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FOOD INDUSTRY WASTE: AN APPROACH OF REUSING WASTE RESULTED FROM VEGETABLES PROCESSING

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Abstract: *The residues resulting from the consumption of various fruits contain bioactive compounds with a significant value, but continue to remain unused. The aim of the present study is the capitalization of the properties of banana and apple peels and pomegranate seeds and their incorporation in new appetizer biscuits in powder form to improve the property of the products obtained.Physico-chemical and sensory properties of biscuits obtained with different proportions of powder obtained from the recovery of vegetable waste (10% powder obtained from banana peels, 10% powder obtained from apple peel, 10% powder obtained from pomegranate seeds and 30% mixed of the three powders obtained) in relation to the proportion of wheat flour added or analyzed. The crushing strength demonstrated that the samples with added powder obtained from the three sources recorded the highest force required for crushing - 1027.38 N/ mm^2, and the lowest force required for crushing was required for samples with added powder from apple peel - 1006.87 N/ mm^2.*
Keywords: *waste, reusing, rheological properties, products, industry*

1. INTRODUCTION

Biscuits are flour products obtained by baking a loose dough prepared by using: flour, sugar, fats, eggs, honey, glucose, milk, flavors, chemical and biochemical softeners and other raw and auxiliary materials that improve their organoleptic characteristics (margarine, honey, etc.).
Consisted mainly of white wheat flour, the development of the manufacture and the quality conditions of the biscuits require that the flours used for this production meet certain physicochemical and technological characteristics.
The range of biscuit assortments is very rich due to the numerous raw and auxiliary materials used, the different proportions of raw materials and the applied technological processes. The high content of fatty substances and carbohydrates in biscuits is an important source of energy in the diet.
Currently, there are considerable amounts of residues from the industries that process vegetable sources such as – juice processing, preserves, different jelly products and several desserts. After closing the production cycles, the quantity of peels, seeds and drained products are redirected and stored in order to be thrown away. Even after grinding of vegetables and fruits, the resulting matter contains important amounts of valuable substances that can be easily reused. The residues resulting from the consumption of various fruits contain bioactive compounds with a significant value, but continue to remain unused. [1]
Regularly, depending on the type of food source material and the technological indications definitely influences the type and volume of wastes produced. They mainly include the skins and outer coverings of fruits and vegetables, peels, seeds, pits and pulp.
Processing wastes can be derived from several considerations, the most important mentioned including processes losses, lack of conformity and inappropriate storage.
According to Eurostat database of the European Union Commission (EC) the amount of waste is estimated around out of 89.279,000 tons/ year of waste resulting from processing in the European Union and about 2.734,756 million/ year generated from the manufacturing sector. [2]
Concerning breadmaking industry, bread and bread products offer the perfect substrate for delivering health benefits to human consumption. Considering this aspect, biscuits are a priority medium for improving functional components. Side-products of fruits and vegetables are usually exploited for their high content in valuable content of dietary fiber. [3]
These flours will improve the nutritional composition of classic biscuits and in addition will give them a special flavor.
Banana (*Musa*) peel powder has a high content of iron, potassium, vitamin B complex and vitamins C and K. [4]
Apple (*Malus domestica*) peel powder has a very high content of antioxidants, vitamins and minerals. Amino acids and vitamins B, C and E are found in abundance having an important role in the immune system. [5]

Pomegranate (*Punica granatum*) seed powder is rich in fiber, vitamins K and E, contains low amounts of magnesium, calcium, zinc and iron. [6], [7]
By introducing banana peel powder, apple peel and pomegranate seed powder into the composition, the aim is to increase the content of fiber, vitamins and proteins, thus obtaining biscuits with superior qualities in terms of composition.
The object of the present study is to highlight the properties of banana, apple peels and pomegranate seeds and their incorporation in new appetizer biscuits as powder form in order to improve the properties of the obtained products.

2. MATERIALS AND METHODS

2.1. Materials

White wheat flour
White wheat flour, type 000, with and ash content of maximum 0.48%, was obtained from a Romanian Milling Company (7 Spice, Vâlcea).

Pomegranate seeds powder
Was obtained by grinding the dried pomegranate seeds and sieving the resulting powder.

Apple peel powder
Was obtained by drying the apple peels in small pieces, then dehydrate until the moisture content decreased and mincing until resulting a fine powder.

