Effect of Composite Flour Made from Tomato Seed and Wheat of 650 Type of a Strong Quality for Bread Making on Bread Quality and Alveograph Rheological Properties

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***Abstract*—The effect of composite flour made from tomato seed and wheat flour of 650 type of a strong quality for bread making on Alveograph rheological properties and bread quality characteristics were investigated. In this study, dough and breads were prepared using five levels of replacement of wheat flour with Tomato Seeds Flour (TSF) (0, 5, 10, 15 and 20%, on flour basis). Incorporating of TSF in dough formulations significantly ($p < 0.05$) influenced dough rheological properties. Dough extensibility and deformation energy decrease with increase level of TSF addition in wheat flour. Up to 10% replacement with TSF the loaf volume, porosity and elasticity of the bread samples increases. Regarding the mechanical textural parameters, significant changes were found for the hardness parameter which presented higher values for all the bread formulations compared to the control one. The crumb cells structure the bread samples with TSF addition it seems less compact that those of the control sample. Regarding sensory properties, when TSF was used at the level of 10%, lead at either acceptable sensory characteristic than the sample without TSF addition. Addition of more than 10% TSF decreased overall acceptability of bread. The multivariate statistics technique, Principal Component Analysis was used to highlight correlations between chemical characteristics of wheat flour-tomato seed flour formulation, Alveograph rheological properties, bread physical characteristics, bread textural parameters and bread sensory characteristics of the sample formulation.**

***Index Terms*—wheat flour, tomato seed flour, Alveograph, bread quality**

I. Introduction

The proposal of recovery food process wastes is rapidly expanding around the world to reduce pollution effects with an increasing demand for their conversion into useful by-products. In the last few decades, various by-products have been successfully included in the baking technology due to their nutritional value. One of theses by-products is tomato pomace. Tomato pomace, consist mainly of skin and seeds [1], contain good quality nutrients [2] and found to be a promising sources of valuable compounds which may be used in foods products. Tomato pomace is a good source of fiber, protein, fat and mineral [3]-[5]. Tomato seeds, the major part of pomace which makes approximately 60% of canning waste [6] are a valuable source of nutrients. Their contain appreciable amounts of protein (22.27-33.9%), fat (20.57-29.6%), fiber (35.1%) and mineral elements such as potassium, calcium, iron, manganese, zinc and copper [7]-[10]. Due to its content in these valuable components with beneficial effects on human body, the use of tomato seed in various food formulations is increasing nowadays. In addition, the tomato seeds lack anti-nutritional factors which are often present in other unconventional protein sources [11]. The nutritive value of tomato seed protein was similar to that of soybean and sunflower proteins [12] and less than that of casein [13]. Also, tomato seeds are recognized as a potential source of protein having all amino acids in high amount [14]. Due to the high amount of lysine, the seed protein can be use to supplement products that are deficient in this amino acid like cereals [15].

The addition of tomato seed to wheat flour bread had a positive effect on loaf volume and improved the overall protein quality of the bread. Also, the addition at 10% and 20% levels increased lysine by 40.2 and 69.0% respectively [15]. The replacement of wheat flour with tomato seed flour change dough rheological properties and bread sensory characteristics [9]. A good sensory characteristics and an improved protein quality can be found in bread supplemented with 10% seed flour. The whole seed meal at 20% level does not show any significant change in staling rate while the loaf volume increases by 20.4%, however, 20% level of defatted seed tomato decreases the specific loaf volume by 72% [9]. A fancy grade for organoleptic evaluation was obtained for balady bread with 10% seed meal [15].

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In the present study we evaluated the effect of tomato seed flour addition in wheat flour of 650 type of a strong quality for bread making at five levels (0, 5, 10, 15 and 20%) on Alveograph dough rheological properties and bread quality due to it physical-chemical, textural and it sensory characteristics. In addition, the correlations between chemical characteristics of tomato seed-wheat flour-formulation, dough rheological properties, and bread characteristics were analyzed by using Principal Component Analysis. To our knowledge no studies have been made yet to compare the effect of the tomato seed flour addition on dough rheological properties by using the Alveograph device and bread quality characteristics.

II. Materials and Methods

A. Materials

A commercial wheat (harvest 2015) and tomato seed flour was used. The flours were analyzed according to ICC methods as fallowing: moisture content (ICC methods 110/1), ash content (ICC 104/1) and protein content (ICC 105/2). For the wheat flour was also determined: falling number (ICC 107/1), wet gluten (ICC 106/1) and gluten deformation index (SR 90:2007).

