2020).

Table 3. Physico-chemical properties of bread with the addition of TMF

Sample Code	BY [%]	BL [%]	Specific volume [cm^3/g]	Crumb moisture after 24h [%]	Crumb moisture after 72h [%]	Crumb porosity [%]
CB	140.1±0.6^c	12.3±0.3^a	301.4±5.3^a	42.7±0.3^a	40.7±0.4^a	78.0±0.3^a
BTMF5	141.8±0.6^b	11.6±0.3^a	290.1±5.1^b	43.5±0.2^c	42.5±0.2^c	76.81±1^b
BTMF10	142.9±0.6^a	11.5±0.5^a	285.7±5.1^b	42.3±0.3^a	41.3±0.3^a	76.11±1^b
BTMF15	144.5±0.5^a	11.0±0.3^a	280.8±2.2^c	42.5±0.1^b	41.5±0.1^b	75.80±0.4^c
BTMF25	141.2±0.6^b	11.9±0.4^a	265.5±2.3^c	42.8±0.4^a	41.8±0.4^a	74.06±1^b

Note: Control sample (CB); Bread with 5% tomato pomace powder (BTMF5); Bread with 10% tomato pomace powder (BTMF10); Bread with 15% tomato pomace powder (BTMF15); Bread with 25% tomato pomace powder (BTMF25); Bread yield (BY); Baking loss (BL); Values are means ± SD of triplicate determinations.; different letters in superscript within the same column indicate significant differences (Tukey test, $p \leq 0.05$).

In this study, it was found that replacing wheat flour with TMF at levels ranging from 5% to 25% resulted in only a slight increase in BY and a slight decrease in BL compared to the control. The BY value ranged from 140.1% (CB) to 144.5% (BTMF15). This increase in BY can be attributed to the increase in WA observed with the addition of TMF, which is consistent with previous studies reported by other researchers (Dziki et al., 2019).

The examined bread samples had a BL value ranging from 11% to 12.3%, slightly lower than values reported by other authors for wheat bread and bread with added dietary fiber components (ranging from 11.0% to 15.8%) (Blicharz-Kania et al., 2023; Kasprzak & Rzedzicki, 2012; Wirkijowska et al., 2020; Zarzycki et al., 2022). Additionally, the overall baking loss was not significantly affected by the inclusion of TMF ($p>0.05$).

The loaf volume is one of the most important variables in determining bread quality as consumers tend to find larger-volume loaves more enticing (Makowska et al., 2023). The addition of vegetable by-products resulted in a decrease in SV, which ranged from 265.5 cm^3/g (BTMF25) to 301.4, with the control sample having the highest value. However, it can be observed that the SV decreased with increasing the percent of TMF added. The specific volume decreased by 11.9% with the addition of 25 TMF, which was the most sensible reduction observed. In their study, (Nour et al., 2015) investigated the effect of adding dry tomato waste on bread volume and reported that the bread with tomato waste added showed a strong decrease in volume compared to the control bread. Furthermore, (Mironeasa et al., 2018) showed a rise in bread volume in their investigation on the impact of tomato seed flour addition, especially when the addition did not surpass 10%.

The moisture content of the crumbs ranged from 42.3% to 43.5% after 24 hours and from 40.7% to 42.5% after 72 hours. The addition of TMF caused a maximum increase in moisture content of 2.84% after 24 hours and 4.42% after 72 hours. Moreover, there were significant variations ($p\leq0.05$) in the moisture content of the crumb after 24h and after 72 amongst the bread samples. In contrast to the control, the TMF-enriched bread showed somewhat more crumb wetness.

Crumb porosity showed the greatest reduction when TMF was substituted for wheat flour among the physical characteristics assessed in the study that was presented (Table 3). For the BTMF25 sample and the control sample, the crumb porosity varied from 78.0 to 74.06%. Other authors report a crumb porosity of 88.4% and 79.8 % for two pan bread samples made from white flour, 64.8% for steamed bread and 79.4% for a French baguette (Falcone et al., 2006; Gao et al., 2015). According to the results, a lower porosity of the bread crumb is correlated with an increased inclusion of vegetable by-products.

TMF can be a valuable resource for producing functional bread due to its substantial higher content of dietary fiber, protein, and fat compared to wheat flour (Table 4).

Table 4. Chemical composition of wheat flour, TMF and bread with addition of TMF

Sample Code	Moisture content [%]	Fat [%]	Protein [%]	Ash [%]
F550	9.4±0,1	1.3±0.2	11±0.3	0.55±0.3
TMF	8.1±0,1	12.2± 0.2	21.7± 0.4	2.5 ± 0.6
CB	43.8±0.6^{b}	0.6±0.3^{a}	11.5±0.1^{b}	2.61±0.1^{a}
BTMF5	41.8±0.6^{b}	1.0±0.3^{a}	12.1±0.1^{b}	2.72±0.2^{c}
BTMF10	42.9±0.6^{a}	1.3±0.5^{a}	13.5.7±0.1^{b}	2.85±0.3^{a}
BTMF15	43.1±0.5^{a}	1.5±0.3^{a}	13.8±0.2^{c}	2.97±0.1^{b}
BTMF25	43.3±0.6^{b}	1.9±0.4^{a}	16.5±0.3^{c}	3.5±0.4^{a}

Note: Wheat white flour type 550 (F550); Tomato pomace powder (TMF); Control sample (CB); Bread with 5% tomato pomace powder (BTMF5); Bread with 10% tomato pomace powder (BTMF10); Bread with 15% tomato pomace powder (BTMF15); Bread with 25% tomato pomace powder (BTMF25); Values are means ± SD of triplicate determinations.; different letters in superscript within the same column indicate significant differences (Tukey test, p≤0.05).

The moisture content in tomato pomace can range from 45% to 80% depending on the processing technology (Vasyliev et al., 2022). In this study, the moisture content of the dried TMF was found to be 8.1%. This value differs from the moisture content of 5.1% reported by other authors (Beglița et al., 2023). The moisture content of the samples with added tomato pomace ranged from 41.8% to 43.3%. Although there was a small increase in moisture content, the maximum being found in BTMF25 (43.3%), these changes were not statistically significant (p>0.05). Ather authors (Nour et al., 2015; Wirkijowska et al., 2023) also noted a change in moisture content with the addition of tomato pomace.

The fat content of tomato pomace may vary depending on the amount of seeds present, as they are richer in protein and fat compared to the peels. According to some authors, the fat content ranged from 85.2 to 244.7 g/kg, with an average of 128.7 g/kg, based on the specific variety of tomatoes and the local processing conditions (Lu et al., 2022). The study found a significant (p≤0.05) increase in fat content in bread samples with added tomato pomace, with the increase being proportional to the amount of pomace added. The maximum increase was observed in the BTMF25 sample, which had a fat content of 1.9%. Compared to the control bread (CB), the fat content increased by 166.7% in the BTMF5 sample and 316.7% in the BTMF25 sample. These results are consistent with previous studies in the literature (Wirkijowska et al., 2020; Zarzycki et al., 2022).

The protein content of dried tomato pomace can vary from 20.77% to 21.9% (Lu et al., 2022). The protein content of the samples with added TMF ranged from 12.1% (BTMF5) to 16.5% (BTMF25) in this study. Compared to CB, we observed an increase in protein content of 5.2% for BTMF5 and 43.5% for BTMF25. Furthermore, we found that the increase was proportional to the amount of TMF added. Other authors have also observed this trend (Wirkijowska et al., 2023).

The addition of tomato pomace did not significantly affect the ash content of the bread samples. The ash content varied slightly based on the percentage of tomato pomace used, which is consistent with previous research by other authors (Wirkijowska et al., 2023). The ash content ranged from 2.72% for the BTMF5 sample to 3.5% for the BTMF25 sample.

Sensory evaluation of bread

The success of a new product or formula is largely dependent on consumer desire and sensory acceptability. In order to ascertain consumer approval and pinpoint any insufficient sensory aspects, a sensory evaluation was carried out in addition to evaluating the bread's other quality elements.

Figure 1 shows the sensory attributes of bread samples with varying percentages of tomato pomace powder, including shape, crust and crumb color, crust thinness, smell, taste, elasticity, porosity, aftertaste, attractiveness and overall acceptability.

The bread with medium BTMF15 tomato pomace powder, to which 15% powder was added, received the highest mean score of 4.82 out of 5, indicating its preference among customers due to its distinctive characteristics. This finding suggests that consumers prefer a moderate amount of tomato pomace powder in their bread. Conversely, samples with 25% powder additions received the lowest score of 4.04 points and were rejected. The samples BTMF15 and BTMF10, which had 5% and 10% tomato pomace powder added, respectively, received ratings of 4.45 and 4.59 points. These ratings were slightly higher than the control sample, which received 4.4 points.

Other authors (Majzoobi et al., 2011; Wirkijowska et al., 2023) reported different findings regarding the use of tomato pomace, which also affected taste. These results are not consistent with the current observations.

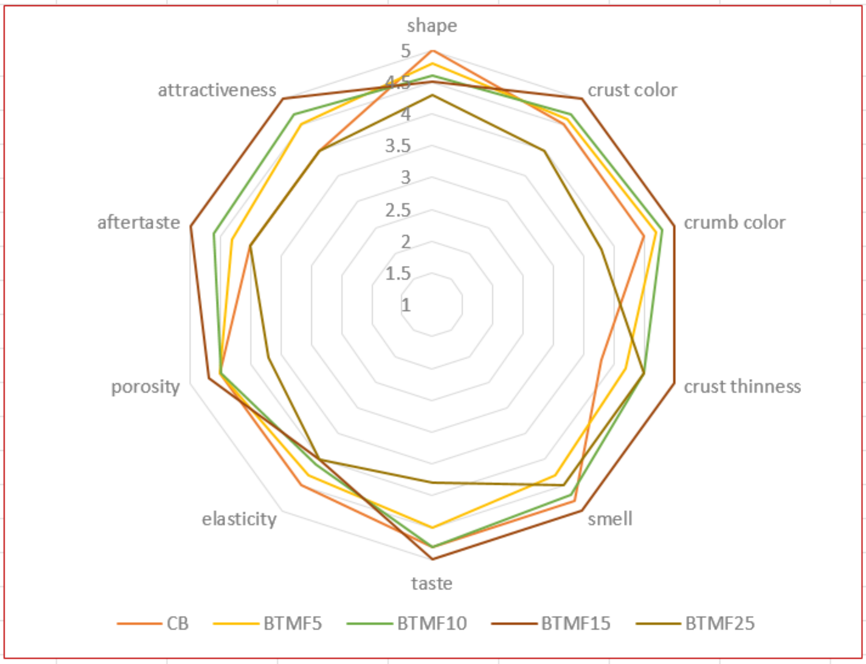

Figure 1. Sensory analysis of the bread samples. Control sample (CB); Bread with 5% tomato pomace powder (BTMF5); Bread with 10% tomato pomace powder (BTMF10); Bread with 15% tomato pomace powder (BTMF15); Bread with 25% tomato pomace powder (BTMF25).

CONCLUSIONS

The addition of tomato pomace powder influenced farinograph characteristics by increasing water absorption and dough softening, while decreasing dough development time and stability time. However, there were no significant changes observed in the quality of the bread, including baking yield, loss, and crumb moisture. The addition of 25% tomato pomace powder resulted in a significant decrease of 11.9% in the specific volume, which was the most notable reduction observed. The study assessed various physical characteristics, and the greatest reduction was observed in crumb porosity, which ranged from 78.0 in control bread to 74.06 in bread with 25% tomato pomace powder. The results indicate that an increased inclusion of vegetable by-products is correlated with a lower porosity of the bread crumb. The incorporation of vegetable processing waste from tomatoes into a bread recipe resulted in significant improvements in the nutritional composition of the bread. The bread with added tomato pomace powder showed higher protein and lipid content compared to the control sample. Specifically, the addition of 25% tomato pomace powder increased fat content by 316.7%, protein content by 43.5%, and ash content by 34.1%. The sensory evaluation revealed that higher levels of tomato pomace powder (25%) negatively affected overall acceptability of the bread while the bread with medium tomato pomace powder, to which 15% powder was added, received the highest mean score of 4.82 out of 5, indicating its preference among customers due to its distinctive characteristics. This finding suggests that consumers prefer a moderate amount of tomato pomace powder in their bread. These results highlight the potential of vegetable by-products, specifically tomato pomace powder, as beneficial food additions that can improve bread's nutritional value. Not only does this support sustainability, but it also aids in lowering food waste when these waste materials are used in food production. In addition, future studies ought to focus on finding new uses and maximizing the use of this vegetable processing waste in a range of food items. It is crucial to concentrate on determining the ideal supplementation levels to enhance the bread's sensory qualities with different percentages of tomato pomace powder while maintaining the intended nutritional advantages. Such initiatives will support a more resource-efficient and sustainable method of producing food, as well as increase the use of vegetable by-products in the food sector.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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VALORIZATION OF COMMON BEAN (*PHASEOLUS VULGARIS* L.) BY-PRODUCTS TO OBTAIN NEW BAKERY PRODUCTS

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ABSTRACT

Disposal of by-products from the processing of plant foods is a major industry concern, but these by-products are also promising sources of compounds with technological or nutritional properties and are now being considered as a possible source of functional compounds. The common bean (*Phaseolus vulgaris* L.), which contains a high protein content, fiber, and other critical minerals for humans, is one of the most significant pulses in the world. The objective of this work is to exploit the properties of common bean (*Phaseolus vulgaris* L.) by-products by including them in powder form in new bread products, in order to improve their properties. Empty common bean (*Phaseolus vulgaris* L.) pods were dried, mild and incorporated with different levels (5%, 10% and 15%) into dough and breads made from wheat white flour. The moisture content decreased in proportion to the amount of wheat flour substituted. Analysis of the bread showed that the addition of empty bean pod powder did not significantly improve the textural profile of the bread. In fact, there was an increase in hardness (1011.26 N/mm^2 for the control and 1027.38 N/mm^2 for the breads enriched with 15% powder, respectively). The pH and porosity also increased in proportion to the amount of wheat flour substituted. Regarding the sensory analysis, the breads obtained with different proportions of vegetable waste powder additions were liked by several categories of people and were noted with high scores. To conclude, the powders obtained from vegetable by-products can be used as functional compounds and can partially replace the wheat flour added to make bread.

Keywords: by-products, empty common bean (*Phaseolus vulgaris* L.) pods, bakery products

INTRODUCTION

One of the key strategies for reducing food waste is to recover and convert it for human use. The disposal of by-products from the processing of plant foods can be managed in several eco-friendly ways such as: composting (this process can convert organic waste into nutrient-rich fertilizer; it reduces waste volume, kills pathogens, decreases weed germination in agricultural fields, and destroys malodorous compounds) [1], anaerobic digestion (organic matter such as food or plant waste is broken down by micro-organisms in the absence of oxygen; this process creates biogas, which can be used as a source of energy, and a bio-fertilizer by-product) [2], recycling/reusing (waste can be recycled or reused for utilization by other industries; for example, food waste created during the

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STUDY ON RHEOLOGICAL BEHAVIOR OF BAKERY DOUGH

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Abstract: *Bread and bakery products represent basic food daily consumed of all the people. In this context, the quality characteristics of the bread have an important role regarding the consumer choice. So, in this study are specified the rheological properties of dough and its influence on bread.*
Keywords: *dough, rheological, bread, kneading*

1. INTRODUCTION

The dough is a complex colloidal medium that is formed during the mixing of the flour with the addition of water. The rheological characteristics of dough and the extensibility or elasticity are due to the most to the gluten, which is formed during the process of mixing from the protein of wheat flour gluten. The gliadins cause the extensibility of gluten and the bread volume, and the gliadins causes the extensibility of gluten and its tolerance to the mixing. By adding certain substances of oxidation to the dough, the protein network suffers some important changes, caused by the conversion of cysteine aminoacid in cystine, forming some disulfuric linear molecules in protein fiber [6].
The kneading is the technological operation after which is obtained a homogeneous mass of dough with a specific structure and rheological properties (strength, extensibility, viscosity, elasticity, plasticity), by mixing raw and auxiliary materials. The rheological characteristics of dough affect directly the quality of final product: the elasticity of the core and the peel, the volume and the form of the bread, as well as maintaining its freshness. When the dough has the elasticity and the extensibility sufficiently high, results loose bread, with developed volume and core which has pores with thin walls. If the dough is too tough, the bread is obtained undeveloped, with dense core and when the dough is too extensible, the bread is flatting and it has low volume and coarse porosity [6].

2. THE FORMATION OF THE DOUGH AND THE PROCESSES THAT OCCUR

During the kneading process there takes place a number of physical, chemical, biochemical, colloidal and microbiological processes that cause significant changes of the substances in the dough mass.
The physical processes depend on the way of mixing the flour with water. Depending on the manner of conducting the operation, the forming of the dough is divided into two stages: mixing the raw and the auxiliary materials and proper mixing of the mixture thus obtained.
In the first moments of the mixing, the flour water absorption leads to the formation of small wet clumps separately. Following the contact with water, is developing the hydration heat, around 27 cal/g of flour.
Continuing the mixing, it is reached the development stage of the dough , when little wet clumps merge into an uniform mass, and the water from its surface disappears, becoming smooth and shiny and begins to manifest the elastic properties. The time for the optimum development of the dough is 2…25 minutes, depending on the quality of the flour, the water added and the type of mixer.
The next phase is the stability of the dough when it is subject to the distortion due to the velocity of the gradients that arise.