Banana peel powder
Banana peels were removed from the core, cleaned and then divided in small pieces of about 2x2 cm and then placed for dehydrating and mincing.

Sugar, oil, eggs, baking powder
Were achieved from a local market in Brașov, Romania.

2.2. Methods

Obtaining the powders
The vegetable sources were disinfected using sodium bicarbonate. Then, were divided in small pieces and placed on filter paper on the dehydrator plates for about 6 hours at 45ºC. After the dehydration process, the peels were collected and minced at speed 10 for about 1 minute using Thermomix TM5. The resulted powder was collected and sieved using sieves with 125 m, then stored in paper bags until processing for biscuit manufacturing.

Figure 1: By-products powders obtaining working procedure

Manufacture of the biscuits
The biscuits were obtained following the ratio from Table 1.

Table 1: Samples coding and the proportions of by-products powder added

Sample coding	Wheat flour (g)	Banana peel powder (g)	Apple peel powder (g)	Pomegranate seeds powder (g)
Blank sample (PM)	200	0	0	0
Banana peel sample (P1)	190	10	0	0
Apple peel sample (P2)	190	0	10	0
Pomegranate seed sample (P3)	190	0	0	10
Mix powders sample (P4)	170	10	10	10

The raw and auxiliary materials were prepared – weighted for the required quantity, dosed accordingly. Firstly, the dry matters were mixed for 3 minutes speed 2 using a planetary mixer – Tefal Wizzo QB307538. After the mixing of dry matters, the liquid materials were added and mixed until forming a homogenous mass speed 2 for 5 minutes. The obtained mass was removed from the mixer bowl and placed for rest for 5 minutes at 22°C. After resting, the dough was laminated 1 cm thickness and then cut in the desired shapes. The shaped dough pieces were then placed in the oven tray on a baking paper, greased with egg yolk and then baked at 175°C for 15 minutes using Whirlpool W7OM44S1P oven. After baking, the biscuits were allowed to cool at room temperature for 1 hour.

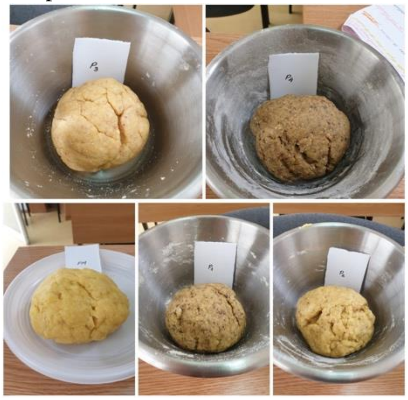

Figure 2: The obtained dough pieces **Figure 3**: The baked samples **Figure 4**: The obtained samples

Physicochemical analysis

Titratable acidity and moisture content – were performed according to the methods described by SR 1227/3-90. [8]

Rheological behaviour

Compression resistance – was performed using Zwick Roell Z010 and compression test kit to determine material behavior under constantly increasing compressive loading.

Sensory analysis

The overall acceptability of the products was evaluated by considering two profiles – odor profile and taste profile. Odor profile included intrinsic attributes as intensity, color intensity, complexity, acceptability, sweetness, complexity, lack of flavor and taste profile included complexity, fullness, astringency, acidity, bitterness, duration and intensity. For performing the analysis, a 9 point hedonic scale was used. Each scale was corresponding to a perception in order to facilitate data processing – 1 = "Dislike extremely," 2 = "Dislike very much," 3 = "Dislike moderately," 4 = "Dislike slightly," 5 = "Neither like nor dislike," 6 = "Like slightly," 7 = "Like moderately," 8 = "Like very much," and 9 = "Like extremely". Sensory analysis was performed at Faculty of Food and Tourism, Brașov. The area was illuminated in white light and day light. Panelists who declared suffering of different digestive problems were excluded from the study due to the high risk of aggravation of the diseases.
While performing the analysis, the panelists were presented a total of five samples of the product as indicated in table 1.
Panelists were asked to evaluate each sample for the assessed parameters. Panelists received the samples by turn in order to diminish the similarity and interdependence between samples with a 5 minutes rest before each sample tasting. Samples were coded accordingly to the codification above mentioned and each sample was dosed

in glass containers 20 ± 1 g and placed at 4…6ºC until serving. Panelists were served a glass of water as a palate cleanser.

3. RESULTS AND DISCUSSION

The obtained results are recorded in Table 2.

