The Influence of Native Inulin and Oligofructosis Addition to Flour and Its Effects on the Rheological Characteristics of the Dough

Georgiana Gabriela Codină[1], Dumitru Zaharia[2], Silvia Mironeasa[1], Adriana Dabija[1], and Sorina Ropciuc[1]
[1]Faculty of Food Engineering, Stefan cel Mare University of Suceava, Suceava, Romania
[2]S.C. Dizing S.R.L. Brusturi, Neamţ, Romania
Email: office@dizing.ro, {silviam, adriana.dabija }@fia.usv.ro, {codinageorgiana, sorinaropciuc}@yahoo.com

***Abstract*—The aim of this paper was to study the effect of native inulin (IN) addition and oligofructosis (FOS) addition in wheat flour of 1250 type on gluten quality, dough rheological properties and amylase activity. The wheat flour has been enriched with IN and FOS in a proportion of 0 – 10%. The gluten quality were analyzed by it extensibility and elasticity. The dough rheological properties were analyzed with a Farinograph device the fallowing characteristic being determinate: water absorption, time of development, stability and degree of softening. The samples with a 5% content of IN and FOS were the ones which presented the lowest time values for dough formation. Furthermore, it has been noted that the time during which the dough maintains its consistency (stability) registers higher values for the flour with a 5% addition of IN and FOS. Water absorption in dough decreased direct proportional with the increase level of inulin and oligofructosis addition in wheat flour. The amylase activity of the wheat flour with inulin and oligofructose addition were analysed by using the Amilograh and Falling Number device. The amylase activity were higher with the increase level of inulin and oligofructose addition.**

***Index Terms*—farinograph, soluble fibre, glutograph, rheology**

I. Introduction

Dietary fibre called fructani, inulin and oligofructosis are not digested by digestive enzymes adapted to hydrolize starch. Once they reached the colon, these fibres trigger a specific change in the composition of the local microbiota, with benefic effects for the human host as they are selectively used as food by bifidobacteria. Full-Sized Camera-Ready (CR) Copy

This bifidogenic action has several benefic physiological effects: improves intestinal transit, increases calcim absorbtion, decreases serum decreases serum lipid levels, increases satiety with positive consequences on the health of the digestive, skeletal and circulatory systems as well as on maintaining healthy weight. Furthermore, it contributes to an increased resistance to infections and boosts the immune system. Soluble fibers are known for many physiological benefits related to 'incidental disease' such as coronary heart disease, obesity, colon cancer and diabetes [1], [2]. Several authors have demonstrated that the soluble fiber consumption can significantly reduce blood cholesterol levels and stabilize levels of glucose in the blood [3], [4]. Apart from the physiological effect on glucose in blood, it is noteworthy that the addition of these fructans is promising because it does not change the flavor of the foods [5]. The indigestible dietary fiber is used in many foods: dairy products, ice cream, bakery, beverages, low fat spreads, cereals and sweets. Inulin from plants can contain up to several thousand fructose units from which, through hydrolysis oligofructose results. The number of fructose unit in the molecule or the polymerization degree (DP) allows for a differentiation between oligofructose (fructooligoglucide) with a DP lower than 10 and medium and long-chain inulin with DP values between 10 – 60 and an average of about 23 – 35, depending on the manufacturer [6]. Inulin is used to increase the amount of dietary fiber or as a prebiotic ingredient, especially in bakery and dairy products [7]. Inulin and oligofructose are characterized by a number of physico-chemical, nutritional and technological properties strictly dependent on the degree of polymerization. The fraction with short chain, oligofructose, is much more soluble and sweeter than the native long-chain inulin which has properties more similar to that of other carbohydrates. Even though a number of oligofructosis were proposed as prebiotics, only inulin, transgalacto-oligosaccharide and lactulose type fructani attained the prebiotic state. The most frequently investigated oligofructosis for their activity as prebiotics are oligofructosis (FOS) and galacto-oligosaccharides. The difference in structure between native inuline and FOS plays a major impact in their functionality. The inulin is capable of forming gels through small crystals and is not perceived as sweet therefore it can be used as fat replacer, while oligofructose is more soluble, has a sweet taste (presenting a sweetening power of approximately 30% of table sugar) and is added mostly as replacement sugar. Technologically, the addition of fibers leads to reduced hydration and lower dough stability. Soluble fibers influence the possibility of processing dough due to reduced gluten content; the dough becomes sticky even when it has the same consistency and becomes more difficult to process [8].

