Grape stems as a functional ingredient for rabbit feed

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Introduction

The grape stem is the only organic by-product generated in the winemaking process that is disposed as a waste, with the consequent economic cost of management and the environmental impact associated with its management. The generation ratio of grape stem is of 0.21 kg per 1 kg of processed grapes, which involves the generation of a huge amounts of grape stems all over the world. They are currently treated as waste through authorized waste managers or used as a direct amendment of soils.

The available data on its phytochemical composition have evidenced its content in flavan-3-ols, mainly flavonoids and stilbenes, which shows significant antioxidant properties (Gouvinhas et al, 2019). In this sense, the phenolic composition of the grape stem (38 mgGAE / g) gives it a wide range of biological and physiological effects such as antiallergenic, anti-inflammatory, antithrombotic, antioxidant, antimicrobial (antiviral, antibacterial, antifungal), and modulators of various enzyme systems (Gouvinhas et al, 2018). These biological and physiological effects imply a series of healthy effects on the organism such as its activity as an anticancer agent, cardioprotective, dermo protective, hepatoprotective and neuroprotective. The high polyphenol content, associated with the high fibre content (21.5 % crude fibre), makes it very interesting as a new fibre-rich functional ingredient for animal feed.

Hence, the use of grape stem as a functional ingredient for animal feed would reduce the environmental footprint of the wine sector from a life cycle approach, while improving its competitiveness by generating a new economic activity based on circular economy. So, the benefits for the wine sector would be the reduction of waste managing costs and the enhancement of its environmental footprint, which new markets are increasingly demanding.

Rabbit farming entails some risk factors that are associated with the proliferation of diseases and high mortality rates, with the corresponding associated economic losses. The main challenges risk factors are the high population density in the hatcheries, the presence of infectious and contagious agents, nutritional and water imbalance, early weaning or excessive lighting. Thus, the diseases that occur with the highest incidence in rabbits are those that affect the digestive, respiratory systems, skin conditions and behavioural disorders.

With the aim of minimizing mortality rates, the cuniculture has traditionally opted for the use of medications as a preventive treatment. However, there are currently several initiatives underway to reduce the use of medicated feed in livestock, so the pressure on livestock activity to adapt to the new regulations is very strong. Consequently, the use of a new functional ingredient rich in fibre from grape stem would have an immuno-stimulatory effect on the animal which would lead to a decrease in mortality. This will also minimize the risk associated with reducing the preventive use of antibiotics in the mortality rate of rabbit farming, as well as increasing the competitiveness of the cuniculture sector by complying with the law [Regulation (EU) 2019/4 on the manufacture, placing on the market and use of medicated feed] in the responsible use of medicated feed, minimizing losses associated with rabbit mortality and the cost of medications.

Therefore, this study proposes a sustainable solution for reusing grape stems as a new functional ingredient for cuniculture through the application of an innovative process for a secondary raw material procurement.

Material and methods

The stabilization process of grape stems is of utmost importance as, on the one hand, its high moisture content makes them rapidly get spoiled due to the microbial activity and, on the other hand, the presence of high value temperature sensitive compounds involves the need of a non-aggressive drying process.

Within this framework, flash dryer technology has been selected as the most appropriate because it allows instant, self-regulating and continuous drying of wet solids. The combination of the turbulence effect and reduced pressure with the high-speed movement of particles results in disintegrating and drying solid instantly. Thus, this technology involves a low operating cost associated to this high thermal efficiency. The target product is very rapidly broken in the drying chamber, its surface area increases significantly and, therefore, the required energy decreases considerably. This technology is suitable for temperature-sensitive products due to this minimum heating of the solid during a short time of residence inside the dryer - fractions of a second - and to maintain their nutritional value and safely (food security). Hence, the methodology for adjusting the operational conditions of the drying process is to carry out several pilot scale tests in which different ingredient prototypes are obtained and assessed.

The obtained grape stem-based ingredient was characterized to assess its nutritional value and a digestibility test was carried out with the aim of determining its maximum level of inclusion. With this information, an experimental diet was formulated to meet all the nutritional requirement for rabbits. Two experimental diets were tested: iso-protein and isoenergetic diet was compared to commercial diet, used as a control. Finally, a specific growth trial was applied with the aim of quantifying its nutritional efficiency, mortality, and growth indicators, compared to control feed.

Feed efficiency trial was carried out with 120 rabbits that were randomly distributed in two groups of 60 animals each for 24 days. The two experimental batches were balanced based on their live weight at birth. The test was run during the last 24 days in which the effective implantation of the formulated feed with grape stems was carried out. One of the lots received a commercial control feed and the other the innovative feed with 5% grape stems in its composition. The handling of the feeding was the habitual one of the exploitations, but the quantity of feed offered and rejected in each cage was registered. These records were made weekly from weaning to slaughter. The animals of each cage were weighed in group at the beginning and at the end of the bait, and the mortality that could occur is recorded.