The last phase of mixing, which should be avoided is the softening of the dough, and is characterized by changing the rheological characteristics. The dough becomes soft, slightly elastic and highly extensible and finally loses cohesion, becoming sticky and just like a viscous liquid.
The phases of dough forming can be observed by tracing the farinograph curve.
During the kneading, due to the heat of hydration and the transformation of part from mechanical energy into heat kneading, the dough temperature increases. The increase of dough temperature accelerates its formation. Exceeding the optimum temperature of dough formation, 28°C, leads to the increase of enzyme activity, the dough viscosity decreases, which has negative influence on the rheological properties of dough and can occur even distortion of proteins.
The colloidal processes are represented by the hydration and swelling processes of the dough components.
Hydration of the flour is a complex meal. Flour components bound water in various ways. Although the protein and the starch binds the largest amount of water in the dough, an important role also have the pentozans.
The proteins from flour bind the water both by absorption and by osmosis. The osmosis leads to the swelling of gliadin and glutenin resulting the gluten. The water related through absorption forms around the proteins the film hydration [4].
At the formation of the gluten an important role is played by the amount of water used. Not enough water will not satisfy the necessary required by the gluten, its structure is not formed completely, and its quality will be poor [4].
Biochemical processes occuring under the action of enzymes and they tend to the degradation of macromolecular constituents of flour to form simpler compounds which modifies the rheological characteristics of dough [4].
As a result of amilolyses process, during the kneading the dextrins and the maltose increase in the dough. They, in particular β – dextrins contribute to the increase of the dough viscosity. Also, the dough begins to activate the lipoxygenase, which in the presence of oxygen oxidizes the polyunsaturated free fatty acids and their monoglycerides [1].
The nature of chemical groups on the protein structure leads to the formation of covalent bonds as: disulfide, as well as non – covalent bonds: hydrogen bonds, hydrophobic bonds, ionic bonds. The gluten is formed so as a result of the interaction between gluten protein. The main role in the formation of gluten plays the glutenin, which favors the interactions and the associations with other proteins and other constituents of flour. Due to its large molecule, the hydrated proteins can form films, and at the kneading, its ability to interact increases.
During the kneading in the dough is included some air. A part is dissolved in the aqueous phase, and the remaining air forms microbubbles. These bubbles contribute to the pore formation in the dough at the kneading, and the oxygen from the air takes part in the oxidation processes from the dough.

2.1. The factors which influence the dough formation

The formation of the dough and its rheological properties are affected by a number of factors, as they are represented in the following figure 1.
The kneading conditions are represented by the intensity of kneading, the amount of energy transmitted to the dough, the kneading duration. It decreases with the increase of the speed of the kneading arm. The kneading duration influence a lot the kneading properties, thus lead to an optimal development, or an incomplete development or to an development too high [1].
The flour quality. The dough obtained from flour of poor quality is different from the dough obtained from flour of good quality. The dough made from low flour the protein' films break easily, even before their uniform distribution in the dough. In the dough obtained from flour of high quality the hydrated proteins are elastic, and to a kneading too high, the protein films present just a few breaks. This stability to this kneading is one of the most important characteristics of flour required.
The amount of water. A higher or a smaller quantity of water different than is required to achieve the normal consistency extends the kneading duration. Dough is very sensitive to a kneading too high, contrary to the dough that has a sufficient tolerance.
The electrolytes, particulary the salt (NaCl). The addition of neutral salts modifies the nature and the intensity of the hydrophobic interactions between the gluten proteins. Increasing of the ionic strength in the dough following the introduction of salt reduces the water capacity of retention by proteins [1].

2.2. The constituent phases of dough

From the physical point of view, the dough is composed of three phases: solid, liquid and gas.
The solid phase is composed of insoluble constituents and bound water: gluten proteins limited swollen, starch granules, bran particles and other solid ingredients.

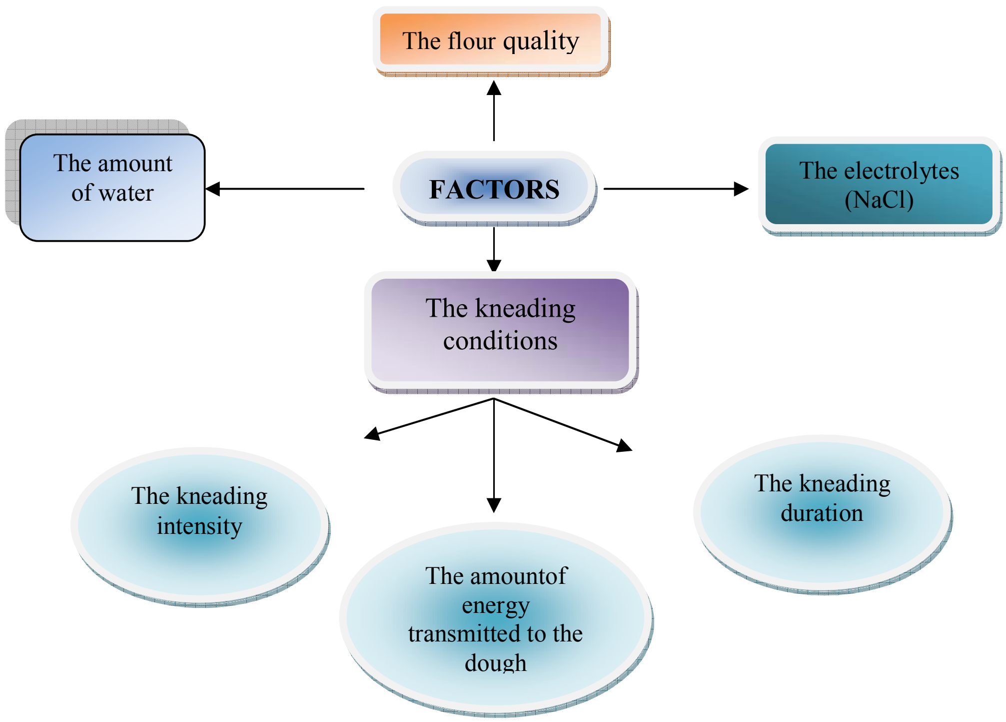

Figure 1: The factors which influence the dough formation

The liquid phase is formed in that part of water which is not bound by adsorption and there the soluble constituents of the dough which are dissolved: minerals, simple sugars, dextrins, water soluble proteins, polypeptides, amino acids. It is found partly in the form of thin films surroundings the elements of the solid phase and most of it is in the dispersed state, osmotic input by the gluten proteins in the swelling process. The liquid phase represents 8-37% by the weight of the dough. A big influence on the liquid phase has the flour quality and the kneading time. To a normal kneading it represents approx. 20%, and to a short kneading about 11% by the dough weight.

The gas phase is formed of air bubbles included in the dough while kneading. It is presented as an emulsion of gas in the liquid phase of the dough, and mostly in form of air bubbles included in the gluten protein which are swelling. To a normal kneading, the gas phase reaches 10% of the dough volume. To the kneading extension it can reach 20% [1].

3. THE DOUGH AND ITS RHEOLOGICAL PROPERTIES

As defined by The International Organization of Standardization (ISO Standard 5492.1.1977), the food rheology is the science that deals with the study of the deformation and the flow of raw materials, the intermediates and the finished products in the food industry.

The rheology accepts as old models the bodies with uniform properties, those whose behavior is described by linear law. The perfectly elastic solid (Hooke), perfectly plastic solid (St. Venant) and purely viscous fluid (Newton) are particular rheological bodies.

The rheological properties express the deformation of dough in time under the action of external forces exercised on it.

The dough prepared from wheat flour is a non-liner visco-elastic body. It has properties which are characteristic to both solids and liquids, and therefore has an ideal behaviour intermediate between solids and the liquids: when it is stress, some of the energy is dissipated and the other part is stored [2].

3.1. The rheological properties of bread dough

The rheological properties of dough are: elasticity, viscosity, relaxation, creep. All these properties are largely due to the gluten which is formed at the mixing, but also how it interacts with the other components of the flour and the dough ingredients [3].

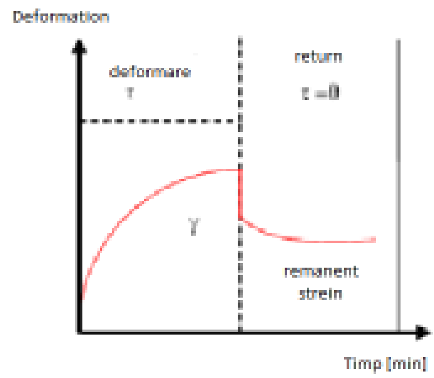

Figure 2: The deformation and its returning for a visco-elastic body
T- the applied voltage, γ-deformation

The elasticity is a property of a solid, deformable to reversibly store strain energy [5].

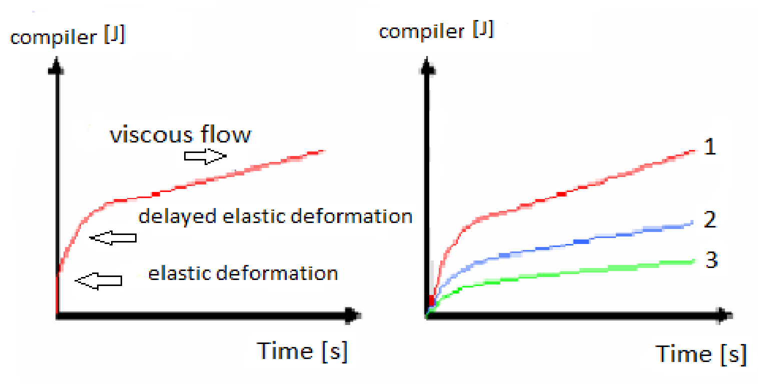

Figure 3: The typical curve of a viscoelastic material/ Deformation curves of dough from what flour (1-strong flour, 2-good flour, 3-weak flour)

The dough elasticity is provided by gluten, and particularly by glutenin, and that consists in that the dough deforms reversibly to a given applied force, then is it irreversibly deformed. The dough has an instantaneous elasticity that occurs upon the force application, and an elastic delay which occurs after the removal of the force.
The viscosity is the property of the bodies to resist to the deformation. The viscosity of the dough is an apparent viscosity, which, unlike the viscosity of the liquid, depends not only on the temperature and pressure, but also of a number of other factors such as the rate of shear that the dough has previously submissively.
The relaxation is the process of bone resorption, by decrease of the internal pressures of the dough, while maintaining the shape. The reabsorb of the pressures is made through the gradual elastic deformation in plastic deformation. The relaxation does not occur until the cancellation of internal tensions, but up to a limit determined, that is the limit of the elasticity, under the relaxation does not develop.
The relaxation time is the time when the tension from dough decreases of 2.7183 times, respectively with the base of natural logarithms e = 2.7183.
The creep is the property of a solid to flow slow and continuous under the action of a constant load [5].
The factors which influence the rheological properties of the dough
The rheological properties of dough play an important role in the production process, where the dough is subjected to the action of forces that realize the appearance of tensions and causes its deformation [3].
The quality of the flour, respective the protein content and the glutenin/gliadin report, has a great influence on the properties of dough. Thus, responsible of the dough viscosity are the gliadins which contribute to the dough extensibility, while the glutenins gives elasticity and resistance, increasing the resistance to breaking [2].
During the technological process, the dough is subjected to tensile and shear tensions.
The viscosity at the breaking by stretching and the breaking tension increases with the protein content of the flour, which explains the good performance of baking of the flour with high protein content [3].

The study of the dough behavior at shear with rotary viscometer showed that, at the request through shear, it increases its viscosity, proving its growth resistance. Increasing the viscosity of the dough to the severance occurs when it drops. The maximum viscosity to the shear decreases with the incresing of the protein content, but increases with the glutenin/gliadin ratio [1].
The amount of water. Increasing the water content is accompanied by a reduction of the elastic properties of the dough and its viscosity.
The rheological properties of the dough, the elasticity and the viscosity, increase until certain values of water content, corresponding to the maximum swelling of the protein, after which the value decreases. The optimum consistency is achieved when the dough contains enough water for the flour swelling components. An optimal swell of the components influence favorably the shape stability of the dough and the bread quality [1].
The optimum temperature for dough is 28…32°C. During the mixing process, the dough temperature increases due to the heat released during the hydration of flour particles and to the pass of an energy quantity into thermal energy. Increasing the temperature above the optimum temperature leads to the elasticity worsening and consistency of the dough, due to the increase of the fermentative activity. Lowering the temperature under its optimal value shrinks the dough plasticity with negative consequences on products quality [1].
Due to the temperature influence on enzyme activity, on the microbiota activity and on the rheological properties of the dough, it is best to use a lower temperature to the process of the weak flours and to the strong flours a higher temperature.
The kneading time is influenced by: the quality of the flour, the water quantity and the speed of the kneading arm.
Depending on the flour quality used, the dough can be formed slower or faster. The dough prepared from flours with high extraction and big extraction is more sensitive to the kneading than those obtained from low extractions flours and high extraction.
The dough of low consistency is very sensitive to a high kneading, contrary to the consistent dough which has a big tolerance. The kneading time decreases with the kneading arm speed [2].
For the traditional kneading, the kneading duration is between 6 and 12 minutes, while in case of the indirect method, the yeast is kneading 6…10 minutes, and the dough 8…12 minutes [2].
The end of kneading. It is appreciated through sensory analysis. The dough well kneading should be smooth, tight, consistent, flexible and easy to detach by the arm mixer and by the box wall where has been kneaded. At the manually sample, stretched between thumb and forefinger, the dough should stretch into a thin strip, transparent and flexible without breaking. The dough insufficiently kneaded is homogeneous, but is sticky and viscous. The dough excessive kneaded is highly extensible, without tenacity and to the manual sample it breaks.

4. CONCLUSION

- The dough is a complex colloidal medium that is formed during the mixing of the flour with the addition of water.
- The rheological characteristics of dough and the extensibility or elasticity are due to the most to the gluten, which is formed during the process of mixing from the protein of wheat flour gluten.
- From the physical point of view, the dough is composed of three phases: solid, liquid and gas.
- Depending on the flour quality used, the dough can be formed slower or faster. The dough prepared from flours with high extraction and big extraction is more sensitive to the kneading than those obtained from low extractions flours and high extraction.

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THE EFFECT OF THE ADDITION OF DIETARY FIBER IN WHITE BEAN OVER THE TECHNOLOGICAL AND SENSORY QUALITIES OF WHITE BREAD

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Keywords: white bean, dietary fiber, bread.

ABSTRACT

The study aims to trace the influence of addition dietary fibres of white beans over technological and sensory properties of white bread.

White beans, in the form of flour has been added due to high dietary fiber content, thus aiming to achieve a functional product with superior properties for people with digestive problems, those who are prone to diabetes, healing colon and prevent constipation operation, reduces the risk of colon cancer, reduce the risk of breast cancer, reduce the risk of obesity, reduce installation cholesterol levels and hepatic cholesterol synthesis etc.

Bean flour is added to the dough stage (in percentage) of 3, 5, 7 and 10 percent of the mass of the flour used, obtaining four types of bread to which they are determined through a series of physical-chemical indices and sensory as well as volume, porosity, humidity, acidity, smell, yield, taste, color etc.

INTRODUCTION

Obtain bakery products is considered today one of the most important branches of the food industry, the branch is based on the long history of bread, but is also closely related to the evolution and development of new kinds of bread. The quality of products we developed is closely connected with the processes that take place during baking (Hadiyanto, a., Asselman, g., at. All, 2007) and with raw materials and auxiliaries which are manufactured.

The trend of the past few years the world is blaming white bread, which is regarded, rightly or not, responsible for the onset of many diseases of nutrition and not only.

According to a study conducted by AIB International, Romania in 2014 was the country with the highest consumption of bread in Europe, with 97 kg/year, followed by Cyprus 74 kilograms/year, Belgium 67 kilograms/year, Germany 57 kilograms/year, Denmark 43 kilos/yr and 14 United Kingdom pounds/year.

White bread is made from wheat flour extraction with a low content of sheathing, which determines the amount of protein, vitamins and mineral salts. Durum wheat is one of the three major grains that dominate world agriculture today. The importance of wheat for bread-making is evident from the content of the endosperm in gluten, gluten that gives uniqueness in rheological terms, giving it the dough visco-elastic properties (Codina, Bordei, Pâslaru, 2008).

From a nutritional standpoint, the bread best reflects the properties of raw materials and auxiliaries is produced. In this research domain specialists cotext always new combinations of raw materials and auxiliaries from which to get the bakery products with improved properties and which comply with the current concepts of functional food products. As a result of this and of the need to return to the consumption of healthy breads, the present study aims to be the basis of a new product development of functional breads enriched with dietary fibre derived from white beans.

Studies conducted by Hugh Trowell (British dietitian) show that in underdeveloped countries, where consumption of white bread is reduced, consuming mainly bread and vegetable materials with high content of fiber, the incidence of digestive problems, diabetes, mild forms of cancer is very small compared to that of developed countries.

Dietary fibres, long have been considered ballast substances, but research in recent years have demonstrated their importance in relieving and preventing diseases with high incidence in the modern world, such as stomach diseases, diabetes, obesity, cardiovascular disease. The current trend is to consume food products enriched with fibers.

From the point of view of the definition, the fibers can be explained as "*an Assembly of components, constituents of plant tissue, which are currently consumed by deep people and that cannot be degraded by digestive enzymes*" (Hugh Trowell, 1985). In this context, bakery products fall into two broad categories. Products made from flour, containing dietary fiber from wheat bran native and bakery products enriched with dietary fibre of different sourcing included. In the latter category fits the product obtained by the addition of white beans, a product that is the subject of the present study.