Manuscript received July 1, 2017; revised August 1, 2017.

doi: 10.18178/ijfe.4.1.1-7

The addition of fiber in flour triggers a series of changes of its technological parameters, changes that affect directly the quality of finished products. The main effect of adding fibers in bakery products is the decrease of their volume. Bread volume decrease occurs mainly due to a decrease in the percentage of gluten content in the dough and implicitly of the dough's capacity to retain gases for fermentation. Furthermore, the addition of inulin in bread led to the obtaining of smaller pieces with heavier and darker core. Studies on the addition of inulin in bread confirm the benefits it has on the absorption of minerals process and the effect of improvement of the immune response as well as the important role prebiotics play in preventing co-rectal cancer, improving feeling of satiety and weigh control.

II. Materials and Methods

The samples were prepared using wheat flour type 1250 with 31% gluten content and a 3 mm deformation index, derived from S.C Dizing S.R.L Brusturi, Neamt, Romania.

In the experiments two types of inulin were used namely native inulin and oligofructose both of them extracted from chicory root. The inulin samples used differ between them by their polymerization degree (DP) and by their sugar free content. The native inulin presents a higher content of sugar free compared to the oligofructose and a higher DP than the oligofructose.

The determination of falling number values as a measurement of the α-amylase activity was made according to SR ISO 3093/2007.

The determination of peak viscosity in the flour sample with Brabender Amylograph was made according to SR ISO 7973:2000.

The determination of wet and dry gluten content in the flour samples with added soluble fibers was performed with Perten Glutograph (Instruments AB, Huddinge, Sweden) according to SR EN ISO 21415 – 1: 2007.

The gluten deformation index was determined according to SR 90:2007.

The determination of water absorption and dough's rheological properties were performed with Brabender Farinograph according to SR ISO 5530 – 1:1999.

Statistical analysis: Data analysis was performed by determining the mean average, by analyzing main components, and conducting probability tests and correlations using XLSTAT vers. 2016 and Minitab 17.

III. Results and Discussion

A. *Properties of Flour Mixture*

Results of this study offers information regarding the characteristics of the quality of wheat flour type 1250 with 31% gluten content and deformation index of 3 mm, by mixing with the native inulin and oligofructose between 0 - 10%. The results regarding mixtures amylase activity, Amilograph properties and water absorption capacity are shown in Table I.

TABLE I. Amylograph Viscosity, Amylograph Properties and water Absorption Values of Flour Mixed with NI and FOS

Fraction	FN (s)	Amylograph viscosity	Wabs (%)	Peak viscosity (UB)
F 1250	363	637	59.5	85.6
F1250 + 2.5%IN	344	580	55	86.4
F1250 + 5%IN	331	532	50.7	86.6
F1250 + 7.5%IN	307	488	48.7	87.2
F1250 + 10 %IN	330	420	47.3	87.8
F 1250 + 2.5%FOS	375	589	56.1	86.3
F 1250 + 5%FOS	339	537	51.4	86.8
F 1250 + 7.5%FOS	326	493	47.4	87
F 1250 + 10 %FOS	261	455	44.1	87.5

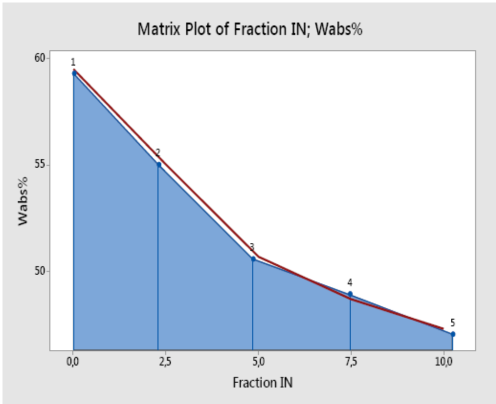

Figure 1. Water absorption in flour mixtures (addition native inulin)

