Scientific report

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Project: Innovative approach to develop value-added snack products through extrusion technology

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Project website: https://fia.usv.ro/cercetare/inadext

The research project aims to make better valorization of grape pomace obtained from some of the Romanian grape intensively cultivated varieties (white and red) in combination with maize flour by using extrusion technology to enhance snacks production sustainability and to contribute to a lower ecological impact.

Related to this concern, in the *first stage* of the project, it will be assessed the physical-chemical characteristics, molecular characterization and functional properties of grape pomace and maize flour (**O1** objective) that wants to be used as raw materials in extrusion process. The activities related to this objective (**O1**) from the first stage of the project 2/06/2022 - 31/12/2022, according to the Annex II/Additional act 1/2022 of Contract no. PCE 60 / 2022, were the following:

A1.1. Physico-chemical composition, molecular characterization and functional properties of grape pomace determination. The following estimative results will be obtained: moisture, ash, acidity, colour, protein content, fat, dietary fiber, total sugar, total phenolic content, antioxidant activity, molecular characteristics, and functional properties (water retention capacity and swelling capacity).

A1.2. Physico-chemical, and molecular characterization and functional properties of maize flour assessment. The estimative results that will be obtained consist on: moisture, ash, acidity, colour, protein content, fat, dietary fiber, total sugar, total phenolic content, antioxidant activity, molecular characteristics, and functional properties (water retention capacity and swelling capacity).

A1.3. Data collection, elimination of aberrant results and evaluation of the degree of validity and fidelity of the obtained results.

As deliverables associated to activities (A1.1, A1.3, and A1.3) specific to O1 objective, a data base with physical-chemical, molecular characteristics and functional properties of grape pomace and of maize flour was achieved. Also, the scientific report on these characteristics of grape pomace and of maize flour respectively, the raw materials which will be use in future experiments, was made.

The objective of the first stage with specific activities and deliverables have been achieved.

Research materials and methods

To carry out the activities related to the objective of the first stage of the project and to achieve the estimated results, the *research materials* and *methods* presented in Table 1 were used.

Maize flour and grape pomace represent the main materials used in the experimental research. Maize flour was supplied from Ruagnessy S.R.L., Satu Mare, and grape pomace from Iasi Research and Development Center for Viticulture and Vinification. In order to preserve the grape pomace, two gently drying methods were used, drying in convection oven at 50 °C and lyophilization which may help us to maintain in a more compact way the biochemical components. The grape pomace samples studied with their specific abbreviations were presented in Table 1.

Table 1. Methods for determining the characteristics of maize flour and grape pomace

Material	Method / standard	Characteristics
Maize flour (MF) Grape pomace *dried in a convective oven* (O): - grape pomace from white variety (GPW_O) - seedless grape pomace from white variety (SGPW_O) - grape pomace from red variety (GPR_O) - seedless grape pomace from red variety (SGPR_O) *Lyophilization* (L) grape pomace: - grape pomace from white variety (GPW_L) - seedless grape pomace from white variety (SGPW_L) - grape pomace from red variety (GPR_L) - seedless grape pomace from red variety (SGPR_L)	- moisture determination / SR EN ISO 712:2010	- moisture (%)
	- determination of ash content by calcination / SR EN ISO 2171:2010	- ash (%)
	- acidity determination / SR 90:2007	- acidity (degrees of acidity)
	- colour parameters determination by using colorimetric method	- colour parameters in CIE Lab system: L^*, a^*, and b^*
	- determination of lipid content by using the Soxhlet method / AACC Method 30-25.01 or ICC 136	- lipid (%)
	- determination of protein content by using the Kjeldahl method / AACC Method 46-12.01 or ICC 105/2	- protein (%)
	- determination of total dietary fiber content / AACC 32-05.01 method	- total dietary fiber (%)
	- determination of total sugar content by using Fehling's reagent	- total sugar (%)
	- determination of molecular characteristics by using Fourier-Transform Infrared (FTIR) spectroscopy	- molecular characteristics: primary and secondary metabolites
	- determination of functional properties, water retention capacity (WRC) and swelling capacity (SC)	- WRC (%) - SC (mg/L)
	- determination of the total phenolic content (TPC) by using Folin-Ciocalteu method	- TPC (mg GAE/g dw)
	- antioxidant activity determination by using 2,2 – diphenyl-1-1picrylhydrazyl (DPPH) method	- antioxidant activity (µg/mL)

Results and discussions

The data collected from the research activities proposed and conducted during the first stage of the project, 2/06/2022 - 31/12/2022, according to the Annex II/Additiona act 1/2022 of Contract no. PCE 60 / 2022, were assessed from statistically point of view, the aberrant results were eliminated and then the degree of validity and fidelity of the obtained data were evaluated. A data base with physico-chemical, molecular characteristics and functional properties of raw materials, grape pomace and maize flour was achieved. This data base with the results obtained will serve as basis for subsequent objectives that were included in next stages.