The use of food in the bakery in significant proportions (more than 5% of the prepared flour) it brings of a range of effects, both positive and negative on the dough and bread-making quality obtained from it. Thus, the negative effects are the reduction of volume of low machinability of the dough, it become more sticky and having a higher approach towards aderence of working bodies of the workpiece, and cars in the category of positive recall great moisturizing power, which prolongs the freshness lasting.

All the positive effects we can frame and the physiological effects of food fibres make operation of colon work and prevent constipation, reduce the risk of colon cancer, reduce the risk of breast cancer, reduce the risk of obesity, reduce installation cholesterol levels and hepatic cholesterol synthesis etc.

MATERIAL AND METHOD

Experimental research to study the influence of the content of dietary fiber in the white bean flour on the technological properties of white bread. During experimental studies have traced the humidity, acidity, porosity, the H/D ratio, volume, mass, respectively, yield losses at baking.

The provenance of food fibres has been chosen following bibliographic studies carried out, it was found that the beans are on the first places in the hierarchy of plant products with high content of dietary fiber.

The dough was prepared by one method, using the type 650 wheat flour and flour from white beans as a percentage of 3, 5, 7 and 10% compared to the mass of the flour. White bean flour was introduced into the batter, along with other raw materials.

For bakery products with the addition of dietary fibre have been used following raw materials and auxiliaries: white flour quality type 650, compressed yeast, salt, dietary fiber (white bean flour), drinking water.

Direct method of preparing dough is mixing, kneading and fermentation in one phase of all raw materials and auxiliaries.

Manufacture of bread with added white bean flour is similar to that of manufacturing of white bread made from wheat flour.

In order to achieve the desired bread assortment have been carried out several experimental samples with different percentages of auxilire material with a high content of dietary fiber. Thus, there has been a standard sample without added dietary fiber and 4 types of bread to which have been added to different percentages of dietary fiber white bean flour. These samples were symbolized as follows: PM bread of wheat flour quality type 650; P1: sample with added 3% flour white beans; -P2 sample with addition of 5% of white bean flour; P3: tester with added 7% white bean flour; -P4 sample with addition of 10% white bean flour.

To obtain the PM used 500 g wheat flour, yeast, 3% 1.5% salt and 310 ml water.

In the preparation of other samples with different fiber additives, the quantity of flour with white bean flour, determination of the amount of flour required was accomplished by recalculating dry substances. The amount of yeast and salt remained the same, but the amount of water has varied, depending on the dough hydration needs.

For each of the 4 types of bread was determined moisture, acidity, porosity, the H/D ratio, volume, yield and baking losses.

To perform research used wheat flour type 650, whose characteristics are presented in table 1.

Table 1

The characteristics of the flour used

No. crt.	Flour type	Moisture content, %		Gluten content, %		Acidity, %		Ash, %	
		Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2	Sample 1	Sample 2
1.	White wheat flour quality I	14,1	14,5	28	30	2,0	2,2	0,48	0,49
		14,3		29		2,1		0,485	

Experimental research of the working temperature of the flour was 24.9°C and 28°C water.

After measuring the temperature of the flour has been sifted, înglobânu, and a quantity of air necessary for fermentation and yeast activity of panification. Follow the dosing of raw materials, after which was done mixing-kneading dough with the mixer with vertical arms until the temperature has reached a temperature of 30°C.

The dough thus formed was divided and prepared, are to be left at the initial fermentation for 20 min. This time of fermentation has been applied to all samples. After short period of time, the dough has been shaped and made the final fermentation for 30 min.

After the rising time is over, the product was baked in an oven at a temperature of 240°C for 45 minutes. After baking, the period of time the product has been removed from the oven, it was sprayed with cold water and left to cool for 24 h.

Organoleptic analysis of white bread with white bean flour was done according to the standard SP-3,232-97 Bread, loaf product and bakery specialties. Annalysis methods. Thus, all products have been analyzed, the shape of the shell and core, volume, consistency, smell, taste and color core and shell.

For the determination of physico-chemical properties of bread have been used the methods of analysis provided for in SR-90-2007.

RESULTS AND DISCUSSIONS

4.1. Organoleptic analysis of white bread with added white bean flour

Organoleptic analysis was done according to the scoring scale, for each sample is given the appearance of color and form, core and shell, smell and taste.

Organoleptic analysis results have been summarized and are presented in table 2.

Table 2

Synthesis of organoleptic analysis results

Code number of the sample	The number of points awarded				Comments
	Layout and form	Colour	Odour	Taste	
PM	4	5	5	5	19p
P1 3% White bean flour	5	5	5	5	20p
P2 5% White bean flour	4	5	5	4	18p
P3 7% White bean flour	4	5	5	4	18p
P4 10% White bean flour	4	5	5	4	18p

As a result of sensory analysis, the addition of white bean flour proved to be a crucial influence on the quality of the products obtained. Following the addition of white beans in different percentage, has noticed an improvement in flavour and taste, products with a special aroma and taste.

Organoleptic point of view, the best results were obtained from the sample with added 3% flour white beans.

4.2. Estimation of physico-chemical

Physico-chemical quality assessment of products involved analyses for both blank and other samples with the addition of white bean flour.

Table 3

Quality indices estimation of blank sample

No. crt.	Features	PM
1.	Pound of bread, g	440
2.	The volume of bread, cm³	1650
3.	The elastisity of bread, %	113,6
4.	Porosity of bread, %	77,03
5.	Humidity of bread, %	40,0
6.	The acidity of the bread, degrees	2,0
7.	Baking losses, %	12,0

Table 4

Assessment of quality indices of the bread with addition of white bean flour

Features	*P1 3% White bean flour*	*P2 5% White bean flour*	*P3 7% White bean flour*	*P4 10% White bean flour*
Weight, g	*430*	*435*	*440*	*440*
Volume, cm³	*1390*	*1395*	*1380*	*1360*
Return of bread, %	*113,1*	*114,4*	*115,7*	*115,7*
Elasticity, %	*80,5*	*80,0*	*79,4*	*78,5*
Humidity, %	*38,9*	*38,0*	*36,5*	*34,0*
Acidity, ^{o}T	*2,3*	*2,6*	*2,9*	*3,1*
Losses, %	*12,5*	*12,9*	*13,1*	*13,9*

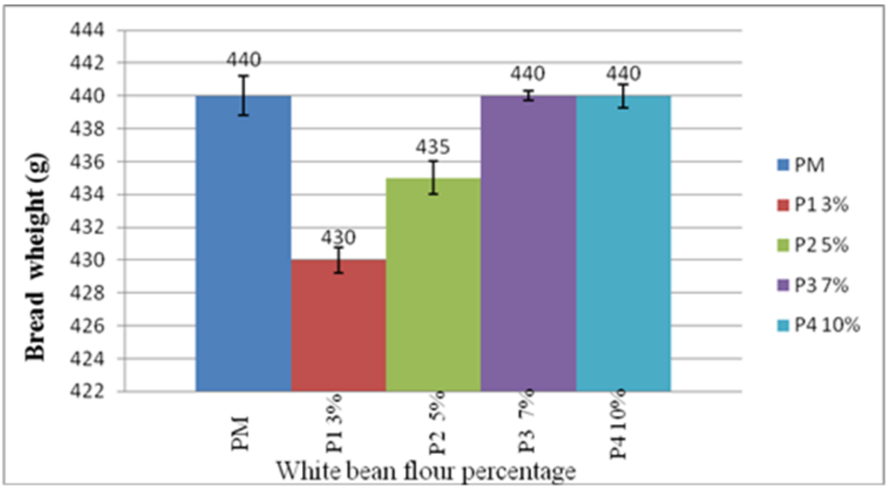

Fig. 1. The dependence of the mass amount of bread and white bean flour added

The addition of dietary fiber from bean white flour makes a number of changes of technological parameters, changes that directly affect the quality of the finished product. The addition of white bean flour does not influence critical mass of bread, and this apparent growth to the addition of 5 and 7% of white bean flour.

From the graph it is observed that at 3% bread flour for white bean, the table bread is less like that of blank and with the growth of the addition of white bean flour and bread rises, reaching out to have the same value as that of the blank.

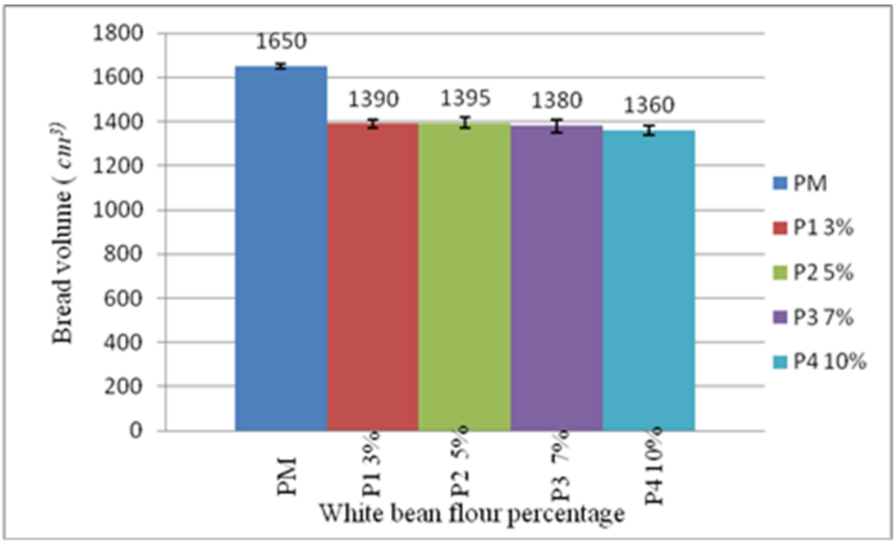

Fig. 2. The dependence of the volume of bread and the volume of added white bean flour

The main effect of the addition of white bean flour into bread reflects the volume of the products obtained. It is observed that the volume of bread is reduced in proportion to the percentage of white beans added flour, this is mainly due to the decrease of the content of gluten in the dough and thus reduce the capacity to keep the dough fermentation gases.

The study showed that the addition of up to 7% of white bean flour, bread volume decreases proportionally with reduced protein content glutenice. This phenomenon is explained by mechanical damage of glutenice films by white bean flour introduced. Another opinion is that in the presence of white beans, due to competition for water in the dough, glutenic proteins do not moisturize enough, so glutenică is insufficient network formed.

Aiming to change volume at baking, it was observed that the dough made of flour with white bean added, expand less volume than that simple, this fact being blamed on more rapid fixing of the shape and volume of the bread, because of fast gelatine formation of starch due to the larger quantity of water in the dough with white bean flour.

From the diagram it can be seen that the largest volume it takes P2 with 5% white beans and flour along with the increase of the quantity of white beans meal it reduces the volume of bread.

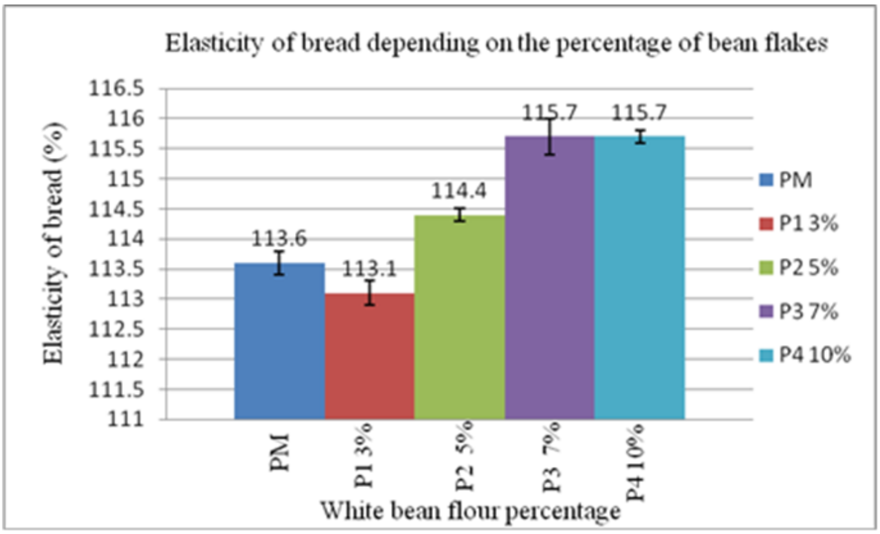

Fig. 3. The dependence of the elasticity of the bread and the amount of added white bean flour in varying percentages

The bread with white bean flour has a much smaller volume of bread as witness PM regardless of the amount of added white bean flour. The largest volume of bread should be recorded at the bread with 5% addition of white bean flour and decreases with increasing of added fiber, having the lowest value for bread with 10% addition of white bean flour.

In terms of efficiency we can notice that the samples with the addition of dietary fibre have an efficiency of bread. Increase in yield is due to the fibre properties: capacity of absorption and retention of water in addition.

We can see from the graph that the yield is lower at bread bread with 3% white bean flour than bread witness and increases with increasing fiber content.

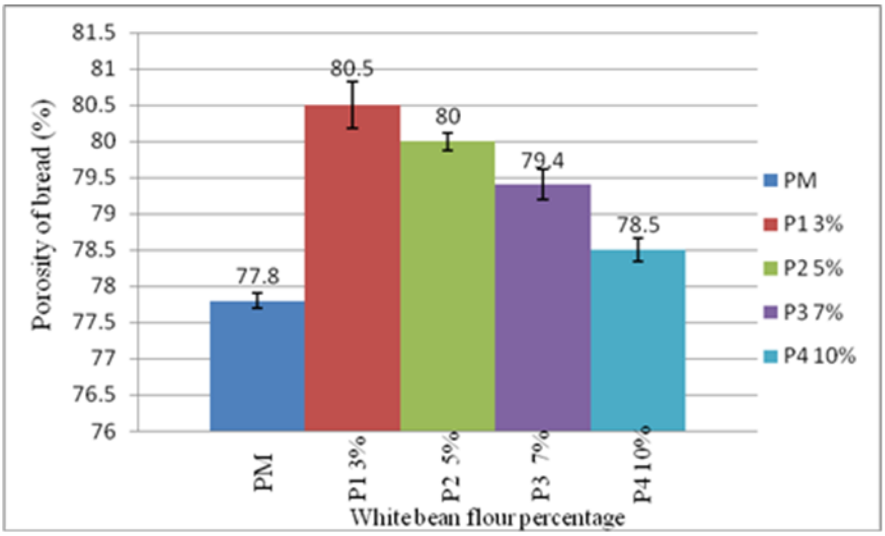

Fig. 4. The dependence of the porosity of bread and the amount of added white bean flour in varying percentages

In terms of core porosity it is observed that all samples of bread have porosity values in product standards recommendations. You may notice a slight decrease in the value of the porosity, the trend is closely related to the amount of added white bean flour.

Pursuing the values plotted in figure 4, note the porosity of the 4 samples is greater than that of the blank. The highest value was recorded in the case of the sample with 1% White bean flour and decreases as the amount of white bean flour added dough rise.

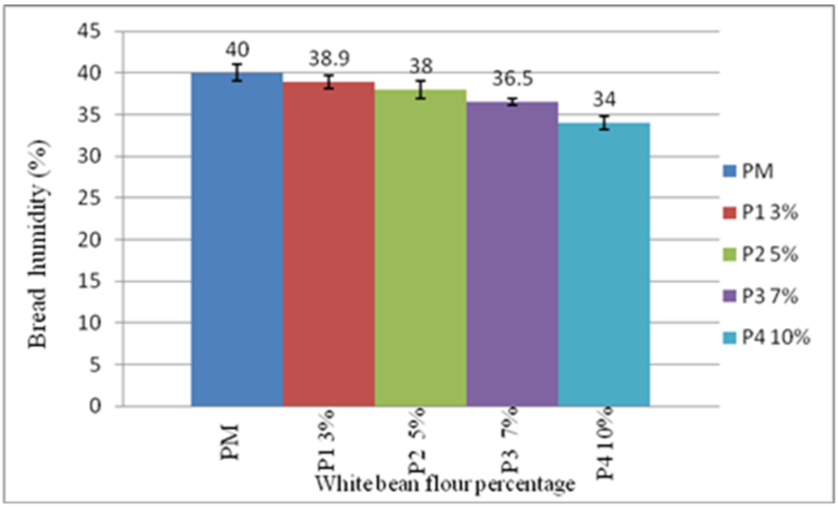

Fig. 5. ***Dependence of humidity quantity of bread and white bean flour***

According to the results presented graphically in figure 5, we can notice a decrease in humidity in the samples with the addition of white bean flour vs blank. This decrease is due to the increase in the capacity of absorption of water by the fiber in the product and its evaporation during baking.

From the graph it appears that moisture from the bread with the addition of white bean flour is lower than that of bread witness and also decreases with increasing the amount of the addition is the white bean flour. The smallest value of humidity shall be recorded at the 4 with 10% addition of white bean flour.