Results and discussion

The initial moisture content of the grape stems was 70 % and, after the flash drying, the water content was 7.43 %.

The nutritional composition of grape stem-based ingredient is shown in the Table 1:

Table 1. Nutritional value of grape stem-based ingredient

Parameters	Unit	Value
Moisture	%	7.43
Ashes	%	6.28
Energy	KJ/100 g	1480
Protein	%	4.07
Carbohydrates	%	81.58
Neutral detergent fiber	%	40.81
Acid detergent fiber	%	40.81
Lignin acid detergent	%	19.72
Crude fat	%	0.64
Starch	%	4.90
Total sugars (expressed in glucose)	%	19.74
Total polyphenols	(g GAE kg^{-1})	24.3

The ingredients that make up the commercial diet used as a control and the experimental diet with a 5 % inclusion of grape stem ingredient are presented in Table 2:

Table 2. Experimental and control diet composition

Ingredients	Control diet (%)	Experimental diet (%)
Wheat Quarters	22.00	23.80
Sunflower BP	24.58	21.00
Black oats	10.00	19.40
Alfalfa	10.00	10.00
Sunflower husk	10.00	7.00

Grape stem	0.00	5.00
Maltese rootlets	5.00	5.00
Beet pulp	6.50	4.00
Barley	5.50	0.00
Cane molasses	3.00	2.50
Calcium Carbonate Hna 38.9	2.00	1.00
Salt	0.82	0.64
Lapin Engraissement 76 / 0.5	0.50	0.50
L-threonine	0.05	0.05
L-Lysine HCL	0.05	0.05
DL-Methionine	0.00	0.05

With regards the **daily ingestion of feed**, it was observed that the animals of the control group consumed more average feed than the rabbits of the control feed group (150.81 g / d vs. 143.63 g / d, respectively), as it is shown in Figure 1.

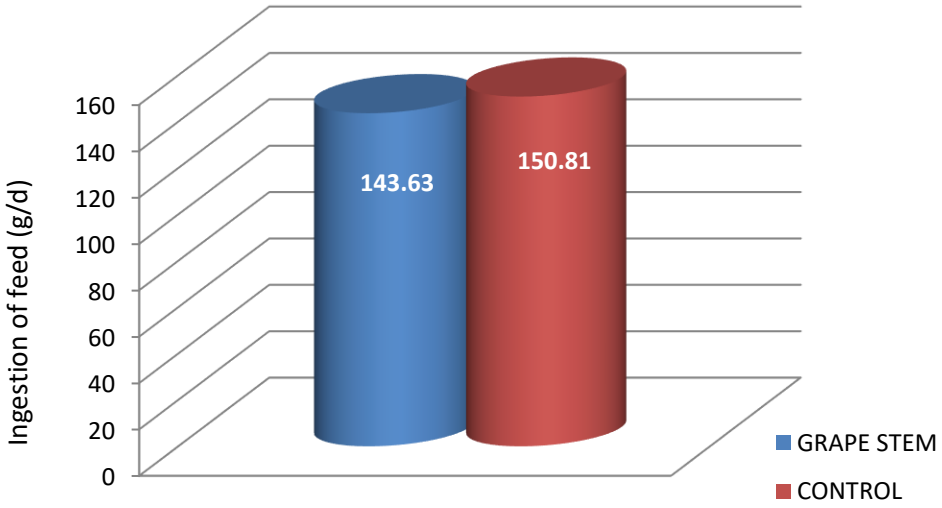

Figure 1. Ingestion of feed (grams / day)

Regarding the **average daily gain data**, a higher average daily gain was observed in the animals of the control group than in those with 5 % of grape stem flour (44.7 g / d vs. 41.8 g / d, respectively), as it is shown in Figure 2.

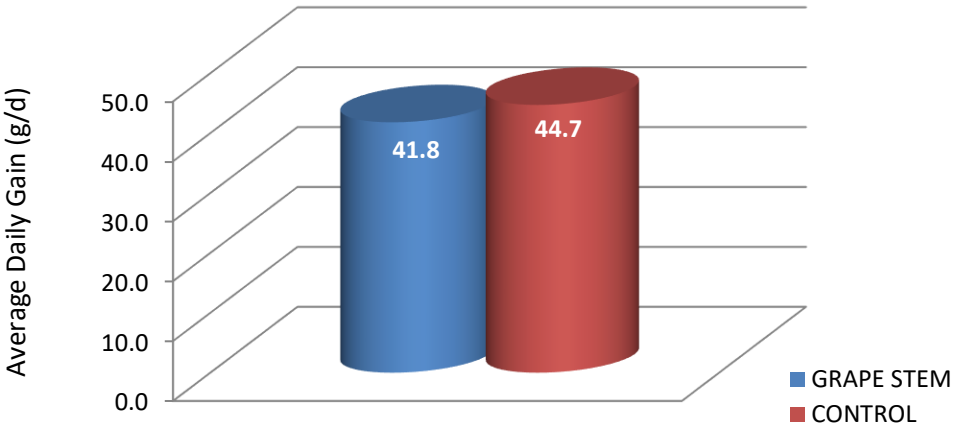

Figure 2. Average Daily Gain (grams / day)

It was observed that the **conversion rate** of the grape stem group was slightly higher than one of the control group (3.43 vs. 3.38 for the 5 % of grape stem group and the control group respectively), as it is shown in Figure 3.