The results showed that the physical-chemical characteristics of pomace varied depending on the grape variety, the dried method and the type of grape pomace sample (seedless or with seeds). The values obtained were in according to those presented in specialty literature (Iuga and Mironeasa, 2020; Beres et al., 2019; Maurer et al., 2019).

Grape pomace *acidity* showed variations from one type of sample to another as function of components, dried method and grape variety. Both grape pomace and maize flour acidity are within the recommended limits.

No regular trend was observed when comparing *ash* among white and red grape pomace samples with the same components and of the same type, in respect to the drying method.

Regarding *moisture* content, the values obtained depended on initial moisture of grape pomace and type of the dried method applied. Maize flour had a higher moisture compared to dried grape pomace, but the moisture content for both raw materials ensure appropriate storage stability.

The *colour parameters*, luminosity (L^*), red or green nuance ($+a^*/- a^*$), and yellow or blue nuance ($+b^*/- b^*$) of analyzed samples were directly connected to the chemical compounds of grape pomace and maize flour, such as pigments. All lyophilizated samples presented a lighter color (higher L^* value) compared to the oven dried samples for both white and red grape pomace samples. The maize flour luminosity is approximately twice that of the grape pomace samples.

The content of *lipids* was lower in seedless grape pomace, for both white and red varieties, dried in oven or lyophilization, whereas the carbohydrates decreased. A high content of lipids was found in the both varieties of grape pomace with seeds. Lipids value is mainly associated with the seeds that are richer in oil, more than peels. There were no significant differences between grape pomace samples dried in oven or through lyophilization from point of view of lipids, proteins, and ash. Maize flour has a much lower lipid content compared to grape pomace.

Ash, protein and lipids were in higher amounts in red grape pomace compared to white grape pomace. This findings are in agreement to those observed by other authors (Mironeasa, 2017; Spanghero et al., 2009).

The results obtained for *total dietary fiber* content showed that the values depending on variety and grape pomace sample type. The grape pomace seedless contain a lower total dietary fiber compared to grape pomace with seeds. Also, differences between samples dried in oven and thoses lyophilizated from the total fiber content point of view were identified. For maize flour, the total fiber content was much lower compared with analyzed grape pomace samples.

Regarding *total sugar*, grape pomace from red variety presented a high content compared to grape pomace from white variety, probably due to the different winemaking procedures applied. White grape pomace was procured right after pressing juice, whereas red grape pomace was obtained after fermented several days in order to extract colour and polyphenols. A high content of total sugar was obtained in grape pomace lyophilizate samples compared to the samples dried in a conventional oven, fact which revealed the strongly influence of the drying methods applied.

The results obtained for physical-chemical characteristics of grape pomace showed that the difference in winemaking practices resulted in different chemical compositions of grape pomace. The data obtained are included within the usual range reported for white and red grape pomaces from wine production (Saura-Calixto, 1998; Llobera and Canellas, 2007). The results obtained for maize flour characteristics revealed values that are within the limits mentioned in national or international standards.

The *molecular characteristics* evaluated by using FTIR spectroscopy technique allowed to obtain the spectra which present some characteristic bands of individual components. These bands provide information about the chemical composition, including both primary and secondary metabolites, of the investigated samples. FTIR spectra for *maize flour* revealed the distribution of nutritional components, such as moisture, proteins, lipids, ash, carbohydrates, starchy polysaccharides, and also amide I, amide II, amylose and amylopectin at typical bands of individual components. In addition, the functional groups of the bioactive compounds, different phenolic compounds, fatty acids, polysaccharides, lignins, pectins, and organic compounds, such as sugars, alcohols, and organic acids present in *grape pomace* were identified. These results show that FTIR spectral features are linked to grape variety, methods used to dry, and also depending by the grape pomace sample type.

The *total phenolics* from grape pomace were influenced by the pomace drying methods, depending also on the grape variety, and on the grape pomace sample type. The higher values for

the total phenolic content was found in seedless grape pomace samples. The amounts of total phenolic compounds determined in the maize flour are much lower than those obtained in grape pomace.

The *antioxidant activity* of grape pomace samples, evaluated through their action in DPPH radical inhibition, showed different trends depending of the sample type. The high antioxidant activity was observed in grape pomace with seeds compared to seedless grape pomace. Maize flour presented a lower antioxidant activity as compared to grape pomace. This data indicates that the antioxidant activity is not only related with the total phenolic content, but also with the different phenolic compounds that are presents in each sample extract. Different compounds have different antioxidant activities (Natella et al, 1999). The results obtained highlited that grape pomace, an underused by-product of the wine making process, could be an alternative source of natural antioxidants that can be considered completely safe in comparison with the synthetic ones.