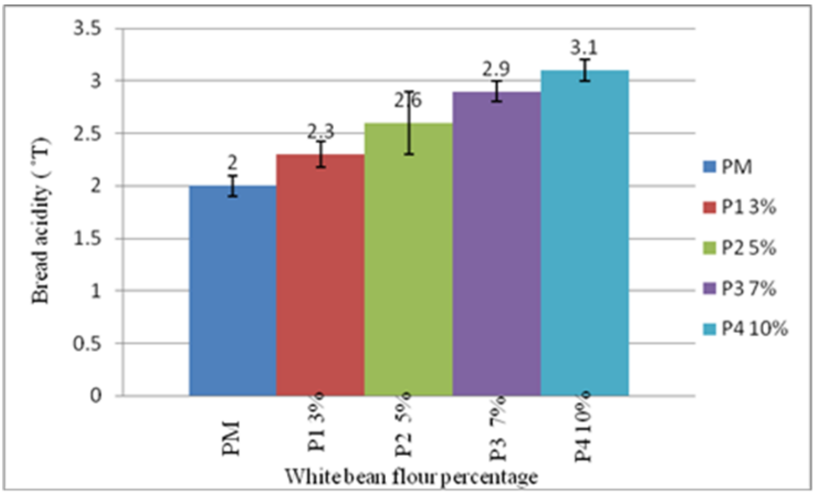

Fig. 6. The acidity dependence of the bread and the amount of added white bean flour in varying percentages

The measured acidity from the bread with the addition of white bean flour is higher than that of bread witness. Also can be seen from the graph that the acidity increases directly in proportion to the increase in the amount of added white bean flour.

Acidity index flour characterize the quality of the finished product. In the case of the addition of white bean flour, the acidity increases with the increase of the quantity of white beans and flour in the dough of the accumulation of lactic acid that occurs as a result of lactic fermentation.

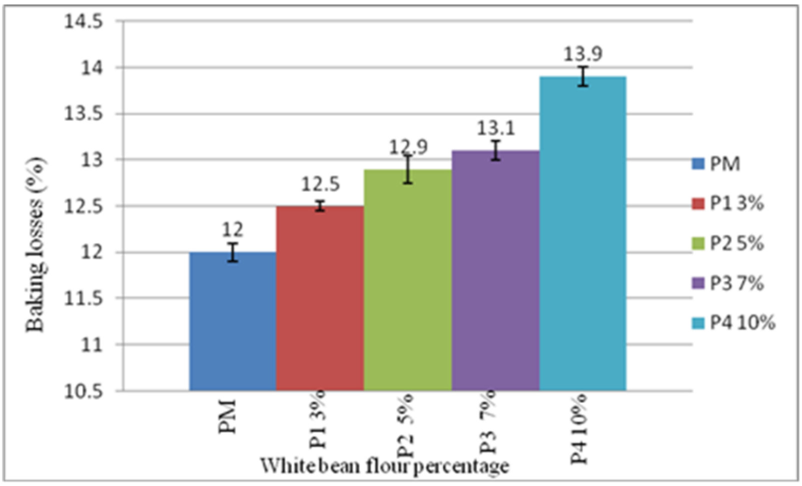

Fig. 7. The dependence of the baking of bread losses and the amount of added white bean flour

The losses are higher in baking bread with the addition of white bean flour than blank, due to the extra amount of water added to the dough hydration. The biggest value losses from baking bread to be recorded with the greatest amount of added white bean flour.

CONCLUSIONS

The use of food in the bakery in significant proportions (more than 5% of the prepared flour) brings a range of effects, both positive and negative on the dough and bread-making quality obtained from it. In this context, the results obtained in the present study, from the technological point of view the addition of dietary fiber from bean white flour does not distort organoleptic properties and physico-chemical properties of the product obtained.

As a result of sensory analysis, the addition of white bean flour proved to be a crucial influence on the quality of the products obtained. Following the addition of white bean has noticed an improvement in flavour and taste, products with a special aroma and taste.

All results obtained from the study conducted shows that, from the technological point of view, white bread flour with the addition of white bean meets the requirements of current standards and satisfy the tastes of consumers participating in tests.

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EFFECT OF SALT ON GAS PRODUCTION IN BREAD DOUGH

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Abstract: *Salt is an essential ingredient to life and good health and is used in a variety of processed food. It not only confers its own specific flavour on products, it is also used to enhance and modify the flavour of other ingredients. It contributes to taste and it controls fermentation, a key part of the bread making process. This paper presents some aspect concerning the effect of salt on gas production in bread dough.*

Key words: *bread dough, fermentation, salt.*

1. Introduction

Salt is a commonly occurring mineral, the chemical name of which is sodium chloride. Sodium is needed by the body for it to function properly. Together with potassium and chloride, it helps keep the body's fluid concentrations at its correct levels, has an important role in nutrient uptake by the cells and helps with the transmission of electrical impulses in the nerves.

However, an excess of sodium affects health, causing the body to retain too much water and increasing the volume of bodily fluids. This is linked with high blood pressure which in turn leads to an increased risk of coronary heart disease. Although there are a number of other sources of sodium in the diet, the most common is salt. Experts now recommend that adult consumption of salt should be reduced from its current average level of 9 g to a population average of 6 g [6].

On average, 75% of the salt eaten by adults comes from processed food, including bread and is, therefore, non-discretionary. As a result, food manufacturers are increasingly expected to reduce the amount of salt they use in their products in order to reduce the levels of non-discretionary salt consumed.

2. Use of Salt in Bread

In the history and civilization of any nation bread is considered, symbolically, a material with spiritual significance, mystery and revelation, connection between man and divinity.

With the Romanian people, to receive the guests with "bread and salt" is a greeting or welcoming ceremony, it is the supreme symbol of hospitality, with deep meanings of respect, affection and total confidence.

Since bread is the staple food to feed people daily, it is necessary to emphasize why it is eaten daily and is as important for maintaining health in normal limits.

These reasons are related, in particular, by the nutrient and energy value of bread and that bread is the main source of sodium

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for the body. Sodium intake of bread is made by using an appropriate amount of salt, amount to be closely monitored so as neither to influence consumer health, nor the quality of the bread making process.

As a result, the aims of this study is to observe the influence of the amount of salt added in dough on the ability to form and to retain gases on dough fermentation.

Salt often performs a technological role in food and cannot always be removed totally. Salt is a major component in bread, and performs several important functions.

The reasons for using salt can be divided into three broad categories: processing reasons, sensory (taste) reasons, and preservation reasons. In some cases it performs all three of these functions, and in many situations the distinction between them is not clear.

It acts as a seasoning and so flavours the dough. It acts as a colour enhancer by reducing the action of sugar within the dough. That means if there is less salt in the dough, yeast action will be more than normal and there will be less sugar for caramelization resulting in poor crust colour. On the other hand if more salt is present, there will be more sugar left at the time of baking due to the controlling effect of salt on yeast and the crust colour will be dark [2].

By slowing down the yeast action, it allows the fermentation to be controlled and retards bacteria growth. It also helps to control the texture by strengthening the gluten. Too much salt kills some of the yeast cells thus preventing the dough from rising properly and making it sticky. The tightening gives strength to the gluten, enabling the dough to efficiently hold carbon dioxide, which is released into the dough as a by-product of the yeast fermentation. When salt is left out, the resulting dough is slack and sticky in texture, work-up is difficult, and bread volume is poor.

Salt has a retarding effect on the activity of the yeast. The cell wall of yeast is semi-permeable, and by osmosis it absorbs oxygen and nutrients, as it gives off enzymes and other substances to the dough environment. Water is essential for these yeast activities. Salt by its nature is hygroscopic, that is, it attracts moisture. In the presence of salt, the yeast releases some of its water to the salt by osmosis, and this in turn slows the yeast's fermentation or reproductive activities. If there is an excess of salt in bread dough, the yeast is retarded to the point that there is a marked reduction in volume. If there is no salt, the yeast will ferment too quickly [2].

Salt influences gluten behaviour, decreases yeast activity in the dough, thus retarding gas production, and enhances bread flavour [5].

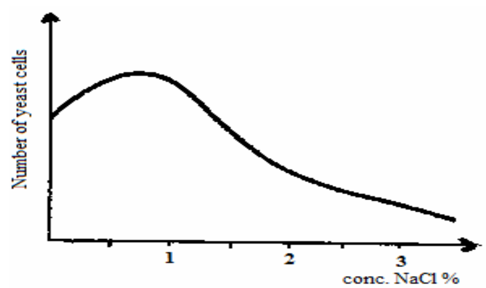

Fig. 1. *Influence of salt on yeast propagation*

Influence of salt on yeast multiplication is shown in Figure 1 [5].

Uncharged salts (such as sodium chloride) influence hydrophobic interactions as they induce conformational changes of the biopolymers in dough. It is generally agreed that salt increases dough development time, resistance to extension and extensibility.

However, research on the effect of salt on breads has shown conflicting results. For instance, fundamental rheology has been recently used to describe the effect of large amounts of salt on dough with dissimilar results [1], [4].

Furthermore, various authors have reported salt addition as increasing, decreasing or having no effect on specific volume measurements [3].

The Expert Committee on Vitamins and Minerals highlighted cereals and cereal products, in particular bread, as a major source of sodium in the diet. 95% of the sodium in bread comes from salt.

3. Materials and Method

To make experimental determinations we can use an installation whose diagram is shown in Figure 2.

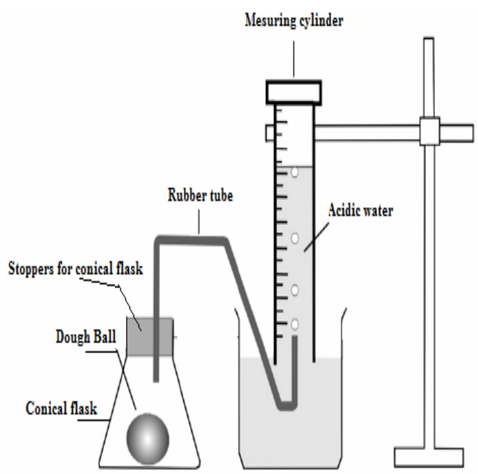

Fig. 2. *Schematic drawing of the setup to measure dough gas production*

Installation consists of the following: measuring cylinders (500 mL), mixing bowls, conical flasks, stoppers for conical flasks, rubber tubes, weighing scale.

The subject of this research is the bread dough, made following the same recipe for manufacturing, but modifying the content of salt solution. Thus, four pieces of dough were formed, which were mixed in separate containers and finished kneading with fingers incorporating all losing particles. After mixing four dough pieces each one was placed in a 500 mL conical flask connected to 500 mL measuring cylinders inverted in a container of water to measure the gas production.

For bread dough, there has been used 25% yeast solution and 25% salt solution.

In order to check the effect of salt concentration on gas production, dough was prepared as follows with varying volumes of salt:

Probe	**A**	**b**	**c**	**d**
Flour [g]	250	250	250	250
25% salt solution [mL]	0	15	30	50
25% yeast solution [mL]	15	15	15	15

4. Result and Discussion

Amount of gas produced in four dough pieces were recorded after every 10 minutes until the rate of gas production is established.

The results are presented in Table 1.

Table 1

Amount of gas produced in time

Time [min]	**Volume of gas [mL]**			
	a	**b**	**c**	**d**
0	0	0	0	0
10	30	20	14	6
20	57	43	26	12
30	75	59	43	20
40	95	77	57	24
50	122	95	69	34
60	140	116	85	45
70	176	142	107	63
80	213	164	124	87
90	233	203	134	106
100	253	215	140	114

According to the graph gas formation has decrease with high salt concentration (Figure 3). This is because salt has a tightening effect on yeast cells which reduces the gas production.

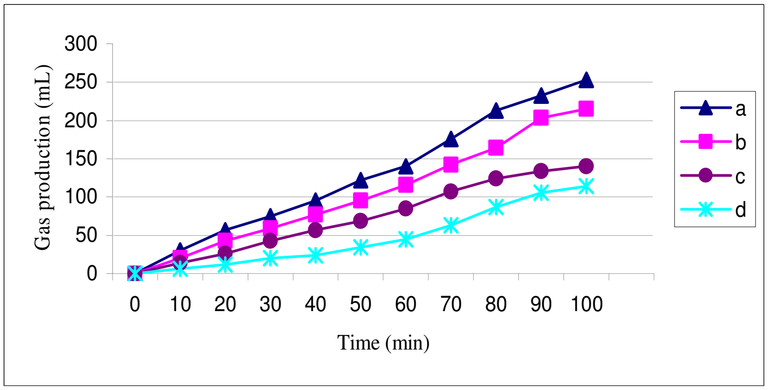

Fig. 3. *Effect of salt on gas production*

5. Conclusions

Gas formation of the dough decreases with the increase in salt concentration.

Salt has a retarding effect on the activity of the yeast.

If there is an excess of salt in bread dough, the yeast is retarded to the point that there is a marked reduction in volume. If there is no salt, the yeast will ferment too quickly. In this sense, the salt aids in controlling the pace of fermentation.

Salt levels will vary in baked products according to the functional needs. In general salt levels have fallen gradually in foods because of concerns over high levels of sodium in many diets.

Acknowledgements

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STUDIES ON INFLUENCE OF WATER ON DOUGH RHEOLOGY AND BREAD QUALITY

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Abstract: *The water content is a very important parameter of the dough. The consistency of dough depends on the amount of free water in the dough, which facilitates the enzymes mobility, reported to the substrate and therefore the intensity of biochemical processes. Too little water will lead to a too high viscosity and this will cause difficulty during dividing, handling and molding. Too much added water will lead to dough with a low viscosity and it will stick to processing equipment. The present paper aimed is studying the influence of water on the rheological characteristics of bread dough and quality of bread was studied.*
Keywords: *bread dough, water content, consistency*

1. INTRODUCTION

Water absorption in baked products can be defined as the amount of water addition required to produce a dough optimum for processing. Moisture levels in bread formulations influence the rheological properties of the bread dough as well the textural properties of the baked bread. It is thus important to produce a dough whit an optimum water level. Too little water will lead to a too high viscosity (the dough will be stiff) and this will cause difficulty during dividing, handling and molding. Too much added water will lead to dough with a low viscosity (the dough will be too soft and may not retain its shape) and it will stick to processing equipment. Dough water levels are also dependent on bread variety, bread making process and processing methods.
In the baked bread, moisture content contributes towards the textural properties. Perception of freshness is generally linked to the moisture content of the crumb, although bread stored under the proper conditions for several days will have the same moisture content as that of freshly baked bread. [4]
Water is regarded as one of the critical factors that contribute to bread staling. Another major factor is starch. The overall staling process can be divided into two sub processes: firming of the crumb caused by moisture transfer and intrinsic firming of the cell wall material, which is due to starch retrogradation. Bread with lower moisture content does stale faster than that with higher moisture content.
The water levels are critical when referring to bread spoilage. Too little water would accelerate staling and too much water would encourage spoilage by moulds.
If exist an excess of water, the dough will have small consistency and bread obtained will be flat

2. INFLUENCE OF WATER CONTENT ON RHEOLOGICAL DOUGH PROPERTIES

Rheological properties of the dough plays an important role in the production process, in which the dough is suppose to action of forces which causes stress and strain.
Water is an essential component of the dough, primarily because when mixed with flour result a mixture which mechanical behavior enables the desired formation on bread making process, and secondly because after the baking there is more or less water in bread, water which play an important role in determining the texture.
Absorbed water from flour in mixing process is in the form of water related, integral part on the structure of dough, and partly as free water, responsible for the fluidity of the dough.
Related water represent 30-35% on the total amount of water in dough, the remaining of 60-65% being under the form of free water. [1]
Largest amount of water from bread dough is related to gluten and starch. The formation of dough, the gluten must be hydrated. Optimal time for mixing grow at small dough humidity, like we can see on table 1.
Grow of time for dough develop it is bigger when the flour used are much stronger. [2] Rheological properties of the dough, elasticity and viscosity, increase up to certain values of water content, corresponding of maximum swelling of

the proteins, then their value decreases. Optimum consistency is obtained when the dough contains enough water to swelling flour components. An insufficient amount of water on the dough not achieved optimal swelling of gluten proteins; dough is obtained with reduced elasticity, and the final breads will have volume and porosity underdeveloped.

Table 1 Influence of water content on time of dough develop [3]

Water, %	**Time for dough develop,** s
36,52	260
38,52	300
40,52	350
42,52	415

Influence of dough humidity on viscosity and storage module are presented in table 2

Table 2 Influence of dough humidity on rheological characteristics of dough [3]

Dough Humidity, %	**Rheological parameters of dough**	
	Viscosity η**,** [$Pa \cdot s^{-1}$]	**Storage module [G],** Pa
36,52	1,9 10^6	1675
38,52	1,6 10^6	1640
40,52	1,2 10^6	1602
42,52	1,2 10^6	612

3. MATERIALS AND METHOD

Materials
Three commercial wheat flour samples (FA_1, FA_2 and FA_3) of varying quality characteristics were procured from the local market, and used in the studies.
Methods
Flour analysis: moisture, ash, protein content, gluten and acidity characteristics were determined, characteristic shown in table 3.
Bread formula and ingredients
Bread dough was prepared using direct method preparation. It was preparing dough's with different consistency: dough with normal consistency, dough with soft consistency (+10% water from hydration capacity) and dough with strong consistency (-10% water from hydration capacity).
Preparation of the dough
For preparation of bread dough was used flour, water, yeast and salt. The ingredient was mixing using the Spiral Mixer Silver 50, for 8 minutes at 90 rpm, and next for 4 minutes at 180 rpm. After resting, the dough was baked at 200°C for 40 minutes.

Table 3 Characteristics of flour used

Characteristic	**FA_1**	**FA_2**	**FA_3**
Moisture, %	14,03	14,00	13,98
Ash, %	0,58	0,61	0,49
Proteins content, %	13,29	13,46	13,12
Gluten, %	29,3	29,9	29,5
Acidity, %	2,4	2,5	2,4

Measurement of influence of consistency on bread
After baking we measured the volume, porosity, acidity of the bread, and were also carried out a sensorial analysis of bread obtained. The results are shown in table 4.