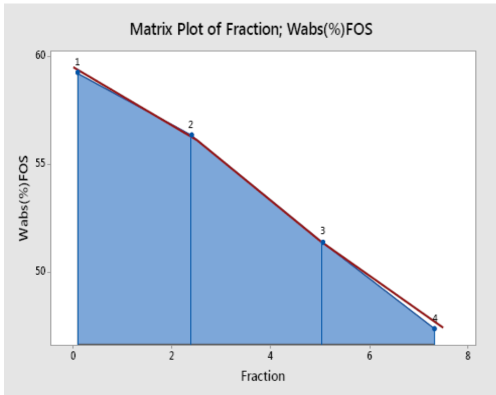

Figure 2. Water absorption in flour mixtures (addition oligofructosis)

Mixtures of flour with added native inulin and oligofructose tend to have a decreased capacity for flour hydration. Water absorption decreases with increasing added amount of soluble fiber compared to untreated flour. The evolution of water absorption in the forming of dough is plotted in Fig. 1 and Fig. 2. The addition of native inulin in a proportion of 10% decreases the water absorption to 47.3%. Approximately the same values are noted when oligofructose is added in 10,07,55,02,50,0605550 Fraction INWabs%54321Matrix Plot of Fraction IN; Wabs% percentage of 7.5%. The water absorption in this case is 47.4%.

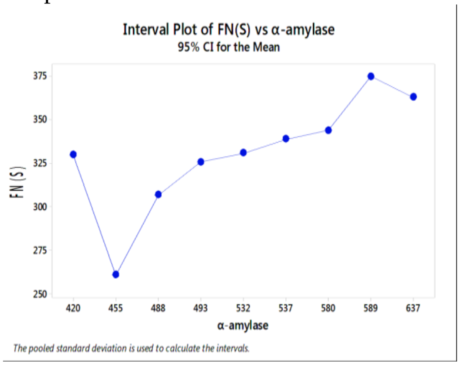

Figure 3. Graphic representation of amylase evolution in relation to the fall index

The lowest percentage of water absorption occurs when wheat flour is substituted with 10% oligofructose.

Water absorption capacity is an important parameter because it affects not only the dough but also the quantity of manufactures bread. This is determined by the protein content in the flour, the amount of starch damaged during grinding and the presence of non-starch carbohydrates. Flour for bread should have a high water absorption capacity for a normal consistency of the dough so that the yield of dough and bread is high [9]. It can be assumed that the forms of inulin form a barrier around the grains of starch and thus limiting the possibility of water retention. The falling number index provides information about the activity of amylase (α-amylase) and the fermentation process that will take place in the dough made of wheat flour. The damage in starch granules and the α-amylase activity in flour determine the quality of flour. The water absorption value it is a very important aspect for the bread making technology with inulin addition because a water addition similar to those for the control sample make the dough very difficult to process. The decrease of the water absorption value proportional with the increase level of inulin addition may be attributed to the increase of the osmotic pressure outside to the protein micelle which will reduce the water osmotic absorption. This is a consequence of the presence of the fructose molecule in the dough system by inulin addition which is in a higher amount in oligofructose than in native inulin.

The degree of conversion of starch can be measured in conventional manner with the help of the falling number index (FN). The flour sample type 1250 has a falling number value of 363 s. As you increase the percentage of flour substituted with native inulin and oligofructose the falling number index and the amylase activity decreases [10]. The Farinograph dough stability increases direct proportional with the level of inulin addition for flour of 1250 type more for the dough with oligofructose addition (19.2 min) than for the dough with native inulin addition.

The increase Farinograph values of dough stability and dough development time indicates the fact that dough with inulin addition needs a higher time for processing without significant changes on it capability to maintain it form during bread making process.

For 1250 flour type the dough weakening also decrease with the increase level of inulin addition but at the highest level added (10%) the value of this parameter increase (19 UB for native inulin addition and 29 UB for oligofructose addition).

Fig. 2 shows the evolution of the α-amylase activity in relation to the falling number index value (FN).

