Valorization of grape stems as a functional ingredient in ruminant diets

D. San Martin*[1], J. Ibarruri[1], A. García-Rodriguez[2], I. Goiri[2], R. Atxaerandio[2], N. Luengo[1], J. Ferrer[1], J. Zufía[1], M. Gutierrez[1], E. Sáez de Cámara[3], B. Iñarra[1]

[1]AZTI, Food Research, Basque Research and Technology Alliance (BRTA), Astondo Bidea, Edificio 609, 48160 Derio, Bizkaia, Spain

[2] NEIKER, Basque Institute for Agricultural Research and Development, Basque Research and Technology Alliance (BRTA), Campus Agroalimentario de Arkaute s/n, 01192 Arkaute, Spain

[3] Faculty of Engineering Bilbao, University of the Basque Country (UPV/EHU), Ingeniero Torres Quevedo Plaza, 1, 48013 Bilbao, Spain

Keywords: Circular economy; food waste; wineries; Sugar; animal feed

*Presenting author email: dsanmartin@azti.es

Introduction

The average annual production of wine in the EU is of 167 million hectolitres (Eurostat 2019). Among the winery by-products, grape stems, pomace, and lees are the most significant, being grape stem the only by-product of winemaking that is managed as waste by amending the soil, usually in the vineyard itself. For each kilogram of grapes processed in winemaking, 0.21 kilograms of grape stems are generated. Currently, the management of wine by-products is carried out without a standardized protocol and is assumed individually by the wineries. Within this context, it is necessary to improve the valorization options that lead to the development of an innovative plant where new bioproducts are developed from by-products such as grape stems.

At the same time, the scarcity of raw materials for feed formulation makes it necessary to search for new alternatives to current ingredients, with less external dependence and environmental impact. The available data on the chemical composition of grape stems show its content in polyphenols, which show important antioxidant properties. In this sense, the phenolic composition of grape stems confers a wide range of biological and physiological effects such as anti-allergic, anti-inflammatory, antithrombotic, antioxidant, antimicrobial (antiviral, antibacterial, antifungal) and modulators of various enzymes. These biological and physiological effects imply a series of healthy effects for the organism. Thus, the high polyphenol content, associated with its high fiber content, makes it very interesting as a new fiber-rich functional ingredient for ruminant diets.

In addition, it is necessary to use a drying technology to reduce the humidity and to avoid the microbial spoilage and the degradation of main high value-added nutritional and healthy compounds such as polyphenols. Even more, the traditional drying processes (rotary drum, fluidized bed, etc.) are energy-intensive processes and, consequently, most of the time they are economically unfeasible at industrial scale. Hence, more efforts are required to develop more sustainable and economical drying technologies, such as the flash drying technology used to dry the grape stem ingredient for ruminants. These grapes have a high sugar content that reduces the drying efficiency due to sugar melting at high temperatures. In order to avoid it, a previous washing step, traditionally applied in the citrus juice industry has been applied obtaining a liquor rich in sugar with food applications.

In this framework, this study aimed to evaluate the effect of flash drying process on the nutritive value of grape stem-based ingredients and to evaluate the use of the grape stem ingredient as a functional ingredient in the concentrate of dairy ewes in vivo tests.

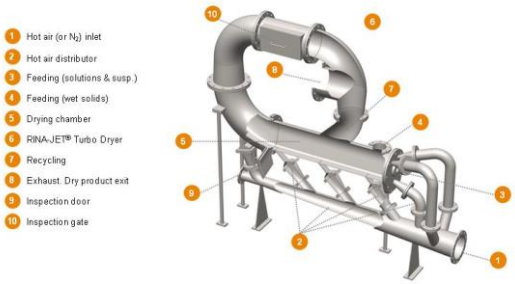
Material and methods

The grape stem samples were collected from Baigorri S.A. winery from Samaniego in Spain.

The grinding was performed in a Comitrol® Model 1700 Processor (Urschel, Chesterton, Indiana, USA) to reduce particle size and ensure homogenization of the samples. The equipment consisted of a 10 hp motor with 1000-3000 rpm.

