Biorefinery of grape stem to obtain a sugar-rich liquor for food applications and an ingredient for animal feed

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Keywords: Circular economy; Food waste; Wineries; Bioethanol; Ruminants

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Introduction

EU is the world-leading producer of wine with 167 million hectolitres per year (Eurostat 2019). Among the winery by-products, grape stems, pomace, and lees are the most significant ones. About 0.21 kg of grape stems are produced per kg of grapes. Grape stems are not currently valorised, and they are sent for composting or discarded in open areas, which involves important economic costs and environmental impacts to the wineries.

The stems include a significant number of grapes that have not been separated during destemming. These grapes have a high sugar content of value in the food industry (bioethanol production). This sugar content can be recovered by applying a water washing pre-treatment: around 15 and 22 g/L of reducing sugars. On the other hand, they are rich in fibre, such as cellulose, hemicellulose and lignin, which are of great interest in animal nutrition, and in polyphenols, with beneficious biological and physiological effects if they are included in the diet of animals. However, they must be stabilized through a drying process to increase their shelf life. In this sense, although the benefits of using these by-products as feed ingredients have already been proven through in-vitro assays, there is still the need of gaining knowledge about other livestock species (e.g., dairy cattle and sheep) by performing not only in-vivo tests but also, analysing the potential increase that might occur in milk quality and production.

Within this framework, the present study proposes the following diagram (Figure 1) to valorise grape stems to obtain a sugar-rich liquor and an ingredient for animal feed.

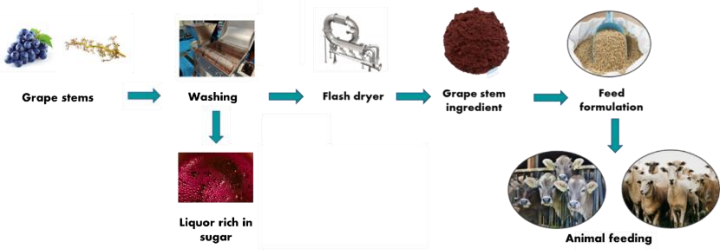

Figure 1. Proposed diagram for valorising grape stems from wineries.

Material and methods

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

A preliminary washing process was developed by adapting a pulp washing technology. This process adds 1 litre of water per kilogram of grape stem, and the liquor with the soluble sugars is separated from the solid part using centrifugal force. The liquid part is removed for human food applications (bioethanol production).

The stabilization and adaptation of the solid part (grape stems) to the needs of the animal feed sector was performed using RINA-JET turbo-dryer (Figure 2). This technology is suitable for thermosensitive products.

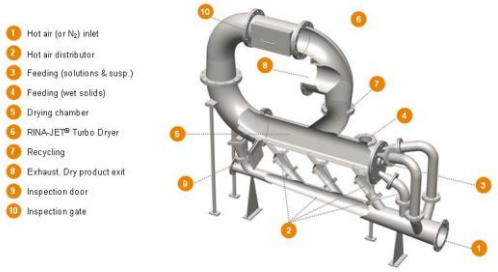

Figure 2. Diagram of the RINA-JET turbo-dryer.

The content of sugars of the obtained liquor was monitored during all the process by measuring the ° Brix content. On the other hand, the nutritional value of the ingredients prototypes was measured by applying the Association of Official Analytical Chemists (AOAC) Official Methods. Then, a digestibility test was carried out with the aim of determining its digestibility. Finally, feeding trials with animals have been performed to assess the suitability of these ingredients for animal feeding.

Results and discussion

The proportions obtained for the intermediate and final products of the washing process are shown below: [1 kg of grape stems (75 % moisture) + 1 kg of water → 0.685 Kg of liquor (5° Brix) + 1 kg de washed grape stems (80 % moisture)]. The liquor rich in sugars (5º Brix) are processed to produce bioethanol and the washed grape stems (80 % of moisture) are processed to obtain an alternative ingredient for ruminant feeding. Within this framework, the sugar content of the liquor is approximately 5º Brix, which is a good amount to be used as raw material to produce bioethanol.

Regarding the nutritional composition of washed grape stem-based ingredient for animal feeding (Table 1), they are characterized by high water content, low protein and starch content concomitant with a high fibre content resulting in a relatively low gross energy containing raw material. Mean values reported in the current experiment are in line with those found in the literature (Filippi 2021).

Table 1. Chemical composition of washed grape stem-based ingredient.

Parameter	
Dry matter (%)	93.4
Ash (% DM)	6.2
Crude Protein (% DM)	5.3
Neutral Detergent Fiber (% DM)	51.1
Acid Detergent Fiber (% DM)	43.7
Hemicellulose (% DM)	7.4
Cellulose (% DM)	26.0
Acid Detergent Lignin (% DM)	17.7

Conclusions

Grape stems are not currently valorised, and they are sent for composting or discarded in open areas. This involves that they are an available and cheap raw material with high potential to be valorised.

They have a high sugar content due to the presence of a significant number of grapes. A washing process could be an effective pre-treatment for sugars release. The obtained liquor has a great value in the food industry for bioethanol production.

The high fibre and polyphenols content of washed grape stems gives them a high potential to be used an alternative raw material for animal feeing. Flash drying is presented as a suitable technology to adequate them to the feed industry requirements.

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.

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