B. Alveograph Analysis

The Alveograph instrument (Chopin Technologies, France) was used for evaluation the dough rheological characteristics of the composite dough's fallowing the SR EN ISO 27971:2015 standard. The fallowing parameters were measured: maximum pressure (*P*) representing the peak height (mm), dough extensibility (mm) indicated by length (*L*) of the alveogram curve, baking strength (*W*), index of swelling (*G*) and configuration ratio of the Alveograph curve (*P/L*).

C. Bread Samples Preparation

Bread samples were prepared from tomato seed flour added in different doses in wheat flour: 0% (control sample), 5%, 10%, 15% and 20%. Salt, yeast and water were added in doses of 1.5%, 3% respectively up to 56% reported to the composite flour mass. All the ingredients were mixed in a Lancom mixer for 15 min after which the dough was modeled and fermented for 60 min at temperature of 30^0C and 85% relative humidity. There after the samples were baked for 30 min at 180 ℃ in an electrical bakery convection oven (Caboto PF8004D, Italy).

D. Physical Properties of Bread Samples

The physical properties loaf volume (determined by seed displacement method), porosity and elasticity were determined according to SR 91:2007.

E. Textural Properties of Bread Samples

Textural properties of bread, hardness, cohesiveness, elasticity, gumminess and chewiness was obtained from a texture profile analysis (TPA) test using a texture analyzer Mark-10-ESM301.

F. Image Analysis of the Bread Crumb Structure

The MoticSMZ–140 stereo microscope with the 20x objective was used for image analysis of the crumb structure of the sliced loaves. The images were recorded with a resolution of 2048 x 1536 pixels.

G. Sensory Characteristics of Bread Samples

Sensory characteristics of the composite bread samples were evaluation by using semi-trained panelists from Stefan cel Mare University of Suceava, Faculty of Food Engineering, Romania. The panelists assessed the following characteristics: appearance, colour, flavor, texture, taste, smell, texture and overall acceptability using 9-point hedonic scale. A score of 1 represented "extremely dislike", a score of 5, "neither like nor dislike" and a score of 9 represented "extremely like".

H. Statistical Analysis

Statistical analysis was performed with Microsoft Excel 2007 and the Statistical Package for Social Science (SPSS, Version 16.0; IBM Corporation, Chicago, IL, USA).

III. Results and Discussion

A. Analytical Characteristcs

The wheat flour and tomato seed flour analytical characteristics are shown in Table I.

TABLE I. The Analytical Characteristics of Wheat and Tomato Seeds Flour

Characteristics	Wheat flour	Tomato seeds flour
Moisture (%)	13.90	6.94
Protein (%)	12.20	29.50
Fat (%)	1.70	19.50
Ash (%)	0.65	3.92
Wet gluten (%)	27.50	-
Gluten deformation (mm)	3.00	-
Falling number (s)	325.00	-

According to the results, the wheat flour is of a strong quality for bread making, having a low alpha-amylase activity [16] due to it falling number value.

The chemical composition of the tomato seed-wheat flour samples formulation is shown in Table II.

The results showed that addition of tomato seed flour in wheat flour increased protein content, fat and ash, but an increase in lysine content it is possible, according to the results obtained by [17], while the carbohydrates content decreased.

TABLE II. The Chemical Characteristics of Tomato Seeds – Wheat Flour

Samples formulation	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Carbohydrates (%)
0%_TSF	13.90	12.20	1.70	0.65	71.55
5%_TSF	13.55	13.07	2.59	0.81	69.98
10%_TSF	13.2	13.93	3.48	0.98	68.41
15%_TSF	12.86	14.80	4.37	1.14	66.84
20%_TSF	12.51	15.66	5.26	1.30	65.27

B. Alveograph Rheological Parameters

The Alveograph rheological parameters of the tomato seed-wheat flour blends are shown in Table III. As we

can see for TSF addition in wheat flour the dough extensibility (P), index of swelling (L) and baking strength (W) decreases with the increase level of TSF addition. The baking strength (W) decreases even more with the increase level of TSF addition indicating dough weakening that could be due to the addition of non-gluten flour.

TABLE III. THE ALVEOGRAPH CHARACTERISTICS OF TOMATO SEED-WHEAT FLOUR BLENDS

Characteristics	The levels of replacement with tomato seed flour of wheat flour				
	0 %	5 %	10 %	15 %	20 %
P (mm)	121.00	118.00	114.00	119.00	126.00
L (mm)	64.00	60.00	40.00	26.00	24.00
G (mm)	17.76	17.19	14.04	11.31	10.87
W (10^{-4}J)	286.00	262.00	225.00	163.00	151.00
P/L	1.89	1.97	2.85	4.57	5.25

Alveograph parameters: P, the maximum over pressure needed to blow the dough bubble, expresses dough resistance (mm); L, the length of the curve, expresses dough extensibility (mm); G, index of swelling (mm); W, baking strength (surface area of the curve) (10^{-4}J); P/L, configuration ratio of the Alveograph curve.