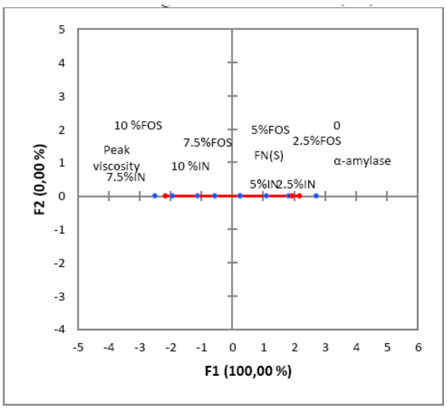

Figure 4. PCA Analysis of the quality chemical characteristics of flour mixtures

The representation of main components groups dependent variables (FN, α-amylase, Wabs and peak viscosity) in relation to independent variables (flour mixtures). It is notable an association of samples in groups with an added 2.5% - 5% FOS which relate to a falling numbe index and other groups of samples with added native inulin which relate to α-amylase.

The rheological properties of dough made from flour mixtures were studied using a Glutgraph and Farinograph. The quality indicators were studied for its gluten content and its quality.

Considering the fact that flour is characterized by its protein content and its quality, the results in the Farinograph took into consideration the characteristics of dough during kneading. The values of the parameters determined in the Glutgraph and Farinograph for the control flour and the mixtures of flour with 2.5%, 5%, 7.5% and 10% native inulin and oligofructose are shown in Table II.

The gluten dough elasticity and viscosity obtained from the wheat flour dough with different levels of inulin addition were expressed by the Glutograph stretching value and Glutograph Relaxation value respectively. Gluten extensibility value is constant in most of the samples, except the sample with 5% FOS.

Addition of inulin determined significant changes of the rheological parameters. There is a progressive decrease in gluten content where 2.5% native inulin was added (28.85%). The extensibility of the dough made with 2.5% and 5% inulin did not prove to be significantly different than the extensibility of the control dough, however the addition of 7.5% and 10% of inulin decreased the extensibility of the dough – a phenomenon which is not desired. The same effect is observed in samples of flour with added oligofructose, in which there is a greater decrease in gluten content. Reducing the percentage of gluten content in the dough and thus reducing the douh's capacity to retain gases for fermentation will lead to a decreased volume in bread [11]. The presence of native inulin and oligofructose determined a significant decrease in viscosity and an increase in the extensibility of gluten.

TABLE II. RHEOLOGICAL PARAMETERS OF DOUGH AS AFFECTED BY ADDITION OF INULIN AND OLIGOFRUCTOSE TO WHEAT FLOUR.

Fraction	Glutograph parameters			Farinograph parameters		
	Wet gluten (%)	Stretching (sec)	Relaxation (UB)	Development time (min)	Stability (min)	Degree of softening (UB .10 min)
F 1250	35	125	117	4.7	6	46
F1250 + 2.5%IN	28.85	125	120	4.5	9.4	33
F1250 + 5%IN	26.40	125	121	1.8	12.2	18
F1250 + 7.5%IN	27.50	125	126	4.2	16.7	14
F1250 + 10 %IN	21.45	125	112	6.7	17.8	19
F 1250 +2.5%FOS	31.45	125	116	2.2	8	37
F 1250 + 5%FOS	27.10	29	226	1.9	13.8	20
F 1250 +7.5%FOS	24.30	125	169	2.7	18.4	17
F 1250 + 10%FOS	21.20	125	115	3.6	19.2	29

The gluten dough elasticity and viscosity obtained from the wheat flour dough with different levels of inulin addition were expressed by the Glutograph stretching value and Glutograph Relaxation value respectively. Gluten extensibility value is constant in most of the samples, except the sample with 5% FOS.

Addition of inulin determined significant changes of the rheological parameters. There is a progressive decrease in gluten content where 2.5% native inulin was added (28.85%). The extensibility of the dough made with 2.5% and 5% inulin did not prove to be significantly different than the extensibility of the control dough, however the addition of 7.5% and 10% of inulin decreased the extensibility of the dough – a phenomenon which is not desired. The same effect is observed in samples of flour with added oligofructose, in which there is a greater decrease in gluten content. Reducing the percentage of gluten content in the dough and thus reducing the douh's capacity to retain gases for fermentation will lead to a decreased volume in bread [11]. The presence of native inulin and oligofructose determined a significant decrease in viscosity and an increase in the extensibility of gluten.

Gluten extensibility was higher in samples with native inulin in percentages of 2.5 – 7.7 % (571-535 sec) than in the control dough (499 sec). On average values have a homogenous character (Fig. 4). On the other hand, the lowest extensibility was that of gluten with 10% IN and 10% FOS [12].