For *functional properties* (water retention capacity and swelling capacity) of grape pomace and maize flour, different values were obtained and varied depending of the sample type, whereas for grape pomace the values varied as function of the drying method used. Remarkable differences were obtained between some liophilizated and dried oven grape pomace samples, depending on the grape variety for water retention capacity and swelling capacity. The data obtained for maize flour revealed that it can absorb and retain water the same as to the grape pomace. The drying and the milling processes changes the physicochemical characteristics of materials, affecting the functional properties of the studied samples.

In according to the work plan, the main attributes and characteristics of extrusion equipment and the necessary steps for the purchase were carried out. In this regard, the specifications were drawn up and uploaded to the platform of the Electronic Public Procurement System (SEAP), the offers were analyzed, the gainer was designated and the purchase contract was concluded with the supplier S.C. NITECH S.R.L. Bucureşti.

In order to procure the grape pomace, I went at the Research and Development Center for Viticulture and Vinification from Iaşi.

As deliverables in the monitoring an internal evaluation of the project activities, the web site of the project (https://fia.usv.ro/cercetare/inadext) was created, and the scientific and technical report, and financial report for first stage was done. Also, the audit report for this first stage was achieved.

In conclusion, ***all the activities have been carried out, and the estimated results and the deliverables has been achieved***.

Abstract

The project entitled *Innovative approach to develop value-added snack products through extrusion technology* focuses on obtaining new snack products by valorization of grape pomace for superior health properties in extrusion technology. Use of grape pomace and maize flour in new snacks formula can enhance the nutritional content of the extruded snacks. The improvements of nutritional profile of extruded snack products are highly desirable in the food industry.

All the activities (A1.1, A1.3, and A1.3) associated to O1 objective from the first stage were achieved and the estimated deliverables were obtained.

The physico-chemical, and molecular characterization and functional properties of grape pomace from white and red varieties and of maize flour, raw materias used in the extrusion process, were determined. In this respect, the moisture, acidity, colour parameters, ash, lipids, protein, total dietary fiber content, total sugars, total phenolics, antioxidant activity, molecular characteristics and functional properties (water retention capacity and swelling capacity) were determined. A data base with the results was created.

For the extrusion equipment than will be acquired, the purchase contract was concluded with the supplier S.C. NITECH S.R.L. Bucureşti.

The web site of the project (https://fia.usv.ro/cercetare/inadext) has been created.

References

Alonso, C., Rubio, L., Touriño, S., Martí, M., Barba, C., Fernández-Campos, F., ... & Parra, J. L. (2014). Antioxidative effects and percutaneous absorption of five polyphenols. *Free Radical Biology and Medicine*, 75, 149-155.

Beres, C., Freitas, S. P., Godoy, R. L., de, O., de Oliveira, D. C. R., Deliza, R., ... Cabral, L. M. C. (2019). Antioxidant dietary fibre from grape pomace flour or extract: Does it make any difference on the nutritional and functional value? *Journal of Functional Foods*, 56, 276–285.

Deng, Q., Penner, M. H., & Zhao, Y. (2011). Chemical composition of dietary fiber and polyphenols of five different varieties of wine grape pomace skins. *Food Research International*, 44(9), 2712-2720.

Iuga, M., & Mironeasa, S. (2020). Potential of grape byproducts as functional ingredients in baked goods and pasta. *Comprehensive Reviews in Food Science and Food Safety*, 19(5), 2473-2505.

Llobera, A., & Canellas, J. (2007). Dietary fibre content and antioxidant activity of Manto Negro red grape (Vitis vinifera): pomace and stem. *Food Chemistry*, 101(2), 659-666.

Maurer, L. H., Cazarin, C. B. B., Quatrin, A., Minuzzi, N. M., Costa, E. L., Morari, J., ... Emanuelli, T. (2019). Grape peel powder promotes intestinal barrier homeostasis in acute TNBS-colitis: A major role for dietary fiber and fiber-bound polyphenols. *Food Research International*, 123, 425–439.

Mironeasa, S. (2017). *Valorization of secondary products from wine making*. Iași, Romania: Performantica Publishing House.

Natella, F., Nardini, M., Di Felice, M., & Scaccini, C. (1999). Benzoic and cinnamic acid derivatives as antioxidants: Structure– activity relation. *Journal of Agricultural and Food Chemistry*, 47(4), 1453-1459.

Saura-Calixto, F. (1998). Antioxidant dietary fiber product: A new concept and a potential food ingredient. *Journal of Agricultural and Food Chemistry*, 46(10), 4303–4306.

Spanghero, M., Salem, A. Z. M., & Robinson, P. H. (2009). Chemical composition, including secondary metabolites, and rumen fermentability of seeds and pulp of Californian (USA) and Italian grape pomaces. *Animal Feed Science and Technology*, 152(3-4), 243-255.

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