Table 4 Characteristics of bread obtain

Sample	Characteristics Measured	Dough with Normal Consistency	Dough with Soft Consistency (+10% water from hydration capacity)	Dough with Strong Consistency (-10% water from hydration capacity).
FA_1	**Volume**	305	320	290
	Porosity, %	79	82	73
	Acidity, degrees	2,7	2,9	2,6
	Sensorial Analyses	Taste and smell specific; uniform porosity	Taste and smell specific; uniform porosity	Taste and smell specific; brittle crumb
FA_2	**Volume**	290	275	263
	Porosity, %	73	75	70
	Acidity, degrees	2,5	2,7	2,4
	Sensorial Analyses	Taste and smell specific; uniform porosity	Taste and smell specific; uneven porosity	Taste and smell specific; brittle crumb
FA_3	**Volume**	320	308	304
	Porosity, %	76	79	75
	Acidity, degrees	2,5	2,6	2,3
	Sensorial Analyses	Taste and smell specific; uniform porosity	Taste and smell specific; uneven porosity	Taste and smell specific; brittle crumb

Figure 1 Dough with strong Consistency

Figure 2 Bread from dough with Normal Consistency

4. RESULTS AND DISCUSSION

The results are presented in graphic form.

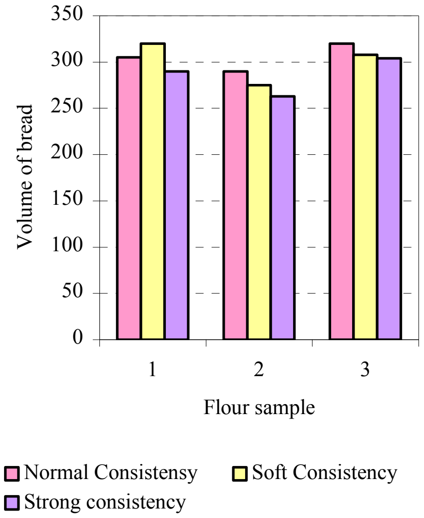

Figure 3 Influence of water added in dough on bread volume

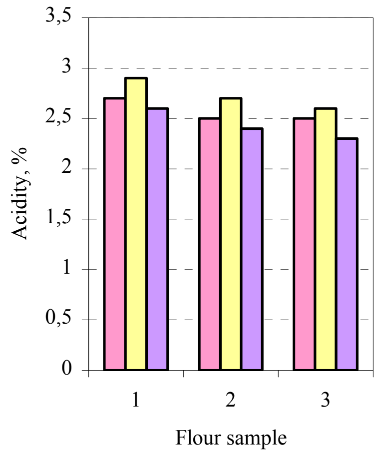

Figure 4 Influence of water added in dough on bread acidity

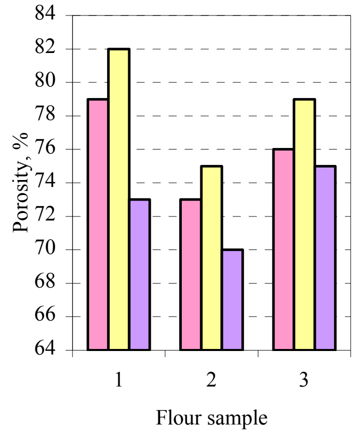

Figure 5 Influence of water added in dough on bread porosity

CONCLUSION

The result obtain under modification of dough consistency realized with added water with 10% to much than hydration capacity of flour, respectively with reducing with 10% of water content than hydration capacity, we can observe that the quantity of added water can influence the quality of the bread.

It has observed that for the bread obtain from flour FA_1 and FA_2 with grow of quantity of water comparatively with hydration capacity have a positive influence on volume and porosity of the bread. Insufficient amount of water on the dough has a negative influence on the bread.

The organoleptic points of view the bread obtained from all 3 types of flour with added water have suffered the same modification; the taste and smell were specific to the bread.

ACKNOWLEDGEMENT

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THE INFLUENCE OF KNEADING TIME ON BREAD DOUGH QUALITY

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Abstract: *Bread is the oldest and more important product made from flour. The information's regarding bread making is from the period of history when man first started to develop civilization. The quality of bread can be influence by a number of factors, like flour quality, production process, mixing and kneading time. In this paperwork was determinate the influence of kneading time on the sensorial qualities and on the other basic properties. Kneading times were varied from 2 to 20 minutes. The bread was obtained from two types of flour: wheat flour and rye flour.*

Key words: *kneading time, rye flour, sensorial qualities, kneading time.*

1. Introduction

Bread is a staple food prepared by baking dough of flour and water. It is popular around the world and is one of the world's oldest foods. One of the most important operations in the manufacturing process of bread is dough kneading.[4]

The main purpose of the kneading operations is to obtain a homogeneous mixture of the raw and auxiliary materials and at the same time obtain dough with viscous-elastic structure and properties. In addition, while kneading, in dough it is included a quantity of air, which is very important for rheological properties of the dough, and for the quality of the final product. During kneading frictional heat causes the rise of the dough temperature. To control the desired dough temperature the water temperature has to be adjusted. When the ingredients are thoroughly mixed and the gluten network is sufficiently elastic and extensible the dough is ready. When a piece of dough is stretched up to a thin film without breaking, it shows that the dough is ready for further operations. [1]

The order in which the ingredients are added is very important. It must ensure a good hydration of the dough's components, mainly of the protein in flour.

The formation of the dough with its specific structure and rheological properties occurs because of several processes such as physical, colloidal, biochemical, and the main role are being held by the physical and colloidal processes. [6]

The formation of dough and its rheological properties are influenced by some factors that are shown in Figure 1.

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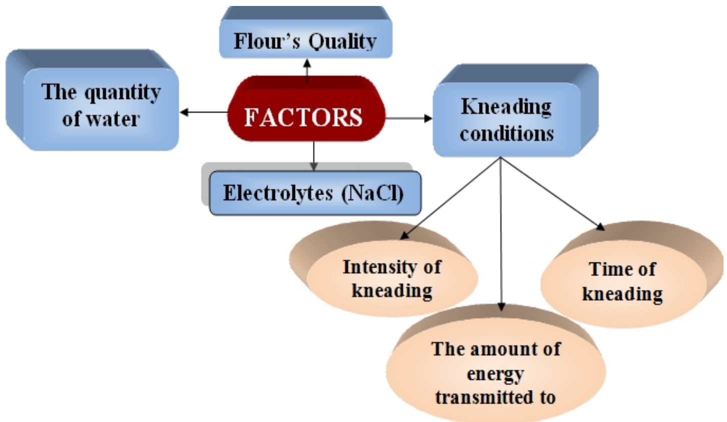

Fig.1. *Factors influencing the formation of dough*

The kneading conditions influence profound the properties of the dough and they can lead to an optimal growth, an incomplete development or to extra-kneaded dough.

The quality of flour influences the quality of the dough and also the bread quality. At the dough obtained from flour of poor quality, the protein pellicles are breaking easily, even before distributing them evenly in the dough. At the dough made from flour of good quality, the hydrated proteins are elastic and, when the dough is extra kneaded, protein pellicles have relatively only few breaks. This stability is one of the most important and desired characteristics of flours.[3]

Increasing water content in the dough is accompanied by the reduction of the elastic properties and viscosity of dough. A humidity of 44…50% does not modify the dough's structure, but exercises a plasticity effect.

Moisture content below 44% does not allow optimum gluten formation.

Electrolytes, especially salt (NaCl) addition changes the nature and intensity of hydrophobic interactions between the gluten proteins. Once with the addition of salt, the ionic force increases and this reduces the capacity of proteins to retain water. The end of kneading is appreciated through sensorial analyses. Well-kneaded dough should be homogeneous, tight, consistent, elastic and easy to come down from the mixer's arm and form the walls of the kneading container. When is tested manually, stretched between thumb and forefinger, the dough is must become a thin strip, transparent and flexible without breaking. [8]

Insufficiently kneaded dough is homogeneous, but sticky and viscous. Excessive kneaded dough is very extensible, without tenacity and is breaking at the manual test. [10]

2. Materials and method

For making the bread were used the following raw and auxiliary materials:

- Yeast
- Salt
- Water
- Wheat and rye flour

There were used tree types of flour, rye flour and two types of wheat flour: type "650" and type "000". The characteristics of all three types of flour are shown the in Table 1.

Characteristics of flour - raw material Table 1

CHARACTERISTICS	WHITE FLOUR type „650”	WHITE FLOUR type „000”	RYE FLOUR
Humidity [%]	14	14.5	14.5
Wheat gluten[%]	25.6	26	Doesn’t have gluten
Acidity	3	2.2	4.5

The bread was made with the follow raw and auxiliary materials characteristics:

- Wheat flour type “650”- 50%
- Wheat flour type “000”- 20%
- Rye flour- 30%
- Yeast - 3%
- Salt- 1.5%
- Water- 58%

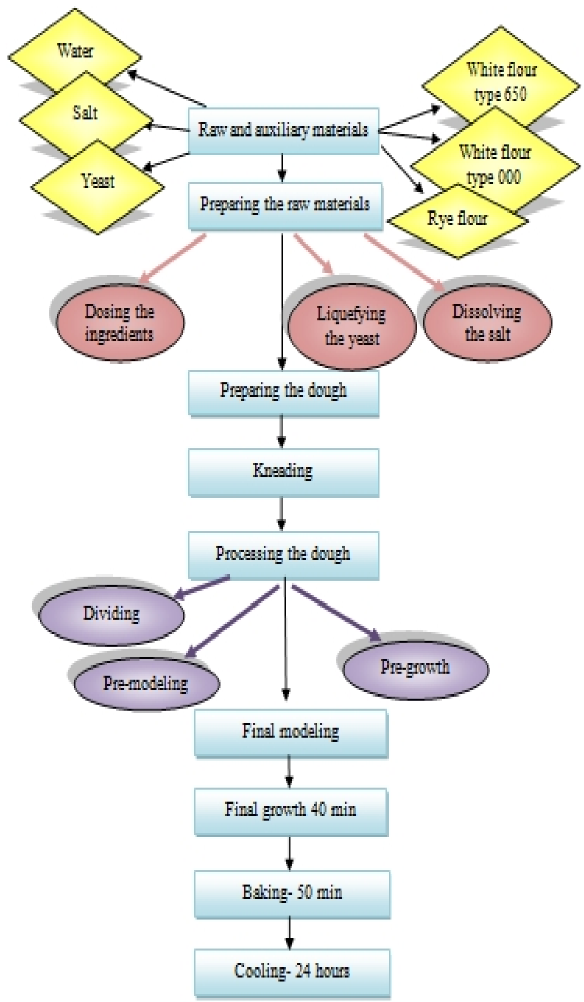

Fig. 2. *The operational program for obtaining the bread*

For the experiment, there were baked four loaves of bread, each following the same recipe. Same operator, in same laboratory and conditions, did the kneading manually. Fermentation and baking times are identical for all of the samples. The first sample was kneaded for two minutes after all the ingredients were incorporated.

The second sample was knead for 4 minutes, the third one eight minutes and the forth one 20 minutes. After being baked, the four loaves obtained were left to cool slowly for 24 hours and then were made the necessary analyses regarding the bread quality. The operational program for obtaining the bread is shown in Figure 2.

3. Results and discussions

After analyzing the results it was found that the kneading time of dough affects physical and chemical properties and the qualities of the finished product, bread. From sensorial analyze point of view, the four samples don't have any significant differences. Using the same recipe, there are no differences in taste or smell; the 4 loaves of bread have the same taste and smell. The color of the peel is white creamy, slightly browned, with a firm consistency. Baking time was identical for all four samples, about 50 minutes.

Determination of porosity Table 2

Kneading time	Cylinder weight with pores [g]	Cylinder weight without pores [g]	Porosity [%]	Standard Porosity [%]
2 min	54,6	59	52,68	Min. 65
4 min	50,0	54,2	56,53	
8 min	42,0	46	63,10	
20 min	52,3	56,8	54,44	

Comparing the results and given the fact that the bread is a semi, the porosity of the sample baked for two minutes is the smallest. On the other hand, the porosity of 8 minutes sample has the highest porosity.

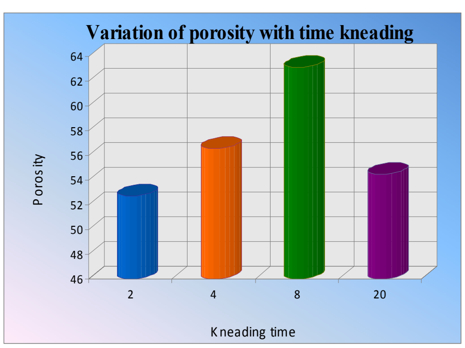

Fig. 3. *Variation of porosity*

Thus, one can say that the kneading time has a great influence on this feature. It is observed that, with increasing time of kneading the dough becomes more elastic, its properties tending to be identical to the properties of the dough which was kneaded for two minutes. This is confirmed by its porosity that reaches 54.44%. Compared with white bread, rye bread is denser, less porous due to the lack of gluten.

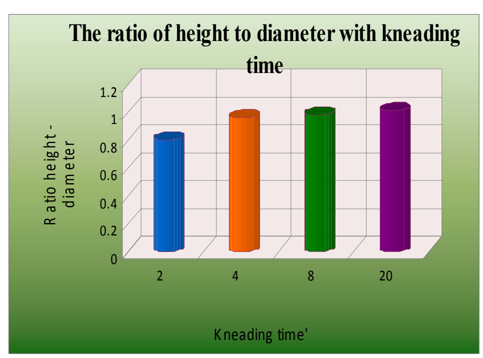

Fig. 4. *Ratio of height with diameter*

The ratio of height with diameter shows that the prolongation of kneading time leads to increasing the bread's volume. From these results, it can be observed a significant increase from 0.80 mm at the sample kneaded for 2 minutes up to 1.01 mm for the bread mixed for 20 minutes. Because it was obtained the highest test result for the bread mixed for 20 minutes, sample shows that with the prolongation of kneading time is increasing the height and the diameter of the bread.

Acidity Table 4

Kneading time [min]	Acidity	Standard Acidity
2	1,8	Max.5
4	1,6	
8	1,6	
20	1,6	

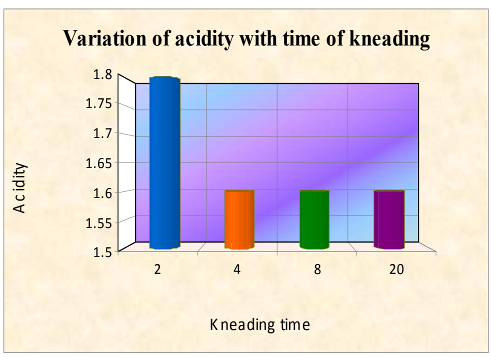

Fig. 5. *Variation of acidity*

The acidity determination reveals a constant value for samples 2, 3, 4. For the bread mixed two minutes, the acidity is higher, but falls within acceptable limits, the maximum acidity being 5 °T.

Moisture values for all four samples fall within the standard 42%. The highest value was found for bread mixed 2 minutes, 38%, for samples of 4 and 20 minutes was obtained a constant value of 36%.

Humidity Table 5

Kneading time [min]	Humidity %	Standard Humidity %
2	38	Max.42
4	36	
8	34	
20	36	

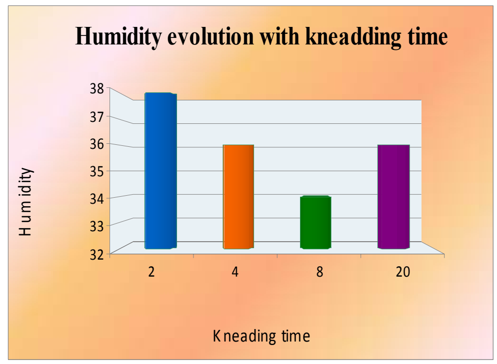

Fig. 6. *Humidity evolution*

The bread kneaded 8 minutes has the lowest humidity 34%, taking into account that we used the same amount of bread core.

Conclusions

1. Bread is a staple food prepared by cooking dough of flour and water and often additional ingredients. Dough is usually baked, but in some cuisines breads are steamed, fried, or baked on a frying pan (e.g., tortillas).
2. All the operations that are done to the dough are very important and influence a lot its growth and so the final product.
3. The preparation method influences greatly the quality characteristics of the finished product, so we see that by diminishing the kneading time, the bread obtained has specific sensorial characteristics but lower quality index.

4. Increasing water content in the dough is accompanied by the reduction of the elastic properties and viscosity of dough.
5. Well-kneaded dough should be homogeneous, tight, consistent, elastic and easy to come down from the mixer's arm and form the walls of the kneading container.
6. The best results were obtained for the bread that was mixed 8 minutes. Comparing white bread and rye bread, we see major differences in terms of quality characteristics.
7. The rye bread is a dense one, with low porosity, with a smaller volume compared with white bread, with a slightly sour taste, with a hard crust, but with important nutritional intake.
8. The caloric intake of rye bread is lower than ordinary bread: 210 calories/100 g, compared with 280 calories/100 g in white bread. The rye bread, unlike white bread is richer in B vitamins, minerals and fiber that are important for the body.