Gluten elasticity, expressed in seconds, shows relatively homogenous values (Fig. 5). The sample with 5% FOS stands out with the highest value of elasticity (226 UB). (Fig. 6)

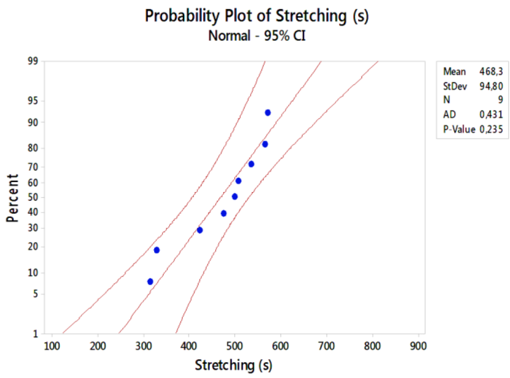

Figure 5. Distribution of values at gluten extensibility

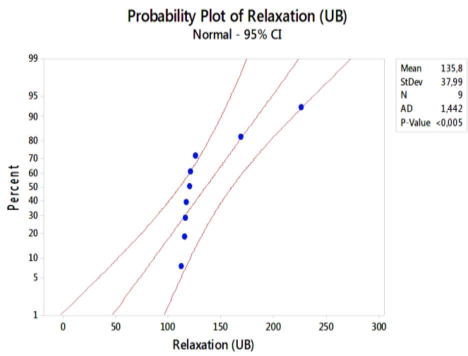

Figure 6. Distribution of values at gluten elasticity

The determinations carried out on the Farinograph have provided information on the characterization of the quality of the flour mixtures in the form of a diagram. The time of development (min), stability (min) and degree of softening (UB for 10 min) were determined.

Mixing the dough is the first step and a very important one in the development of the dough. The time for development is determined by the amount and the gluten formed in the dough. By substituting the flour, the gluten content decreases therefore the time of development will be determined by the percentage with which the substitution of soluble fibers was conducted. For additions of 2.5%, 7.5% and 10% native inulin, it appears that the time of development of the dough increases (4.5min, 4.2 and 6.7min). The addition of native inulin in percentage of 5% decreases the time of development to 1.8 minutes. Similar results are found upon addition of oligofructose. Upon adding 5% FOS the time of development becomes 1.9 minutes.

The mixing parameters are determined by the presence and the nature of fibers added in the dough and they are important for water absorption, time of development, dough stability and degree of soaking of the dough to range between 8 – 20 minutes [13]. A shorter time of formation will lead to a dough more resistant to kneading, as dough will retain viscosity and its structure is more strongly linked.

By comparing the values obtained by the development of dough with those that indicate the stability of dough it is remarkable that the time of development leads to a higher stability of samples of dough knead in the Farinograph's bowl. A development time of 1.8 minutes (5% IN) leads to a stability of 12.2 minutes and the time of development of the sample with 5% FOS leads to a stability time of 13.8 minutes. The highest stability were registered in the samples with 7.5% and 10% native inulin and oligofructose.

The degree of softening is the difference between maximum consistency and consistency after 10 minutes of kneading dough. The samples of dough with an addition of 2.5%, 5%, 7.5% and 10% of native inulin and oligofructose are compared with the reference samples (0% addition) which present the highest levels of soaking. It is noted that the soaking time is directly proportional with the percentage of added fiber.

The increase value of dough development time may express an delay of the protein gluten hydration. Also it may be mention that by increasing the dough development time it increase shear dough viscosity and dough viscosity to stretch.

Pearson correlations between the quality characteristics of the samples of dough rheology, depending on the strength of their link, fall in the range (-1 +1). According to the correlation table (Table III) a strong positive link exists between gluten and its extensibility (r = 0.826). The stability of dough in inverse correlation with extensibility and elasticity (r=0.668, r=-0.668). Softening of the dough is in reverse correlation with its stability (r =-0.766). Even though the rheological properties of the bread dough were affected by the addition of inulin, the addition for strengthened bread of approximately 5% is feasible without significant negative consequences on the possibility of processing the dough. There are conflicting reports concerning the effect of the degree of inulin polymerization in conjunction with the quality of the dough.