A washing process was carried out using The JBT FoodTech UPF100 Finisher, a paddle finisher, which has capabilities for a full range of citrus processing, including juice finishing (separating juice from pulp), oil finishing (separating frit from the oil water emulsion), recovery of soluble solids (pulp wash) core wash and pulp packaging. A ratio of 1:1 grinded grape stem: water was used for the washing process.

The stabilization and adaptation of the grape stems to the needs of the animal feed sector was performed using RINA-JET turbo-dryer. This technology is suitable for thermosensitive products.



The nutritional value of the ingredients prototypes was measured by applying the Association of Official Analytical Chemists (AOAC) Official Methods. Afterwards, feeding trials with dairy ewes have been performed to assess the suitability of these ingredients for animal feeding and its effects in production performance, milk quality and sensory analysis. Finally, sensory tests were performed to ensure the suitability of the obtained milk.

Results and discussion

One ton of grape stem was grinded to reduce the particle size for a better processing of raw material. This grinded grape stem had 69 % of humidity and a 19 % of sugars in dry matter basis. For the washing process water was added in a 1:1 ratio (w:w) and two products were obtained:

- Washed grape stem: 79.5 % humidity 1.23 tn
- Liquor: 0.78 tn, 6.2 °brix, 60 g sugars/L

The sugar-rich liquid could be used as a raw material for other applications such as bioethanol production or as an ingredient in the food industry.

Washed grape stem, on the other hand, is an ingredient with lower sugar content (5-7 % reducing sugars), which makes them better preserved and can be dried more efficiently. Washed grape stem was dried using the flash drying technology and 0.34 tonnes of dried prototype (10 % humidity) were obtained from each ton processed.

The grape stem ingredient was formulated in 10% inclusion in dairy ewes for in vivo trials. Results showed no differences between none of the parameters analyzed, therefore there was no difference between including 10 % of grape stem ingredient in the total intake of the forage and the concentrate (Kg/day), milk yield (mL/day), fat, protein and lactose percentage in milk, and in protein and corrected milk yield. In addition, after the sensory analysis, result showed that consumers cannot distinguish curdles produced with milk obtained from ewes consuming 10% grape stem.

Conclusions

Sugar rich liquor and a potential ingredient for animal feed formulation are derived from grape stems. These stems have a naturally high sugar content due to the presence of numerous grapes. However, a specifically designed washing process has significantly reduced this sugar level, thereby enhancing the efficiency of drying.

The rich polyphenol content in washed grape stems presents them as a promising alternative and functional ingredient in animal feed. Yet, their inclusion in concentrated feed should not exceed 10% to prevent diminishing its nutritional value, given their high fibre content. However, this 10% inclusion reduces dependence on other cereals and introduces a component rich in polyphenols, which may positively affect animal health.

Formulating grape stems up to 10% in the concentrate does not negatively impact dry matter intake, milk production, milk composition, or the overall production efficiency in dairy ewes. Interestingly, consumers are unable to differentiate between curds made from the milk from ewes fed with a 10% grape and that from ewes fed with the control diet.

Acknowledge

The research leading to these results has received funding from the European Union's PRIMA Program for Research, Technological Development and Demonstration under grant agreement n°2013 and Basque Country government through the FEADER funds.

References

D. San Martin, J. Ibarruri, N. Luengo, J. Ferrer, A. García-Rodriguez, I. Goiri, R. Atxaerandio, J. Zufía, E. Sáez de Cámara, B. Iñarra. Evaluation of Valorisation Strategies to Improve Grape Stems' Nutritional Value as an Ingredient for Ruminants' Diets. Sustainability 15, 11951 (2023). Doi: 10.3390/su151511951

I. Gouvinhas, R,.A. Santos, M. Queiroz, C. Leal, M. J. Saavedra, R. Domínguez-Perles, M Rodrigues, A.I.R.N.A Barros. 2018. Monitoring the antioxidant and antimicrobial power of grape (Vitis vinifera L.) stems phenolics over long-term storage. Industrial Crops and Products.126: 83-91

K. Filippi, N. Georgaka, M. Alexandri, H. Papapoustolou, A. Koutinas. 2021 Valorisation of grape stalks and pomace for succinid acid by Actinobacillus succinogenes. Industrial Crops and Products 168, 113578