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A NOVEL APPROACH FOR A HEALTHY LIFESTYLE – DIETARY FIBER AS A FUNCTIONAL INGREDIENT IN BREADMAKING

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Mirabela I. LUPU[1] Adrian MĂZĂREL[1]
Carmen L. BĂDĂRĂU[1]

Abstract: *The importance of fiber in nutrition is an intensely discussed aspect over time. Food fibers are the fraction of the plant's edible part or extracts that are resistant to digestion and absorption by supporting one or more physiologically beneficial effects. Fiber offers a variety of health benefits and is essential for reducing the risk of developing chronic diseases. The purpose of this paper is to study the influence of the addition of fiber derived from vegetable sources in the mass of the product on the properties of the finished product, to define a recipe for creating a product appreciated as a functional food and an optimal procedure in order to obtain the desired results, to determine the optimal quantity of plant matter to be introduced into the product mass in order to confer the proper features and to obtain a product that posses a content of food fibers as high as is possible.*

Key words: *fiber, cranberry, apple peel, breadmaking, health.*

1. Introduction

In the current context, it is generally accepted the fact that a daily consumption of fruits, vegetables, cereals or products obtained by processing it has a beneficial effect on the health of the consumer. Taking into account the nutritional aspect, fiber-rich foods reflect the bivalent - energy and nutritional profile of the raw materials from which it is obtained. In order to satisfy this purpose, have been created food products that are able to provide the daily fiber requirements and generate the desired effects during consumption.

Nowadays, the preference and interest in consuming products with implicit benefits for body health has been drawing the producers interest in using ingredients with specific and well-defined functions.

It is currently well-known and generally accepted that bread and bakery products in various forms cover the nutritional needs of the body and their consumption has a beneficial effect on the health of the population.

According to current considerations,

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food fibers are described as ingredients with specific functions in the production of foods with a defined role for consumers health. Because of the fiber structure that gives them double properties - to be soluble and insoluble, they have the technological ability to gel, link hydrophilic structures, create structures, and can be used as a substitute for fat [2].

Thus, the consumer's tendency to create a lifestyle adapted to physiological and nutritional needs has been observed, considering this perspective as the most appropriate way to prevent cardiovascular, circulatory, or digestive diseases [4].

In order to support this category of consumers there is a continuous attempt to capitalize on the curative and preventive properties of fruits and vegetables. Due to the easy access and wide variation of the plant fiber sources, there have been made several studies and have been highlighted their beneficial character [7].

The current study focuses on the highlighting the nutritional benefits of two fruits belonging to the cultivated flora - Malus Domestica and spontaneous - the cranberry (Vaccinium Oxycoccos) of the country, that were used in terms of food fiber intake.

An important aspect of the chemical composition of apple and cranberry is the ratio of the fiber content found in the core and the peel of the fruit, the peel having the highest proportion of fiber content [3].

Unlike the fiber content of cereals, in the apple peel there is a high percentage of soluble fiber fractions due to the high amount of pectin polymer. In relation to the fiber content of the apple taken as a whole, pulp and peel, it was found that the highest proportion of food fiber is found in the peel - 0.91% of which 0.46% is insoluble fiber and 0.43% being soluble fiber. The cranberry is defined by 65.47% fiber content, of which 60.34% are insoluble fibers, and 5.15% are soluble fibers. The exciting chemical composition of the cranberry classifies it among multi-valent fruit primarily due to high fiber intake, increased antioxidant content and the predominance of vitamins A, E and K.

The best option to enrich food nutritional quality by adding food fibers is adding fiber-rich vegetable matter to the product's composition - fruit fractions - apple peel and cranberry in various forms - raw or dehydrated [4].

In this way, the technological process does not undergo significant changes, the fiber intake is rigorously controlled and the organoleptic impact of the consumer is not so significant, being much more easier to accept a product determined by a white background than a product with a color which can be associated in a negative way by the consumer [5].

A high rate of use in baking have the insoluble fibers - cellulose and lignin, which are abundant in apple and cranberry. Fibers are used in a proportion of 5-35% related to the processed flour, depending on the desired fiber content of the bread.

2. Materials and Methods

For the obtaining of bakery products with addition of food fibers were used as raw materials: wheat flour type 650, yeast culture, sugar, food fibers (apple peel, raw cranberry and dehydrated cranberry), salt, water.

In order to create the intended bread types, a series of samples were made, weighting 300 g where the proportion of added cranberry was varied from 10% to 30% and in case of bread with apple peel, the addition was made with a proportion of 30% shell. In order to perform a comparative analysis, a blank sample was obtained without fiber addition.

The research then focused on the dough preparation stage, manually performed, by the biphasic indirect method. In advance, has been obtained the sourdough starter – fermentation leaven. Yeast, water and flour were used to obtain the leaven, resulting a sticky liquid, with easily constituting consistency in the dough mass.

The organoleptic analysis of the raw materials - flour was carried out in accordance with the provisions of SR 90-88. After performing the analysis, the values obtained for the flour as raw material, it was found that it fits to the provisions of the standard, the values obtained complying with the provisions of the standards (humidity 14.6% - this quality index is important because it has a significant impact on the bread process and the efficiency of the process). Being a product with high hygroscopicity degree, flour changes its relative humidity, depending on the storage conditions parameters.

Deterination of acidity was performed according to SR 90:2007 by the water suspension method in order to determine the amount of 0.1 N sodium hydroxide necessary to neutralize flour acidity, by reference to 100 g of the sample to be analyzed. The result obtained was 2.73 °T, a value accepted by standards.

Determination of wet gluten content was carried out according to the method indicated by SR EN ISO 21415-1 and SR EN ISO 21415-2 by washing the dough sample obtained by addition of flour to be analyzed with a 2% salt solution followed by the washing of the gluten obtained until dryness. The value obtained was 31.9%, the value exceeding the minimum acceptability limit set by the standard, of 26%.

Determination of the hydration capacity was determined in order to establish the optimal amount of water required to form dough of normal consistency, under the established conditions, according to STAS 90-88. The result was 68.9%, a value above the lower limit set by the current standard - 60%.

By analysing the results of the bakery indices of the flour used in comparison with the values provided by the standards, it is observed that the flour meets the required quality requirements, within the ranges stipulated by the standards. This will also be reflected in the quality indices of the finished product, influencing its characteristics.

Cranberry is well known for its antioxidant and nutritional properties. In this experimental research, the cranberries were used with the purpose of highlighting their potential in order to obtain new products with improved nutritional properties.

The chemical composition of cranberry is given by the nutrient content (fiber, manganese, vitamin C, vitamin E, copper, pantothenic acid, vitamin K), phytonutrients (phenolic acid, proanthocyanidins, anthocyanins, flavonoids, triterpenoids), acids (citric acid, malic acid, quinonic acid), sugars, water, as well as the traces of metals found in its structure.

While ordinary nutrients such as vitamin C and fiber play a very important role concerning the health benefits of cranberry. Taking into account this perspective, it is interesting to draw attention on the grouping of phytonutrients, a group that has an important role in contemporary nutrition.

The fiber – rich chemical composition of the apple was also emphasized in this study, with a particular appreciation of the peel of the apple, considered to be the most important part of the fruit according to the chemical composition, where the largest amount of food fibers resides, related to the other anatomical parts of the fruit (2.1 g of fiber / 100 g peel).

3. Results and Discussions

The purpose of the experimental research was to create bakery products with high fiber content derived from vegatable sources.

After obtaining the samples, with cranberry addition in various proportions, apple peel in proportion of 30% and the blank sample, the organoleptic appreciation (Table 1) of the bread quality was performed using the scoring scheme (Figure 1).

Analyzing the information in the chart represented in Figure 1, it is easily observed how P1 and P4 obtained an equal score to PM, being the best organoleptically appreciated sample by the evaluators. In contrast, P1 scored a lower score of 26 points and P3 was rated as the most unsatisfactory from the consumer point of view, being quantified with a value of 24 points. Analyzing the values attributed to each product, it can be said that the addition of apple and cranberry in the analyzed samples was appreciated positively from the point of view of the consumer's acceptance.

The addition of vegetable origin fiber - 10% cranberry, determines a number of changes that affect the qualitative properties of the finished product. The most significant effect observed through the addition of fiber in bread dough is revealed in terms of volume and porosity (Figures 2-5), with a decrease in bread volume compared to the blank sample. Porosity also registered a lower value - 71.9%, compared to the blank sample whose porosity was 74% (Table 2).

Organoleptic evaluation of samples Table 1

Sample coding	Maximum value	Score awarded
PM	30	28
P1	30	26
P2	30	28
P3	30	24
P4	30	28

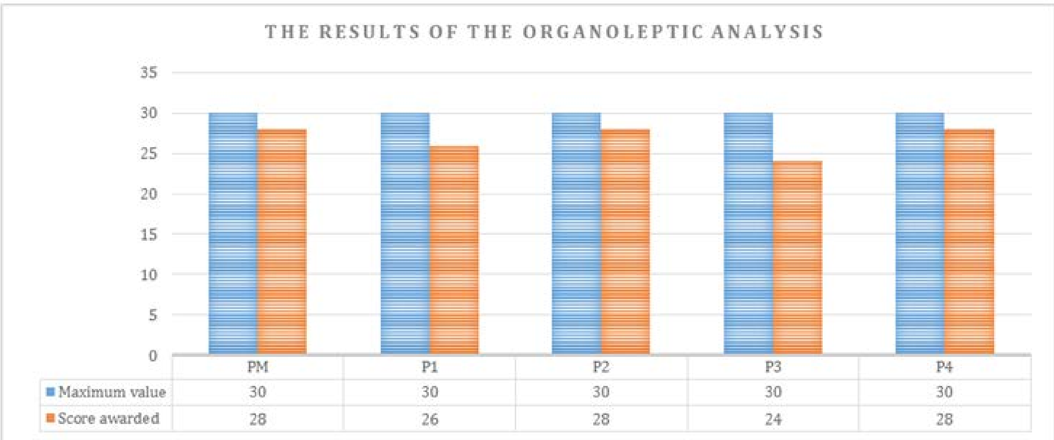

Fig. 1. *The organoleptic evaluation of bread samples*

Physico – chemical analysis of bread samples Table 2

Sample coding	Determined parameter		
	Volume [cm^3]	Porosity [%]	Moisture of crumb [%]
PM	285,5	71,9	43,7
P1	288,5	72,7	44,2
P2	288	72,7	44,2
P3	287,3	72,5	43,3
P4	297,1	74	43,1

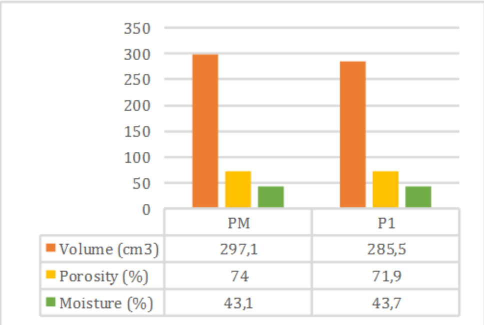

Fig. 2. *Analysis of volume, porosity and humidity of sample with 20% cranberry addition compared to blank sample*

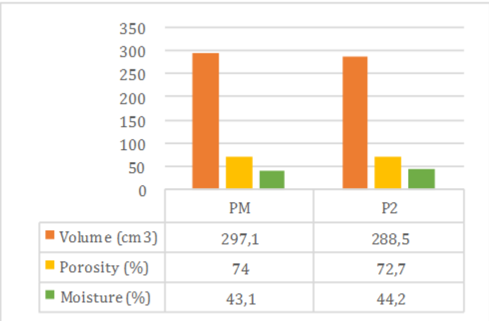

Fig. 3. *Analysis of volume, porosity and humidity of sample with 10% cranberry addition compared to blank sample*

This is due to the introduction of food fibers into the dough mass, their mass affects the pore distribution and decreases the volume.

The humidity of the core is a quality of bread quality. It can be seen that the addition of fibers did not cause unwanted changes in the humidity of the bread crumb, keeping it within the limits accepted by the standard and close to the ones quantified in the case of the blank sample taken as a reference.

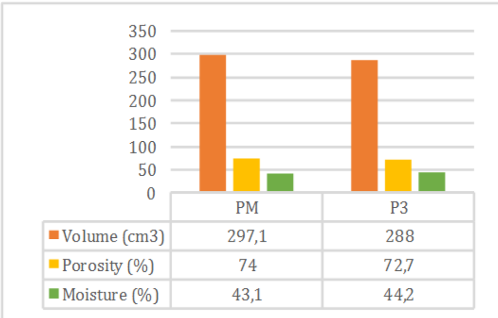

Fig. 4. *Analysis of volume, porosity and humidity of sample with 30% cranberry addition compared to blank sample*

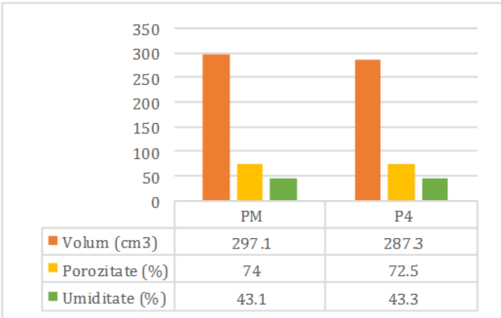

Fig. 5. *Analysis of volume, porosity and humidity of sample with 30% cranberry addition compared to blank sample*

Unlike P1, P2 recorded porosity and humidity values close to those obtained for samples with less fiber. Thus, it can be argued that increasing the amount of fiber added to the dough mass does not significantly alter the physicochemical properties of the product.

Remarkable for P2 is that the moisture percentage of the core has increased from 43.7% for P1 to 44.2% (Table 2), which indicates the fact that the addition of cranberry required the increase of this parameter by the specific humidity of the fruit.

Comparing with previous samples, P3 suffered an almost insignificant decrease in volume, resulting in a value of 288 cm^3 (Table 2). The two parameters simultaneous analyzed determined values equal to those obtained for the other samples. The change in volume is directly proportional to the amount of cranberry added. As the amount increases, the lower the volume, due to the cranberry mass, which causes a decrease in the absorption of the fermentation gases by the flour.

Regarding the addition of 30% apple peel fiber (Figure 6), it can be seen how the volume has decreased slightly compared to the blank sample, but has also recorded an approximate value to that obtained with the addition of cranberry in varying amounts (Figures 7 and 8), indicating that the addition of apple peel does not cause the product volume to be affected.

In case of porosity, a decrease in the value obtained was observed, below the minimum value mentioned in the standard.

Fig. 6. *Apple peel bread 30%*

Fig. 7. *Bread with cranberry addition*

Fig. 8. *Bread with cranberry addiction in different proportions*

This value is justified by the fact that the addition of shredded apple pell interacts with gluten structures, preventing the development of proper porosity.

Following the variation of moisture during baking, it has been observed that the dough containing apple peel fiber increases its moisture percentage compared with the blank sample, this fact due to the percentage of moisture naturally occurring in the chemical composition of the apple peel, which gives the finished product a higher moisture content.

By analyzing the previous graphs, we can see how P2 has the most developed volume and with the increase of the amount of added fiber, the volume of bread is reduced. The addition of fibers from different sources, in varying proportions, has been shown to have an essential influence on the quality of the products obtained. Following the addition of fibers in varying proportions, an improvement in organoleptic properties - taste and smell - was observed, while the volume was diminished as the amount of fiber introduced increased.

Also, the quality of the product diminishes once the amount of fiber increases, the best results being obtained by the addition of 20% fiber.

Failure to comply with the standard in the case of cranberry and apple peel addition in bread dough is not a negative aspect, due to the fact that the addition of cranberry and apple peel has the property to give the product their own properties.

Due to the fact that this is a new product, the standard does not contain clear provisions regarding the values to be respected, so the reporting is made by referring to the values provided for the products already existing.

4. Conclusions

The main objective of the experimental research was to obtain bakery products with improved nutritional properties by the addition of Vaccinium oxycoccos, known as cranberry, as well as Malus domestica, the common apple.

After studying the properties of cranberries and apple as a whole and its fractions, it was decided to use them as an ingredient for obtaining new assortments of bread classified as functional foods, highlighting the intake of dietary fiber brought with its introduction into the consistency of the new product.

The use of food fibers in order to obtain a range of bakery products in various proportions (10%, 20% and 30%) is remarkable by giving effects on the properties of the obtained dough mass and the finished product obtained after heat treatment. Thereby, it has been observed that the introduction of fibrous matter into the mass of the products reduces the bread volume.

As a result of the addition of fibers to the kneaded dough mass, an increase in the amount of water absorbed by the dough has been observed, indicating that the fibers can support the hydration of the dough, which is considered to be a beneficial element for production. Another beneficial implication of the water absorption capacity of the food fibers is that it can provide the product pleasant organoleptic characteristics. The bread obtained showed organoleptic properties similar to those for acidic bread, product that is increasingly prevalent in consumer preferences.

Also, due to the high acidity rate of the added cranberries, the acidity has been developed on the whole product. An acidic environment is inappropriate for the development of microorganisms in the product mass, which contributes to its rating as a product with a high degree of perishability, giving it pleasant organoleptic properties over a longer period of time compared to existing products in the same category.