Table 2: Physicochemical parameters determination

Physicochemical parameter	Value, %				
	PM	P1	P2	P3	P4
Titratable acidity	1.3	1.2	1.2	1	1.4
Moisture	14.2	13.2	10.4	12	11

3.1. Determination of titratable acidity

Analyzing the data obtained after determining the acidity of the product samples obtained, it can be observed that the sample with the lowest acidity value was the sample 4 - 1.4 %. The addition of the three types of powder led to high acidity values, the bioactive compounds contained by them, influencing the values obtained. The highest value of acidity was recorded for the sample with the addition of pomegranate seed powder - 1 %, the acidic character of pomegranate being found in the finished product. Samples with the addition of banana peel powder and apple peel powder provided equal values of acidity - 1.2 %. Compared to the control sample, the acidity values were not significantly different, which highlights the conclusion that the addition of powders obtained from different plant sources does not definitively influence the acidity of the samples.

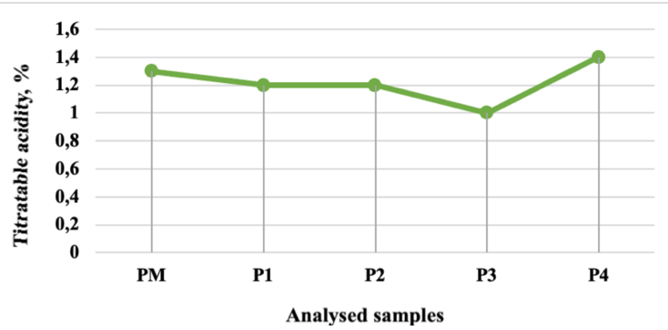

Figure 5: The results obtained for the acidity determination

3.2. Determination of moisture content

Concerning the data in the graph in figure 6, it can be seen how the moisture content of the samples obtained with different addition of by-products powder was significantly lower compared to the control sample. Thus, the lowest value was obtained for sample P2 - 10.4%, followed by sample P4 - 11%, P3 - 12% and P1 - 13.2%. The addition of apple peel caused a lower moisture retention, due to the amount of pectin contained and its hydrophilic character. All the added ingredients used influenced the moisture retention capacity of the samples obtained, their character being reflected in the results obtained.

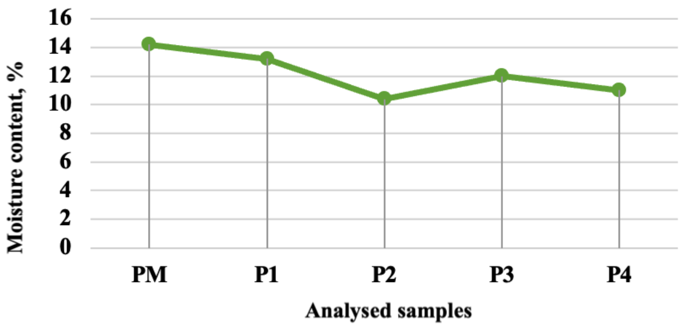

Figure 6: The results obtained for the moisture content determination

3.3. Rheological behavior

Table 3: Values obtained for the determination of crushing strength

Nr. crt.	F_{max} N/ mm^2	F_{Break} N/ mm^2	e-Break mm	e-F_{max} mm	EMod N/ mm^2
1.	1011.26	-	-	9.25	47136.97
2.	1022.64	-	-	10.27	4568.50
3.	1015.86	-	-	9.13	16340.24
4.	1006.87	-	-	12.31	17469.66
5.	1027.38	-	-	9.39	5580.39