C. Bread Physical Characteristcs

The effect of TSF addition on bread physical characteristics is shown in Fig. 1. With increase in the level of TSF addition up to at 10%, bread physical characteristics loaf volume, porosity and elasticity increased. The results showed a decreased of physical characteristics with increase of level of TSF above 10% in wheat flour, which may be probably due to the gluten dilution effect which increases with the increase level of wheat flour replacement with TSF. However, the sample with 20% TSF addition presented higher values for the bread physical characteristics than those for the control one. This implied that addition of TSF in bread increases the volume of the bread and hence its acceptability.

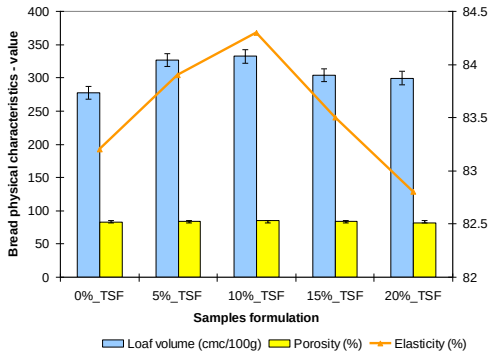

Figure 1. Bread physical characteristics

Regarding the Falling Number (FN) index values (Fig. 2), addition of TSF to the bread recipe up to at 15% leads to an increase of FN index and then, at 20% TSF addition, slightly decreases. No significant difference was found between substituted wheat flour with 15% TSF and 20% TSF from of point of view of FN index values.

Therefore, the replacement of wheat flour with tomato seed flour affected enzymatic activity as the increasing and slightly decreasing FN index value.

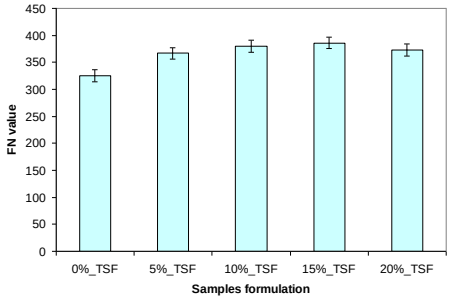

Figure 2. Effects of adding different levels of Tomato Seed Flour (TSF) on the Falling Number index (FN) value

D. Bread Textural Properties

Fig. 3 shows the mechanical textural parameters of bread with and without TSF addition. The highest value for the bread hardness was found for sample with 20% TSF addition. Regarding the elasticity parameter, higher values than the control sample for the bread samples with above level of 5% TSF addition in composition was found. For the textural parameters gumminess and chewiness, the results revealed an increase values with the increase addition of TSF into bread sample.

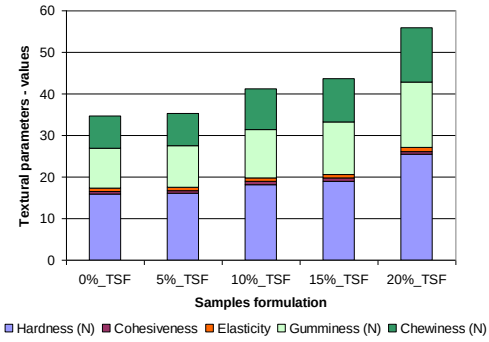

Figure 3. Effect of Tomato Seed Flour (TSF) addition in wheat flour on textural parameters of bread samples

E. Crumb Structure of Bread Samples

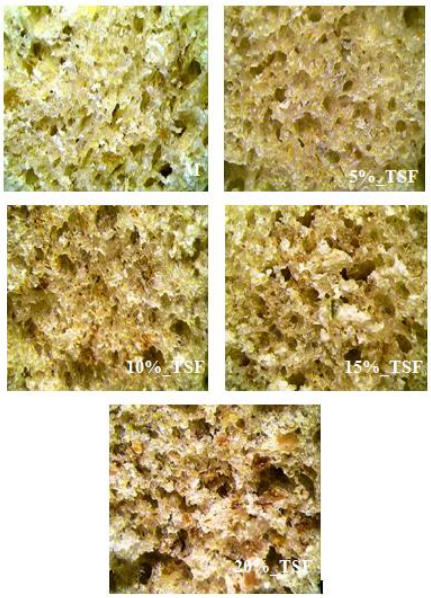

Figure 4. Crumb structure of bread samples at different levels of tomato seed flour addition

The bread crumb structure recorded using the stereo microscope is shown in Fig. 4. A high level of TSF addition in wheat flour, the crumb seems less compact than the bread sample without TSF (0%_TSF).