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VALORIZATION OF COMMON BEAN (*PHASEOLUS VULGARIS* L.) BY-PRODUCTS TO OBTAIN NEW BAKERY PRODUCTS

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ABSTRACT

Disposal of by-products from the processing of plant foods is a major industry concern, but these by-products are also promising sources of compounds with technological or nutritional properties and are now being considered as a possible source of functional compounds. The common bean (*Phaseolus vulgaris* L.), which contains a high protein content, fiber, and other critical minerals for humans, is one of the most significant pulses in the world. The objective of this work is to exploit the properties of common bean (*Phaseolus vulgaris* L.) by-products by including them in powder form in new bread products, in order to improve their properties. Empty common bean (*Phaseolus vulgaris* L.) pods were dried, mild and incorporated with different levels (5%, 10% and 15%) into dough and breads made from wheat white flour. The moisture content decreased in proportion to the amount of wheat flour substituted. Analysis of the bread showed that the addition of empty bean pod powder did not significantly improve the textural profile of the bread. In fact, there was an increase in hardness (1011.26 N/mm^2 for the control and 1027.38 N/mm^2 for the breads enriched with 15% powder, respectively). The pH and porosity also increased in proportion to the amount of wheat flour substituted. Regarding the sensory analysis, the breads obtained with different proportions of vegetable waste powder additions were liked by several categories of people and were noted with high scores. To conclude, the powders obtained from vegetable by-products can be used as functional compounds and can partially replace the wheat flour added to make bread.

Keywords: by-products, empty common bean (*Phaseolus vulgaris* L.) pods, bakery products

INTRODUCTION

One of the key strategies for reducing food waste is to recover and convert it for human use. The disposal of by-products from the processing of plant foods can be managed in several eco-friendly ways such as: composting (this process can convert organic waste into nutrient-rich fertilizer; it reduces waste volume, kills pathogens, decreases weed germination in agricultural fields, and destroys malodorous compounds) [1], anaerobic digestion (organic matter such as food or plant waste is broken down by micro-organisms in the absence of oxygen; this process creates biogas, which can be used as a source of energy, and a bio-fertilizer by-product) [2], recycling/reusing (waste can be recycled or reused for utilization by other industries; for example, food waste created during the

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production process can be turned into animal feed) [1], [3], or feeding surplus food to needy people (surplus food can be donated to those in need) [4]. These methods not only help in managing waste but also contribute to environmental sustainability. They can be applied to various types of plant food processing by-products such as pomace from fruit and vegetable processing, hull/bran from grain milling, meal/cake from oil extraction, bagasse from sugar processing, and brewer's spent grain from brewing.

Common bean (Phaseolus vulgaris L.) is a nutritious legume that contains proteins, carbohydrates, dietary fibre, minerals, antioxidants, and bioactive compounds [5]–[7]. Common bean by-products, such as hulls, pods, and seeds, are usually discarded or used as animal feed, but they can also be a source of functional compounds, such as phenolic acids, flavonoids, anthocyanins, and phytosterols [8]. Functional compounds are substances that have beneficial effects on human health beyond basic nutrition, such as reducing the risk of chronic diseases, modulating physiological functions, and enhancing well-being [5]. Common bean by-products can be processed into various forms, such as flours, extracts, concentrates, and isolates, and incorporated into food products for sportspeople, such as bars, drinks, and supplements, to enhance their nutritional and functional properties [7].

Bread enriched with by-products from the food industry is often referred to as "functional bread". The incorporation of these by-products can enhance the nutritional value of the bread and reduce food waste [9], [10]. For instance, a study investigated the combined effect of carob pod flour, sugar beet fibers, and molasses on dough rheology and bread quality. The presence of high share of dietary fibers increased dough resistance to extension and reduced dough extensibility. The addition of molasses had a positive effect on bread quality. Moreover, carob flour increased the content of polyphenols and antioxidant capacity [11].

The objective of this work is to exploit the properties of common bean (*Phaseolus vulgaris* L.) by-products by including them in powder form in new bread products, in order to improve their properties.

MATERIALS AND METHODS

The commercial wheat white flour type 650 (fat: 1.8%; carbohydrates: 68.2%; protein: 11.1%; dietary fiber: 4.5%) was provided by a local supplier. Type 650 flour is the least refined, so it retains most of its nutritional properties. In addition, this type of flour has a greater amount of protein, which is necessary for the development of gluten, so it also has a higher gluten content, which is ideal for elastic doughs. The ingredients for the bread - iodized salt, dry yeast - were purchased at a nearby market. The national water distribution system provided the tap water used.

After being dehydrated for 12 hours at 40 degrees Celsius in the multitray dryer Klarstein, the empty common bean (Phaseolus vulgaris L.) pods (BP) were shred using the Thermomix TM5 food processor and then divided into size classes using the Analysett 3 Spartan sieves. To create the mixtures, the percentage with particles smaller than 20 nm was employed.

The breads were made by varying the amount of empty bean (Phaseolus vulgaris L.) pods powder (BPP) added to wheat flour in proportions of 5%, 10% and 15% (w/w). A control sample (CB) was also prepared without the addition of BPP. Thus, four loaves of bread formulations were prepared. The recipe of the control sample consists of 500 g of wheat flour, 12.5 g of salt, 15 g of compressed yeast and the amount of water needed to form a dough with optimal characteristics. In bread recipes with added BPP, the wheat flour was replaced by a mixture of wheat flour and 25 g of empty bean pods powder, 50 g and 75 g, respectively. The coding of the bread samples is shown in Table 1.

Table 1 Sample coding

Type	Coding	Wheat flour (g)	BPP (g)
Control sample	CB	500	-
Sample with 5% BPP	BBPP5	475	25
Sample with 10% BPP	BBPP10	450	50
Sample with 15% BPP	BBPP15	425	75

*Empty bean (Phaseolus vulgaris L.) pods powder (BPP)

The dough was made with a KitchenAid Artisan 5KSM7580XEER laboratory mixer. To construct and thoroughly develop the gluten network, all constituents were dosed correctly and mixed for 10 min minutes at 200 RPM. After that, the dough was allowed to ferment for sixty minutes. Following a sixty-minute period, the dough was lightly mixed for thirty seconds before being hand divided into pieces weighing 250g±5g.

The samples were formed, placed into 600 cm^3 rectangular baking molds, and allowed to finish leavening for 30 minutes at 37 degrees Celsius. The Wirlpool 6 scence convection oven was used for baking, and the loaves of bread were baked for 30 minutes at 220 ºC. The breads were weighed and cooled to room temperature before before measuring all parameters. After cooling, the loaves were placed in special bread packaging and stored at 20ºC prior to testing.

The gravimetric method described in ISO 712:2009 [12] was used to determine the moisture content of bread samples. The samples were dried in a drying oven at 130 °C until a constant weight was reached. Samples were weighed in 5 g using an analytical balance into a weighing vial. The weight percentage (%) was used to report the results.

Texture parameters: the mechanical properties of bread were subjected to a double compression cycle using Zwick-Roell Z005 (Zwick, Ulm-Einsingen, Germany). The crumb cubes were subjected to a maximum load of 500 N, 50% penetration depth using a 40 mm diameter probe, and a 20 s interval between cycles. Firmness, or the maximum degree of force during the first compression (N/mm^2), and the deformation (mm) were the parameters analyzed. Measurements were taken 24 hours after baking [13].

pH of the samples was measured using a HALO2 (Hanna Instruments, Inc.) pH-meter. Samples of length, width, and height measuring 1.5 x 1.5 x 1.5 cm from the geometric center of the crumb were obtained for each type of bread in order to determine the porosity [13]. Helium was used as the displacement fluid for the gas pycnometer (Stereopycnometer SPY-3, Quantachrome, Syosset, N.Y., USA) in order to estimate the volume of solids (V_S, m^3). The formula for expressing the solid density (kg/m^3), which is the ratio of dry solids' mass to volume, is as follows: $\rho_s = m_s/V_s$. The following formula was used to estimate the bulk density from the measurement of the real geometrical properties of the bead sample: $\rho_b = m_s/V_b$. The porosity was calculated from the following equation: P (%) =1- ρ_s/ρ_b.

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40 panelists aged 18-60 assessed the organoleptic properties of breads by rating each item on a ten-point hedonic scale for crust color, crumb color, elasticity, porosity, flavor, taste, aftertaste, attractiveness, general acceptability.

Each bread sample was tested in triplicate, and the results were gathered from three separate tests. All data are shown as three-replicate averages, followed by the standard deviation (SD). The significance of mean differences was assessed using one-way ANOVA [14]. Tukey's test (p 0.05) was used to compare mean differences.

RESULTS AND DISCUSSION

The determinations carried out on all the samples of bread gave a series of results which are summarized in Table 2.

Table 2

Sample	Moisture content [%]	Firmness [N/mm^2]	Deformation [mm]	pH	Porosity [%]
CB	38.7±0.9	1011.26±2.07	9.25±0.08	5.55±0.09	73.1±0.02
BBPP5	37.9±0.82	1022.64±1.99	10.27±0.24	5.61±0.11	75.0±0.09
BBPP10	37.6±0.65	1025.43±1.54	10.76±0.31	5.87±0.05	76.3±0.09
BBPP15	37.1±0.32	1027.38±1.23	11.02±0.28	6.02±0.03	77.4±0.08

* Control sample (CB); Bread with 5% empty bean pods powder (BBPP5); Bread with 10% empty bean pods powder (BBPP10); Bread with 15% empty bean pods powder (BBPP15).

From the analysis of the data in the table above, it can be seen that the moisture content of the samples obtained with different percentages of empty bean pod powder additions was significantly lower compared to the control sample. Thus, the lowest value of moisture content, 4.13% lower than the control sample, was obtained for the sample with 75 g of empty bean pod powder added. The following samples were 2.84% (50 g sample) and 2.07% (25 g sample) less than the control sample. All the percentages of the additions used influenced the moisture retention capacity of the samples obtained, their character being reflected in the results obtained.

The textural features of the loaves of bread are critical for achieving consumer approval. During mastication, the brain assesses the physical characteristics of the food and evaluates its texture. Food texture has a significant impact on consumer like and preference for a food product [15]. Analyzing the figures from the graph in Figure 1, it is clear that the values required to achieve maximum force during initial compression (measured in N/mm2) follow a fairly comparable pattern.

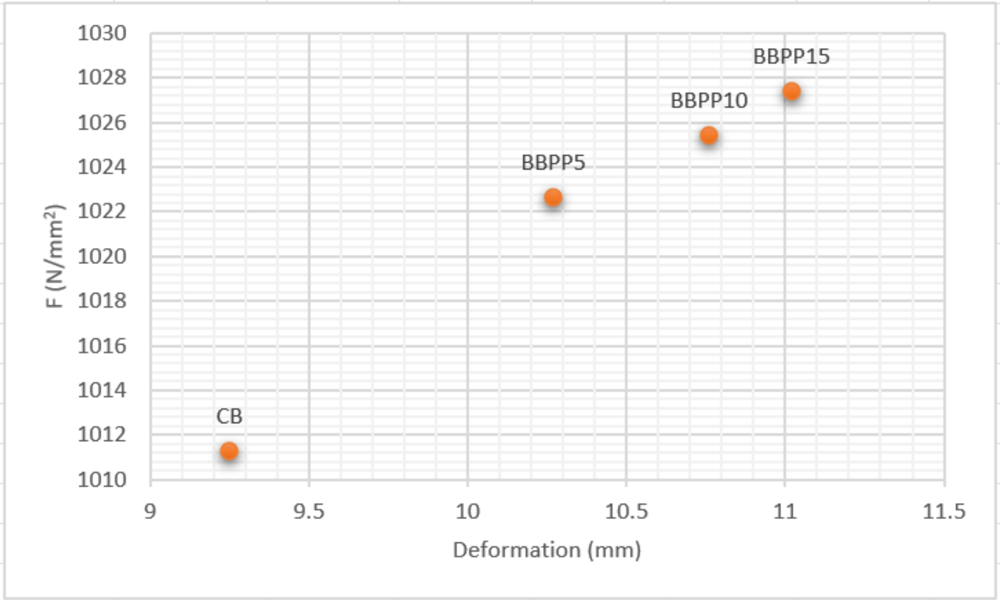

Figure 1 Firmness of the bread samples. Control sample (CB); Bread with 5% empty bean pods powder (BBPP5); Bread with 10% empty bean pods powder (BBPP10); Bread with 15% empty bean pods powder (BBPP15).

The differences were observed for maximum degree of force during the first compression (N/mm^2), the highest value being recorded for sample with the higher amount of empty bean pods powder added – BBPP15 with 15% of empty bean pods powder. The lowest value of the maximum degree of force was recorded for sample containing 5% empty bean pods powder – BBPP15, comparing to the control sample, where the maximum degree of force was lower. The maximum degree of force during the first compression of bread samples with empty bean pod powder added increased by 1.13%, 1.40% and 1.59%, respectively, compared to the control sample. Thus, the results showed that the addition of empty bean pod powder at different proportions of 5 - 15% did not significantly affect the textural profile of the bread.

From the analysis of the data obtained after determining the pH of the samples, it can be seen that the sample with the highest pH was sample BBPP15, with the highest amount of empty bean pod powder - 15%. Moreover, the addition of the three powder components led to high pH values, the bioactive compounds contained in them influencing the values obtained. Compared to the control sample, which has a pH of 5.55, the value obtained in the samples with the addition of 5% of powder from empty bean pods was not significantly different, but the other samples prepared with the addition of 10% and 15%, respectively, were significantly different, which supports the conclusion that the addition of powder from empty bean pods has a definitive effect on the pH of the samples.

After analyzing the data, we saw that the porosity changed according to the amount of BPP added. The higher the dosage of BPP, the more the volume of the bread developed, the larger the pores, and the less the elasticity in the center. Compared to the control sample with a porosity of 73.1%, the samples containing empty bean pod powder exhibited significant variations in porosity. The porosity values were higher by 2.6%, 4.38%, and 5.88%, depending on the amount of powder added. We appreciate that incorporating powders sourced from vegetable waste yielded a positive impact on the results obtained through the porosity's physico-chemical analysis.

Figure 2 shows the sensory attributes of bread samples with varying percentages of empty bean pod powder, including crust color, crumb color, elasticity, porosity, flavor, taste, aftertaste, attractiveness, general acceptability.

Figure 2 Sensory analysis of the bread samples. Control sample (CB); Bread with 5% empty bean pods powder (BBPP5); Bread with 10% empty bean pods powder (BBPP10); Bread with 15% empty bean pods powder (BBPP15).

The bread with medium BBPP5 empty bean pods powder, to which 5% powder was added, received the highest mean score of 10.00 out of 10, indicating its preference among customers due to its distinctive characteristics. This finding implies that consumers prefer a lower amount of empty bean pods powder in their bread. On the other hand, samples with 15% powder additions were given a lower score of 8.56 points and rejected. The sample BBPP10, which had 10% empty bean pods powder added, received a rating of 9.22 points, slightly lower than the control sample which received 9.89 points.

CONCLUSION

When compared to the control sample, the samples that had varying amounts of empty bean pod powder added to them had substantially less moisture content. The moisture retention capacity of the samples was affected by all of the addition percentages utilized, and the character of the samples was represented in the outcomes. Our results revealed the texture profile of the bread was not considerably altered by the addition of empty bean pod powder in various amounts between 5 and 15%. Moreover, the addition of powder from empty bean pods has a definitive effect on the pH of the samples. In the same time, the porosity changed according to the amount of BPP added. The higher the dosage of BPP, the more the volume of the bread developed, the larger the pores, and the less the elasticity in the center. Sensory analysis shows that consumers might prefer a lower amount of empty bean pods powder in their bread. To conclude, the powders obtained from vegetable by-products can be used as functional compounds and can partially replace the wheat flour added to make bread.

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VALORISATION OF GRAPE MARC BY-PRODUCTS IN BEVERAGE INDUSTRY: THE CASE OF FORTIFIED GRAPE JUICE

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ABSTRACT

The difficulty facing the food industry in the future is sustainability, a topic that has received a lot of attention in recent years. The recovery, recycling, and valuing of food by-products is one of the many methods suggested to encourage the development of a sustainable food system. The most abundant sources of bioactive chemicals and by-products that can be used to create new functional ingredients for foods are found in fruits and vegetables. In this paper, the possibility of using by-products of wine industry was evaluated. Grape marc, one of the wastes produced during wine-making process is typically not utilized. In particular, the red grape marc flour (15% and 20% w/w) was employed to enrich white grape juice following a sufficient drying and grinding procedure. Then, the grape juice fortified with red grape marc flour was subjected to ultrasound treatment with amplitude of 50 and 70% for 3 and 6 minutes. In comparison to control samples, the enriched products bioactive compounds and chromatic attributes, as well as acidity, soluble content and pH were assessed. Overall, the findings indicate that fortification of grape juice with by-products improved nutritional quality and chromatic attributes without compromising product acceptability. It is possible to conclude that these examples might serve as a starting point for utilizing industrial by-products and developing viable food with beneficial properties in a more sustainable manner.

Keywords: sustainability, by-products, grape marc, bioactive compounds

INTRODUCTION

Nowadays, scientists are encouraged to devote significant effort to the pursuit of renewable energy sources for product manufacturing. One of the main goals is to develop strategies and policies for sustainable growth based on the efficient use of natural resources. The recovery, recycling, and valuing of food by-products is one of the

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many methods suggested to encourage the development of a sustainable food system [1]. The most abundant sources of bioactive chemicals and by-products that can be used to create new functional ingredients for foods are found in fruits and vegetables.

The consumption of fruit juice from concentrate has declined over the past five years in the EU, but the consumption of non-concentrate juice has climbed, according to the last data presented by European Fruit Juice Association (AIJN) [2].