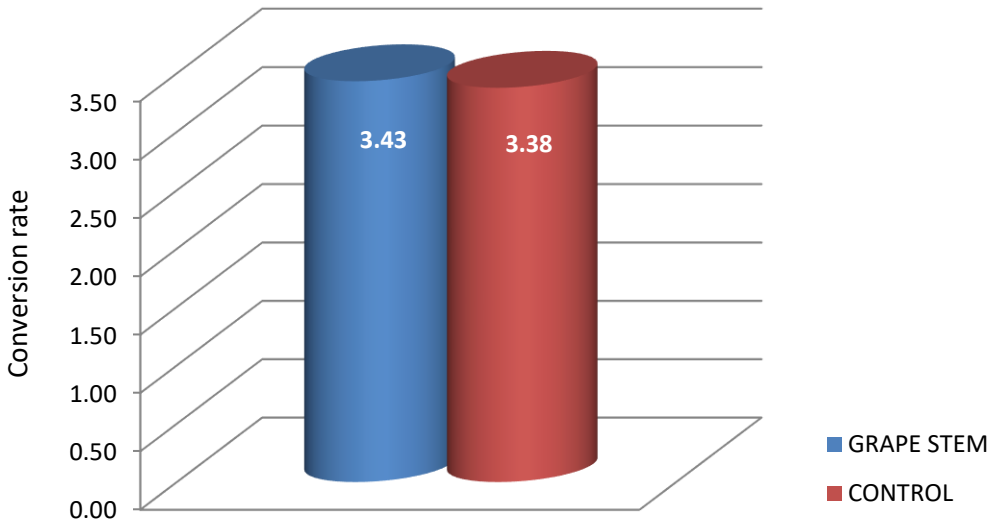

Figure 3. Conversion rates

A tendency to decrease the **mortality** of individuals fed with experimental diet with respect to control was observed. Mortality of 5 with the grape stem-based diet against 13 with control diet, as it is showed in Figure 4.

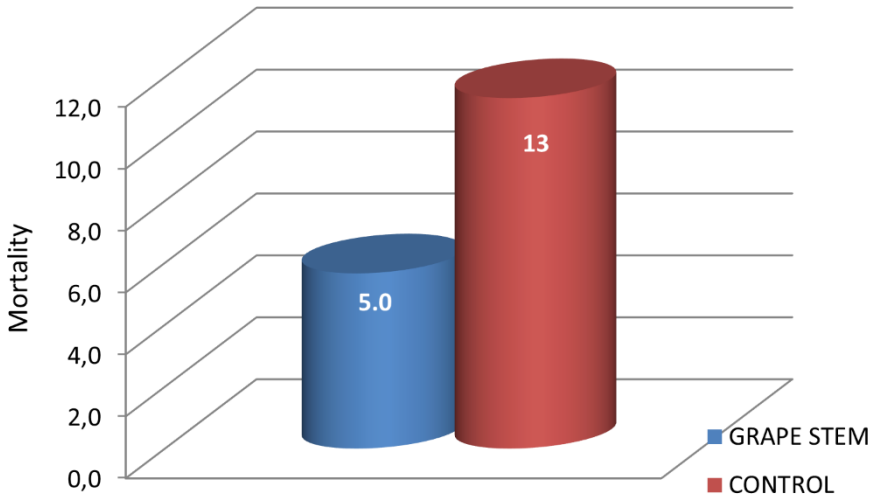

Figure 4. Mortality (%)

Based on the data of the daily feed intake, the palatability of the experimental diet is adequate and does not affect feed intake. The average daily gain data and the conversion rates conclude that, in terms of nutritional efficiency, the inclusion of 5% of grape stem in the diets do not involve differences in the nutritional value of the diets and does not significantly affect the fattening of rabbits. Mortality is higher in rabbits fed with the commercial diet; therefore, there is a slight tendency to immune stimulation of animals fed with grape stem-based diet.

Conclusions

In conclusion, grape stem stands as a potential functional ingredient for cuniculture due to their availability in Europe, their nutritional characteristics and the results obtained in the growing trials. Their use would have an immuno-stimulatory effect on the animal which would lead to a decrease in mortality. In addition, their recovery would reduce the environmental footprint of the wine sector, while generating a new economic activity based on circular economy.

Acknowledge

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