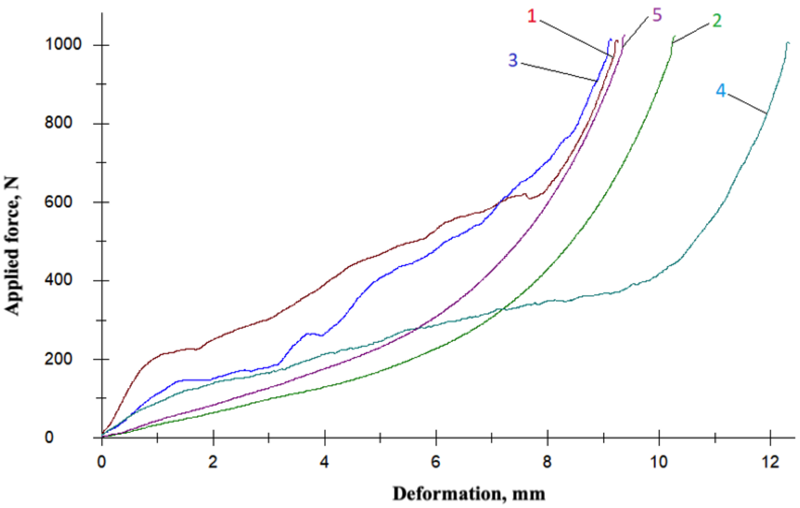

Figure 7: Compression resistance chart resulted
(1 – Blank sample (PM); 2 – Sample 1 (P1); 3 – Sample 2 (P2); 4 – Sample 3 (P3); 5 – Sample 4 (P4))

The chart in Figure 7, shows how the largest deformation was recorded for sample P3, with the addition of pomegranate seed powder. The addition of pomegranate seed powder gave the samples a lower resistance to crushing and provided a greater deformation due to the applied force. The rheological behavior of the samples with the addition of banana peel and apple peel powder was similar to that of the control sample, the values of the deformation recorded being similar.

3.4. Sensory evaluation

Sensory evaluation of samples was conducted using 5 formulation of biscuits. The sensory analysis suggested that the appearance received maximum ratings for all samples, the biscuits being well baked, whole, regular shape, unburned. Also, the odor, color and consistency had maximum score. With a color from golden yellow to uniform brown, a characteristic odor of powders and a tender consistency, the biscuits proved a real success among the tasters. In terms of taste, the lowest score was obtained by the sample with the addition of banana peel powder, followed by the control sample and the sample with the addition of apple peel powder. The scoring points were slightly lower than in the other samples analyzed but for the final test, which contains all three types of powder, the score was maximum. Considering these aspects, the obtained biscuits were accepted by the consumers, the sensory profile being positively accepted.

Table 4: Sensory evaluation of samples

Samples	PM	P1	P2	P3	P4
Appearance	8.8	8.9	7.8	7.5	7.7
Taste	7.2	8.7	7.5	7.8	8.1
Odor	7.5	8.5	8	8.2	8.6
Color	7.8	8.8	8.2	8	8.1
Consistency	8.3	8.8	8.7	8.7	8.5

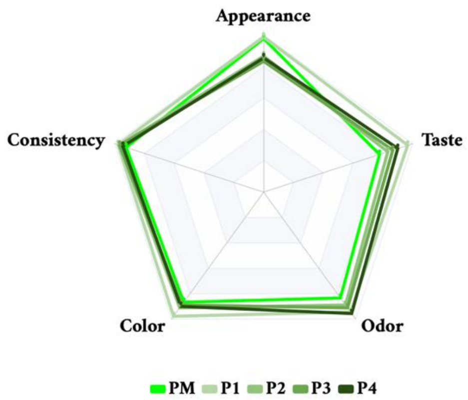

Figure 8: Sensory evaluation of samples

4. CONCLUSION

Valorization of the bioactive components content in several by-products resulted during processing of vegetable sources is a perspective for the future composition of the existing products. Bread and bread products, such as biscuits represent an adequate matrix for adding ingredients with beneficial potential. Biscuits represent a proper alternative for on-the-go snacks due to easiness of handling and storage.

The current study was focused on analyzing and establishing the main physicochemical parameters of the obtained samples – titratable acidity and moisture content, rheological parameters and sensory profile. It was observed that the acidity profile was strongly influenced by the type of addition and the chemical composition of the ingredient. The addition of pomegranate seeds was the most effective, the titratable acidity of the final product being the highest.

Regarding the moisture content profile, the lowest value was recorded for the sample with addition of apple peel – 10.4%, considering the fact that apple peel contains pectin into the structure even after removal from the core and the hydrophilic fractions absorb the moisture existing in the product.

From the analysis of the graph of crushing strength, it can be seen how the largest deformation was recorded for sample P3, with the addition of pomegranate seed powder. Pomegranate seeds provided a higher value of the deformation, requiring a lower value of the applied force.

The sensory profile of the samples was positively appreciated by the panelists, the addition of several ingredients being marked with higher points. The most appreciated sample type was the sample containing banana peel addition and scored with 8.7 points.

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