TABLE III. CORRELATIVE LINK BETWEEN THE RHEOLOGICAL CHARACTERISTICS OF DOUGH

Correlation matrix (Pearson (n)):

Variables	Stretching (s)	Relaxation (UB)	Wet gluten (%)	Dev. time (min)	Stability (min)	Degree of soft. (UB .10 min)
Stretching (s)	**1**	0.020	**0.826**	-0.378	**-0.668**	0.131
Relaxation (UB)	0.020	**1**	0.009	-0.496	0.183	-0.363
Wet gluten (%)	**0.826**	0.009	**1**	-0.336	**-0.867**	0.511
Development time (min)	-0.378	-0.496	-0.336	**1**	0.134	0.118
Stability (min	**-0.668**	0.183	**-0.867**	0.134	**1**	**-0.766**
Degree of softening (UB .10 min)	0.131	-0.363	0.511	0.118	**-0.766**	**1**

IV. CONCLUSIONS

Soluble fibers are known to have many physiological benefits. In addition to the physiological effects on glucose in the blood it is to be noted that the addition of these fructans is promising because it does not change the food's flavor. Regarding the values obtained in the Farinograph, we are led to the conclusion that the dough's stability increases with the increase of inulin and oligofructose percentage. It is also noted that the development time is directly proportional with the percentage of added fiber. Water absorption decreases with increasing addition of inulin and oligofructose. The shorter the degree of polymerization of soluble fibers, the lower the water absorption in the dough is. The extensibility and elasticity determined with the aid of a Glutograph decreased upon addition of inulin and oligofructose. On a general note, the elasticity tends to increase with a procentual increase of inulin and oligofructose addition.

ACKNOWLEDGEMENT

This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, CNCS/CCCDI – UEFISCDI, project number PN-III-P2-2.1-BG-2016-0079, within PNCDI III.

REFERENCES

[1] B. Hiller, W. Schlörmann, M. Glei, and M. G. Lindhauer, "Comparative study of colorectal health related compounds in different types of bread: Analysis of bread samples pre and post digestion in a batch fermentation model of the human intestine," *Food Chemistry*, vol.125, pp. 1202–1212, 2011.

[2] D. Lairon, N. Arnault, S. Bertrais, R. Planells, E. Clero, S. Hercberg, and M. C. Boutron-Ruault, "Dietary fiber intake and risk factors for cardiovascular disease in French adults," A*merican Journal Clinical Nutrition*, vol. 82, pp. 1185–1194, 2005.

[3] A. S. Akalin, *et al*. "Effects of fructooligosaccharide and whey protein concentrate on the viability of lactic culture in reduced-fat probiotic yogurt during storage," *Journal of Food Science*, vol. 72, pp. 222-227, 2007.

[4] M. Iranshahi, S. M. S. Ardebili, and S. A. Y. Ardakani, "Effect of Inulin and β-glucan on the physicochemical, rheological, and sensory properties barbari bread," *Journal of Engineering Research and Applications*, vol. 4, no. 6, pp. 90-97, June 2014.

[5] C. Morris and G. A. Morris, "The effect of inulin and fructo-oligosaccharide supplementation on the textural, rheological and sensory properties of bread and their role in weight management," *Food Chemistry*, vol. 133, pp. 237–248, 2012.

[6] A. Hager, L. A. M. Ryan, C. Schwab, M. G. Gaenzle, J. V. O'Doherty, and E. K. Arendt, "Influence of the soluble fibres inulin and oat beta-glucan on quality of dough and bread," *European Food Research and Technology*, vol. 232, no. 3, pp. 405-413, 2011.

[7] J. Kaur and A. K. Gupta, "Applications of inulin and oligofructose in health and nutrition," *Journal of Biosciences*, vol. 27, pp. 703–714, 2002.

[8] R. Afshinpajooh, M. Saeidi, A. Abdollahzadeh, A. Enayati, M. Amini, and A. Seyedyaghoubi, "The effect of inulin addition on rheological and physical characteristics of pasta dough," *Journal of Food Science and Technology*, vol. 3, no. 4, pp. 15-27, 2012.

[9] T. Bojnanska1, M. Tokar, and A. Vollmannova, "Rheological parameters of dough with inulin addition and its effect on bread quality" in *Proc. Conference Series (Journal of Physics)*, 2015, p. 602.