F. Bread Sensory Characteristics

Bread sensory characteristics (Fig. 5) of the samples formulation shows that the bred with TSF addition was well evaluated up to a level of 10%, in especially for the appearance, texture, flavor and color sensory characteristics and was less appreciated for taste and smell. The samples with 5 and 10% TSF received a well score for sensory characteristics evaluated according to results obtained by [13]. A slightly bitter taste at a 10% or higher replacement level may be due to a steroid compound found in tomato seed flour [17]. Also, the taste can be influenced due to the highest amount of glutamic acid and aspartic acid from the tomato seed [10].

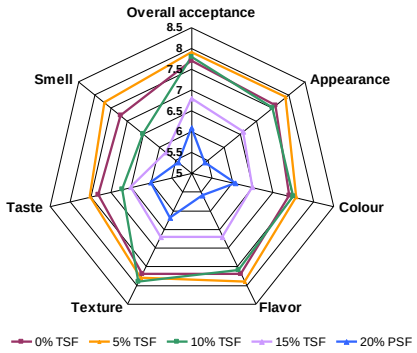

Figure 5. Sensory characteristics of bread samples at different levels of Tomato Seed Flour (TSF) addition

The bread samples with 15% and 20% TSF were the least preferred among the all samples because the replacement of wheat flour with higher levels of TSF leads to an unpleasant aroma and taste. In addition, at higher levels of supplementation, the bread samples were darker. These results are in agreement with those of Rahaie *et al*. (2014) [18].

G. Relationship between the Alveograph Characteristics, Bread physical, Textural and Sensory Characteristics

The Principal Component Analysis (PCA) was used to identify the relationship between the chemical characteristics of wheat flour-tomato seed flour formulation, Alveograph rheological parameters, textural and sensory characteristics of bread samples formulation with different addition levels of 0, 5, 10, 15 and 20% of TSF in wheat flour. The first two principal component explain 94.11% of the total variance (PC1 = 75.51% and PC2 = 18.60%) (Fig. 6). Regarding the first principal component PC1, one can notice that there is a very good correlation between the sensorial characteristics (smell, taste, flavor, appearance) and textural characteristics (hardness, elasticity, chewiness and gumminess). Good correlations ($r > 0.89$, $p < 0.05$) were obtained between textural parameters hardness, gumminess, chewiness and protein content. Also, a high significance correlation was obtained between appearance and overall acceptability ($r = 0.98$, $p = 0.01$). PC1 axis distinguishes between Alveograph parameters (L, G, W and P/L) and protein content and significance correlation ($r > 0.95$, $p = 0.01$) was found. The second component PC2 indicated good correlation between loaf volume and elasticity ($r = 0.80$) and an inverse correlation between loaf volume and hardness ($r = -0.87$). Also, the second principal component, PC2 distinguishes the bread physical characteristic elasticity and the Alveograph parameter maximum pressure (P), which is opposed. A good correlation were found between textural parameter elasticity (Elasticity T) and the physical one ($r = 0.78$), and between FN index and textural parameter cohesiveness ($r = 0.85$).

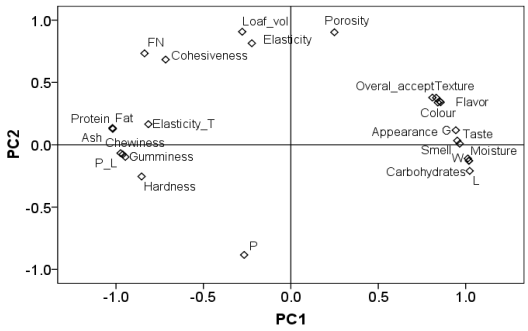

Figure 6. Principal component analysis for the tomato seed-wheat flour chemical characteristics, dough and bread quality values

IV. Conclusions

This study showed an improvement in the protein content of tomato-wheat flour samples formulation. Also, an improvement in nutritional quality it is possibly as a result of the addition of tomato seed flour due to high content of lysine of tomato seed. In addition, increase in the fat content and ash was achieved in the composite flour. Addition of tomato seed flour in wheat flour led to a decreased of dough rheological parameters recorded by Alveograph device. The alpha-amylase activity of composite flour was improved by replacement of wheat flour with tomato seed flour up to at level of 15%. A decreased in loaf volume, porosity and elasticity with the increase level of tomato seed flour addition about 10% was noticed. The textural parameters of bread revealed that hardness, gumminess and chewiness increased with the increase level of tomato seed flour addition. Significant positive correlations ($p < 0.05$) were found between textural parameters and protein content, while a negatively correlation between protein content and baking strength it is established. Acceptable bread was obtained with 5% and 10% supplementation with tomato seed flour. However, the overall acceptability decreased with increase in the composition formulation of tomato seed flour, the least acceptable begin bread samples with 20% and 15% tomato seed flour.

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