Among the world's food industries, the winemaking sector is one of the most important. The winemaking process generate a large number of residues. Among these by-products, the grape marc obtained after the pressing stage constitute the majority (around 20%) of the waste generated by the winemaking industry. Extensive research on the valorization of grape marc as a source of valuable bioactive compounds, in particular antioxidant compounds to be used in the production of functional foods has become available in recent years. Grape marc is made up of seeds (38–52%), skin (38–52%), and residual pulp and steems, seeds and skin particularly rich in a wide range of polyphenols that have beneficial effects on human health [3].

There are some traditional solvent extraction methods for recovering polyphenols from wine by-products. But currently there are emerging alternatives, among which ultrasound assisted extraction, that can increase extraction efficiency by lowering solvent consumption, process temperature, and extraction time [4].

The purpose of this study was to investigate the possibility of using wine industry by-products, specifically red grape marc, for the development of functional food products enriched in bioactive compounds extracted using high-power ultrasound treatment, by incorporating grape marc flour into the manufacturing recipe of grape juice in order to exploit its functional potential.

MATERIALS AND METHODS

Grapes were supplied by Pietroasa Development Research Centre for Viticulture and Wine-making, located in Dealu Mare vineyard, Romania. The variety used for grape juice was Riesling and the variety used to obtain grape marc was Merlot. The grapes used for juice were destemmed, crushed, pressed and then centrifuged. The grape marc was collected at the end of red wine making process, dried using a dryer for vegetables and fruits at a temperature of 53° C for 4 hours, and then ground using a laboratory hammer mill.

The red grape marc flour (15% and 20% w/w) was employed to enrich white grape juice. Then, in order to enhance the extraction of the bioactive compounds from red grape marc flour, the grape juice fortified was subjected to high-power ultrasound treatment (HPU) with amplitude of 50% and 70% for 3 and 6 minutes using a laboratory-scale power ultrasound system (Sonics & Materials Inc. U.S.A.). The system operated at 750 W and 20 kHz frequency. A batch of grape juice was not fortified and eight different samples of grape juice fortified with grape marc were prepared as described in Table 1.

HPLC analysis of polyphenolic compounds

The polyphenolic compounds profile was determinate by high performance liquid chromatography (HPLC) according to the method described by [5]. Separations were performed using an Agilent Technologies 1200 chromatograph equipped with UV-DAD detector, using a 250 mm x 4 mm Licrocart (Licrospher PR-18 5µm) column (Merck, Darmstadt, Germany) operated at 30 °C. The mobile phase consisted of water/acetic acid (97:3, v/v) (eluentA) and acetonitrile (eluent B) at the flow rate of 1 mL/min. The linear gradient profile was as follows: 97% A (0 min), 97–91% A (5 min), 91–84% A (15 min), 84–65% A (15-20.8 min), 65–64,5% A (20.8-36 min), 64.5–50% A (36-37 min), 50% A (37-38 min), 50–97% A (38-39 min) and 97% A (42 min). The injection volume was 20 μL. The polyphenolic compounds were identified based on the analytical standards, by comparing the retention times and the obtained UV-VIS spectra. The quantification of the samples was achieved by injecting standard solutions of known concentrations. Results were expressed in µg/mL.

Table 1 Sample codes

	Description			
Sample code	Grape juice	Red grape marc flour	Amplitude of HPU	Time of HPU
CGJ	100 mL	-	-	-
GJF1	100 mL	15%	50%	3 min.
GJF2	100 mL	15%	50%	6 min.
GJF3	100 mL	15%	70%	3 min.
GJF4	100 mL	15%	70%	6 min.
GJF5	100 mL	20%	50%	3 min.
GJF6	100 mL	20%	50%	6 min.
GJF7	100 mL	20%	70%	3 min.
GJF8	100 mL	20%	70%	6 min.

Total Phenolic Content

The total phenolics of the samples were determined using Folin-Ciocalteu reagent [6]. Sample and standard readings were made using a spectrophotometer (T60 UV-Visible Spectrophotometer, PG Instruments) at 750 nm against the reagent blank. The test sample (1 mL) was mixed with 5 mL of water and 5 mL of Folin-Ciocalteu reagent to make a solution. Then, 20 mL of sodium carbonate solution (20% m/v) was added to the mixture, followed by distilled water up to 100 mL. The reaction was kept in the dark for 30 minutes. Total phenolic content (TPC) was calculated as µg/mL of Gallic Acid Equivalents (GAE) using a Gallic Acid standard curve (5-500 µg /mL).

Chromatic Characteristics

Conventionally, the chromatic characteristics are described by the intensity of color (CI) and shade (N). Sample readings were made using a spectrophotometer (T60 UV-Visible Spectrophotometer, PG Instruments) against the reagent blank. The intensity of color was calculated as the sum of absorbencies (or optical densities) using a 1 cm. optical path and radiations of wavelengths 420, 520 and 620 nm. The shade was expressed as the ratio of absorbance at 420 nm to absorbance at 520 nm [6].

Total Acidity, Soluble Solids and pH

The total acidity (TA), expressed in equivalent tartaric acid content (g/L), was determined using Hanna Instruments' Titratable Total Acidity Minititrator HI84102. The total acids in wine are determined using a neutralization reaction, which is the reaction between the acids found in wine and a base. This type of reaction serves as the foundation for acid titration methods. The Total Titratable Acidity in g/L is displayed at the end of the titration. Total soluble solids (TSS) were measured with an ABBE refractometer (ORT 1RS, KERN & SOHN GmbH, Germany). The pH of the samples was determined using a Consort C5010 digital pH meter [6].

Statistical Analysis

Each grape juice sample was analyzed in triplicate and all values were obtained from three independent experiments. All results are presented as averages of three replicates, followed by the standard deviation (SD). The significance of differences among means was determined by one-way ANOVA [7]. Comparisons among means were performed by the Tukey's test ($p < 0.05$).

RESULTS AND DISCUSSION

The specific structure of the compounds in grape juice makes them absorb relatively low energy radiation from the visible spectral range (400-800 nm). Absorption is not limited to light of a certain wavelength, but occurs with different intensity in the visible spectral range [8]. Figure 1 ilustrates the differences among the samples on the visible spectral range.

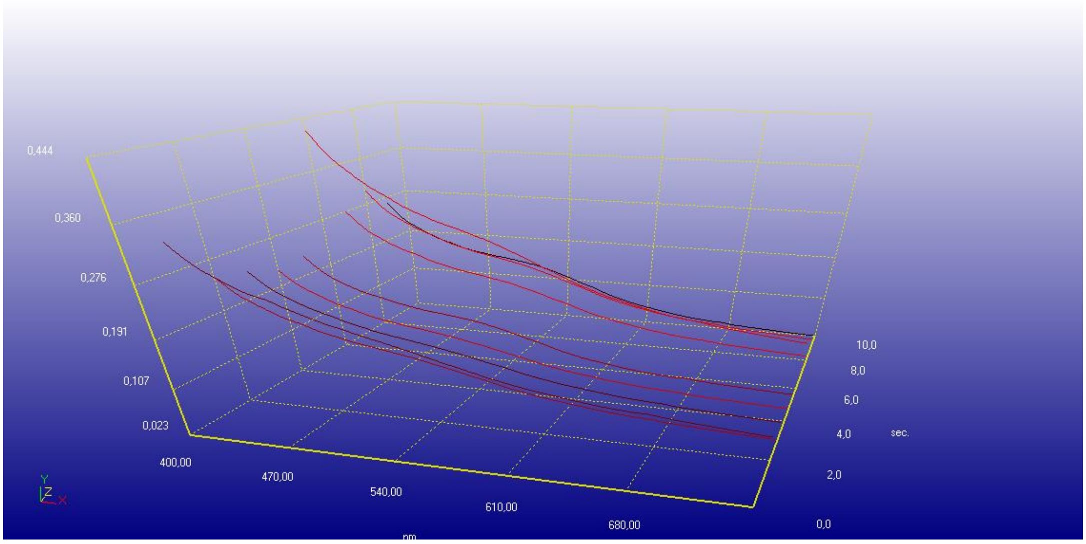

Figure 1 Differences among the samples on the visible spectral range

As highlighted above, grape marc is a by-product of the winemaking industry rich in polyphenols. Polyphenols are important red grape components because they influence the flavor and color of the juice [9] and have several health benefits [4]. Table 2 depicts the evolution of individual phenolic compounds in grape juice samples enriched with grape marc and subject to HPU treatment.

Gallic acid content increased from 6.58 μg/mL in the control grape juice to 24.63 μg/mL in the sample enriched with 20% grape mark and subjected to HPU treatment (A70%, 6 min). In the same grape juice sample (FGJ8), the highest levels of ellagic acid (1.12 μg/mL), ferulic acid (0.52 μg/mL), chlorogenic acid (16.78 μg/mL), and catechins (15.19 μg/mL) were also detected. It can be observed that the increasing of polyphenolic compounds was proportional with the quantity of red grape marc flour added, the amplitude of the HPU treatment and the time of exposure. The most abundant polyphenols detected were gallic acid, chlorogenic acid and catechins, while ellagic acid ferulic acid and were identified in small amounts [4].

Table 2 Individual phenolic compounds in grape juice samples

Sample code	Ellagic acid (μg/mL)	Gallic acid (μg/mL)	Ferulic acid (μg/mL)	Chlorogenic acid (μg/mL)	Catechins (μg/mL)
CGJ	$0.19±0.02^a$	$6.58±0.05^a$	$0.07±0.03^a$	$9.29±0.04^a$	$7.51±0.02^a$
FGJ1	$0.51±0.05^b$	$9.98±0.09^b$	$0.23±0.05^b$	$9.86±0.03^a$	$7.84±0.07^a$
FGJ 2	$0.60±0.07^b$	$12.27±0.08^b$	$0.27±0.03^b$	$10.04±0.02^a$	$8.22±0.05^a$
FGJ 3	$0.81±0.09^c$	$16.10±0.10^b$	$0.37±0.01^b$	$10.06±0.08^a$	$8.42±0.03^a$
FGJ4	$0.92±0.03^c$	$20.73±0.09^c$	$0.42±0.02^c$	$10.17±0.07^a$	$9.83±0.04^b$
FGJ5	$0.97±0.02^c$	$21.26±0.05^c$	$0.44±0.03^c$	$10.98±0.07^a$	$10.75±0.03^b$
FGJ6	$0.99±0.05^c$	$22.24±0.11^c$	$0.45±0.03^c$	$10.81±0.03^a$	$10.87±0.08^b$
FGJ7	$1.02±0.03^d$	$23.42±0.01^c$	$0.47±0.05^c$	$11.50±0.05^b$	$13.76±0.09^c$
FGJ8	$1.12±0.01^d$	$24.63±0.05^c$	$0.52±0.04^d$	$16.78±0.01^c$	$15.19±0.07^d$

Each value represents mean ± standard deviation (n = 3). Within the same column, parameters sharing the different letters have a significantly different mean value.

The increase in polyphenolic compounds in fortified and sonicated juice samples could be attributed to an increase in extraction efficacy caused by ultrasound treatment, resulting in cell wall disruption and, ultimately, the liberation of bound polyphenolic compounds [10].

Following the employment of red grape marc flour and HPU treatments, the total phenolic content (TPC) of grape juice samples is shown in Table 3.

It can be observed that the content of polyphenols increases with the rise of the amplitude and treatment time as well as the amount of added grape marc. The sample with the highest content of polyphenols was FGJ8 (360.72 μg/mL), fortified with 20% of red grape marc flour and exposed to the high-power ultrasound treatment for 6 minutes at amplitudes of 70%, compared to the control sample CGJ that has the lowest content of polyphenols (250.54 μg/mL). The difference in total phenolic content between the control sample CGJ and FGJ8 is significant, of over 43%. Compared with control sample CGJ, all fortified samples shows significant increasing of TPC (Figure 2). These findings show that the TPC content increased in response to the enrichment with red grape marc flour and ultrasound treatments compared to the control sample [9], [11], [12].

It can also be observed that the shade decreases as the coloring intensity increases. The highest values of the coloring intensities, respectively the lowest values of the shade were recorded for the samples where the amplitude and the time of the the ultrasound treatment had the higher value, correlated with the highest red grape marc flour added (Table 3). The shade shows values greater than 1.0 for both the control sample CGJ and the fortified and sonicated samples, these values indicating a brick shade of the samples. The brick color decreases proportional with the grape marc flour added and thus confirming the enhanced extraction of polyphenols, and especially antocyanins from red marc grape flour [13].

Table 3 Changes in Total phenolic content, Colour intensity, Shade, Total soluble solids, Total acidity and pH of the samples

Sample code	TPC (μg/mL)	CI	N	TSS %	TA (g/L)	pH
CGJ	250.54±0.11[a]	3.80±0.03[a]	1.52±0.02[a]	14.5±0.10[a]	8.9±0.03[a]	3.52±0.02[a]
FGJ1	272.58±0.09[a]	3.86±0.04[a]	1.51±0.05[a]	15.6±0.09[b]	11.2±0.05[b]	3.55±0.01[a]
FGJ 2	280.20±0.12[b]	4.17±0.02[b]	1.49±0.05[a]	15.7±0.12[b]	11.4±0.09[b]	3.55±0.02[a]
FGJ 3	300.54±0.15[b]	4.41±0.03[b]	1.46±0.04[b]	15.7±0.08[b]	11.8±0.07[b]	3.56±0.04[a]
FGJ4	308.17±0.10[b]	4.59±0.05[b]	1.46±0.07[b]	15.9±0.08[b]	12.0±0.05[b]	3.56±0.06[a]
FGJ5	319.19±0.11[b]	4.91±0.07[c]	1.45±0.02[b]	15.9±0.07[b]	12.0±0.03[b]	3.58±0.02[b]
FGJ6	323.43±0.08[c]	5.38±0.03[c]	1.44±0.01[b]	16.1±0.03[c]	12.3±0.10[c]	3.58±0.01[b]
FGJ7	328.51±0.10[c]	6.10±0.05[d]	1.43±0.03[c]	16.2±0.04[c]	12.5±0.08[c]	3.58±0.03[b]
FGJ8	360.72±0.15[c]	7.96±0.07[d]	1.42±0.07[c]	16.3±0.05[c]	12.6±0.05[c]	3.62±0.07[b]

Each value represents mean ± standard deviation (n = 3). Within the same column, parameters sharing the different letters have a significantly different mean value.

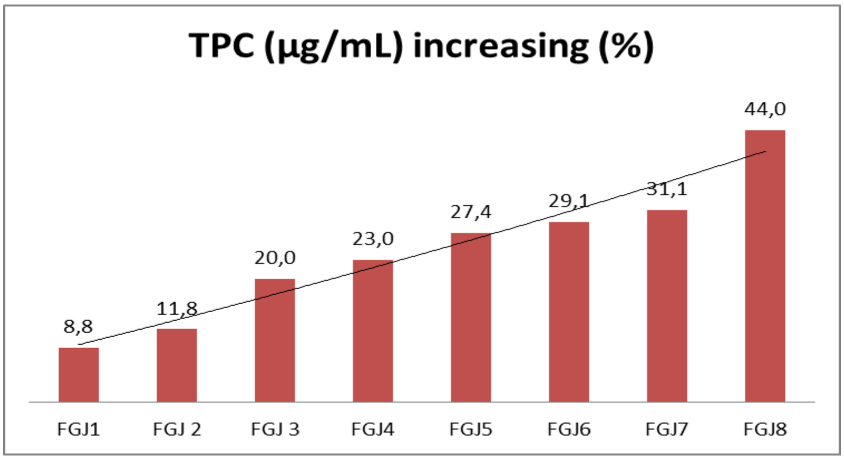

Figure 2 Increasing (%) of TPC (μg/mL) of the fortified samples compared to control sample

It is clear from the data (Table 3) that the different assayed combinations of red grape marc flour added and HPU treatments (ultrasound frequency and exposure time) exert significant effects on TSS and TA of grape juice, and slightly effects on pH.

Due to the fortification with red grape marc flour, the total soluble solids of the grape juice increased from 14.5% in the control sample to a maximum of 16.3% in FGJ8, the parameters of the ultrasound treatment influencing significantly the soluble solids extracted from grape marc [14].

In terms of TA, our findings indicated that ultrasonic treatment improved tartaric acid extraction from red grape marc flour [15], [11]. It can be observed that the extraction was proportional with the quantity of red grape marc flour added, the amplitude of the HPU treatment and the time of exposure (Table 3). The highest TA was found in FGJ8, where a higher content of grape marc flour was added 20%, the amplitude of the ultrasonic treatment was 70% and the exposure time was 6 minutes. Compared with control sample, TA of FGJ8 was 41.5% higher.

As already mentioned, the changes in pH of the samples were not significant. However, a small increase in pH was observed consecutive to the addition of grape marc flour to the grape juice and ultrasonic treatment.

CONCLUSION

The grape marc by-products of the grape industry are a source of important ingredients for new foods because they are particularly rich in chemical compounds with beneficial biological properties.

All samples fortified with grape marc flour and exposed to ultrasound treatment showed a significantly improved phenolic content compared with the control juice sample. The increasing of individual phenolic compounds and total phenolic content was proportional with the quantity of red grape marc flour added, the amplitude of the HPU treatment and the time of exposure.

The addition of red grape marc flour and HPU treatments (ultrasound frequency and exposure period) enhanced the values of TSS and TA in grape juice samples while having a minor influence on pH.

Because of their antioxidant properties and antimicrobial activity, the inclusion of these by-products into white grape juice would not only improved nutritional quality but also enhanced and chromatic attributes without compromising product acceptability.

As a result, valorizing these residues through an alternative processing scheme could contribute to achieving a sustainable industrial sector.

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