[10] J. A. Brasil, K. C. Silveira, S. A. Salgado, A. V. Livera, C. Z. Pinheiro, D. Faro, and N. B. Guerra, "Effect of the addition of inulin on the nutritional, physical and sensory parameters of bread," *Brazilian Journal of Pharmaceutical Sciences*, vol. 74, no. 1, pp. 185-192, 2011.

[11] G. G. Codina, V. Paslaru, and A. Leahu, "Influence of inulin and pea fibre addition on the rheological properties of dough and bread quality," *Journal of Environmental Protection and Ecolog.*, vol. 12, no. 3, pp. 1132-1139, 2011.

[12] Z. Karolini-Skaradzińska, P. Bihuniak, E. Piotrowska, and L. Wdowik, "Properties of dough and qualitative characteristics of wheat bread with addition of inulin," *Polish Journal of Food and Nutrition Sciences*, vol. 57, no. 4, pp. 267-270, 2007.

[13] C. M. Rosell, E. Santos, and C. Collar, "Mixing properties of fibre-enriched wheat bread doughs: A response surface methodology study," *European Food Research and Technology*, vol. 223, no. 3, pp. 333–340, 2006.

[14] S. R. 90:2007, Wheat flour. Analysis method, ASRO, București

[15] S. R. EN ISO 712:2010, Cereals and cereal products - Determination of moisture content - Reference method, ASRO, București.

[16] S. R. EN ISO 2171:2010, Cereals, pulses and by-products - Determination of ash yield by incineration, ASRO, București.

[17] S. R. EN ISO 3093:2010, Wheat, rye and their flours, durum wheat and durum wheat semolina -Determination of the falling number according to Hagberg-Perten, ASRO, București.

[18] S. R. EN ISO 20483:2014, Cereals and pulses - Determination of the nitrogen content and calculation of the crude protein content - Kjeldahl method, ASRO, București.

[19] SR EN ISO 5530-1:2015, Wheat flour-Physical characteristics of doughs-Part 1: Determination of water absorption and rheological properties using a Farinograph, ASRO, București.

Georgiana Gabriela Codină, Associate Professor at Faculty of Food Engineering, Ştefan cel Mare University of Suceava, Romania. Finished PhD Studies with the thesis title: *Modification of rheological properties of dough during the technological process and its influence on the quality of bread*, in industrial engineering field. Teacher of courses in the areas of food science like food technology (bakery, beer and wine technology), sensory analysis, modern methods in food processing technology.

Member of the research team of "Quality Control Laboratory of Cereals and Bakery Products", Faculty of Food Engineering, Ştefan cel Mare University of Suceava, Romania. Member in editorial board of the journals: *Food Research International, Journal of Food Research - Canada, Journal of Food Studies – SUA, Romanian Journal of Food Science,* Reviewer for ISI journals with impact factor: Journal of Cereal Science, Journal of Food Quality, African Journal of Microbiology Research, Food Research International, Food and Bioprocess Technology, LWT – Food Science and Technology, Journal of Agricultural Science and Technology, e.g. Project manager of 3 research projects win by competition, author of 3 books in the food science field, author of 19 articles published in ISI journals (like main author 13), author of 57 articles in journals quoted in different international databases other than ISI (like main author 28), author of 3 patents.

Dumitru Zaharia is an administrator of S.C. Dizing S.R.L., Brusturi Neamt a factory with the main activities in baking, milling and car accessories. He has earned her PhD. in Industrial engineering in the food industry (milling and bakery) in 2012 from Lucian Blaga University of Sibiu. Is one of the most representative figures in Romania in the bakery and milling industry making at S.C. Dizing S.R.L. the most equipped laboratory from the bakery field from Romania country in which are developing different research activities.

She has over 20 years experience in production in the field of Food Engineering (milling and bakery) planning and putting in to service wheat silo at S.C. Dizing S.R.L., making the diagram design of the Dizing mill, planning the technological process and putting in to function the Dizing bakery, conceiving the design and development of new bakery products, e.g.

Results of research: 25 published or presented scientific papers, including 2 ISI articles and is the main manager as the economic partner for 2 research contracts won by competition: PN-III-P2-2.1-BG-2016-0136: High valorization of winemaking by products to obtain new bakery products improved nutritional, PN-III-P2-2.1-BG-2016-0079 Research on the use of inulin and minerals in bakery. Technological aspects (2016-2018).

PhD Engineer Dumitru Zaharia. is an important Member of the Board of the Association of Flour Milling and Baking Specialists Romania (ROMPAN) and of the Standing Bureau of the Chamber of Agriculture in Neamt County, Romania. Is participating as a food science expert on various TV programs from Romania country.

Silvia Mironeasa, Associate Professor at Faculty of Food Engineering, Ştefan cel Mare University of Suceava, Romania. Teacher of courses in the areas of food science like food quality and safety, food processing equipment, modeling techniques used in control of product and processes, et al. Member of the research team of "Quality Control Laboratory of Cereals and Bakery Products", Faculty of Food Engineering, Ştefan cel Mare University of Suceava, Romania.

Researcher in 16 research contracts with private organizations that carry out production and services (in 6 of them as project manager). Research project manager: PN-III-P2-2.1-BG-2016-0136: High valorization of winemaking by products to obtain new bakery products improved nutritional (2016-2018). Member in the project: PN II-RU-TE-2014-4-0214 Improvement of the biochemical, rheological and technological aspects in bread making by using different composite flours (2015-2017). PN-III-P2-2.1-BG-2016-0079 Research on the use of inulin and minerals in bakery. Technological aspects (2016-2018); PN-III-P2-2.1-BG-2016-0089 Diversification of its product range and improving the quality of the fermented milk products (2016-2018). No. of articles published in journals quoted ISI with impact factor: 16.

Adriana I. Dabija is an engineer who graduated Faculty of Food Science, Aquaculture and Fishing, Dunarea de Jos University of Galati in 1986 and an economist graduated from Bucharest Economics Science Academy, specialization: Business Management in 1999. She has earned her PhD. in Food Industrial Engineering in 2000 from Dunarea de Jos University of Galati.

She has over 30 years experience in the field of Food Engineering, 17 years experience in production - of which 15 years in the fermentation industry at S.C. Bere Lichior Margineni Bacau (1986-2001), 2 years at S.C. Pambac S.A. Bacau (2006-2007, Head of Research, New Products Design) and 21 years of service in higher education (1997-2009 at University of Bacau, since 2009 Associate Professor at Faculty of Food Engineering, Stefan cel Mare University of Suceava).

Areas of expertise: food biotechnology, technology and quality control in the dairy industry, fermentation technology, food microbiology. Results of research: 197 published scientific papers, including 9 ISI articles, 12 books, 10 research contracts, 4 as project manager.

Associate Professor PhD. Engineer Economist Adriana Dabija is a Member of the Board of the Association of Flour Milling and Baking Specialists Romania in 2014; Member of the Association of Specialists in Milling and Bakery - Romania in 2002; Member of the Technology Platform 'Food for Life' in 2007; Member SETEC -AGIR in 2009; Member of the Association of Food Industry Specialists in Romania, in Education, Research and Production (ASIAR) 2009.

Ropciuc Sorina- Lecturer at Faculty of Food Engineering, Stefan cel Mare University of Suceava, Romania. A graduate of the Faculty of Food Engineering and the Faculty of Agricultural Biotechnology. He finished a doctoral thesis: "The variation pharmacologically useful elements in fruit Rosehips depending on the stationary".

The activity is supported by scientific studies and researches conducted on the chemical composition of plant and animal materials, the influence of the addition of soluble and insoluble fiber in flour, research on the antioxidant activity of plant material fresh and preserved. Studies that have resulted in 11 articles and 36 articles in ISI journals listed in different international databases other than ISI. The didactic activity includes teaching courses in disciplines General Technologies (milk and meat industry), Principles of food preservation, food Biotechnologies. Membership in research projects: PN-III-P2-2.1-BG-2016-0079 Research on the use of inulin and minerals in baker (2016-2018), PN-III-P2-2.1-BG-2016-0136: High valorization of winemaking by products to obtain new bakery products improved nutritional (2016-2018), PN-II-RU-TE-2014-4-0110 Development and implementation of instrumental techniques for authentication and detection of counterfeiting of honey (2015-2017), Member of the Association of Food Industry Specialists in Romania.