Understanding the composition of grape marc and its potential as a livestock feed supplement

The AWRI is continuing to study the use of grape marc as a feed supplement that can potentially reduce the amount of methane (a potent greenhouse gas) emitted by livestock and improve livestock productivity. This project represents an innovative opportunity for the wine industry to contribute to overall efforts to reduce greenhouse gas emissions, by putting a waste product to good use in another industry. To make this possible, it is essential to have a detailed understanding of grape marc composition, with a focus on the concentration and composition of tannins present. The knowledge of composition can then be applied to understand how different types of grape marc act to alter methane production and contribute to productivity in livestock.

Grape marc processing and sampling

Grape marc samples with four different levels of processing were collected:

- fresh grape marc – obtained from winery marc piles and directly from winery pressings
- ensiled grape marc – from a marc processing facility, stored for a number of days to build up ethanol content
- steam distilled or spent grape marc – post-steam distillation. Most samples were obtained directly after steam distillation; some were obtained months after vintage to understand storage effects
- dried grape marc – steam distilled/spent grape marc that has been dried in a furnace to produce a meal or powder.

In addition, 'red seeds' (seeds from red grapes) were obtained from the bottom of an open tank fermenter, while 'red skin', 'white seed' and 'white skin' samples were separated manually from fresh marc samples. Stalk samples were taken from a destemmer. A total of 20 different marc samples (Table 1) were obtained and analysed to understand how grape marc composition changes with processing and storage, but also to assess the fermentation outcomes of readily accessible sources of grape marc that could realistically be applied to an on-farm situation.

Compositional analyses

The marc samples were analysed for water extractable tannin (AWRI publication #975), highly bound tannin (Grabber et al. 2013) and loosely bound tannin content and composition (Kennedy et al. 2001). Ethanol and acidic extracts were prepared (Iland et al. 1988) and analysed for organic acids and simple sugars, while whole fibres were submitted for analysis of carbohydrates, protein, minerals and nutritional content. Figure 1 shows a combined picture of the concentrations of extractable compounds present in the samples.

Table 1. Origin and description of 20 intensely analysed grape marc samples

Sample No	Description
1	Steam distilled, flash dried marc meal
2	White ensiled marc
3	White ensiled and crimped marc
4	White steam distilled marc
5	Mix of red and white ensiled marc
6	Mix of red and white steam distilled marc
7	Red ensiled marc
8	Red ensiled and crimped marc
9	Red ensiled and crimped marc
10	Fresh white marc 1 - Riesling marc
11	Fresh white marc 2 - Chardonnay marc
12	Fresh white marc 3 - Sauvignon Blanc marc
13	Fresh white marc skin only
14	Fresh white marc seed only
15	Fresh red marc 1 - Pinot Noir marc (sparkling base)
16	Fresh red marc 2 - Shiraz marc
17	Fresh red marc 3 - Cabernet Sauvignon marc
18	Fresh red marc skin only (from sparkling base)
19	Fresh red marc seed only
20	Fresh red stalks only

Notes:

a) 'white marc' refers to marc from white grapes, 'red marc' refers to marc from red grapes, 'red skins' refers to skins from red grapes etc.

b) crimped marc describes marc that has been passed through a roller mill to crack the seeds

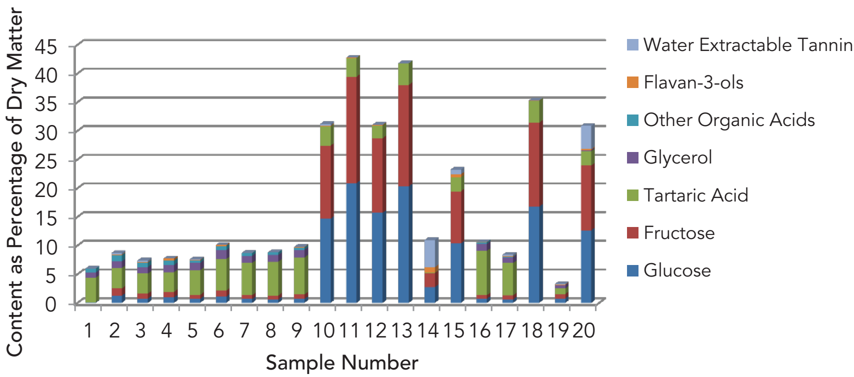

Figure 1. Extractable compounds in grape marc samples expressed as a percentage of dry matter

For the fresh grape marc (samples 10–20), the level of extractable compounds was directly relatable to the amount of extraction that occurs during winemaking. The white marc samples and white skin (10–13) and the sparkling base and sparkling base skin (15 and 18) were much higher in simple sugars, while the red marc samples had been thoroughly extracted during maceration and fermentation.

While the majority of marc samples contained little or no water extractable tannin, high levels were observed in white seeds and in the red stalks, making up 4–5% of the dry matter content. Loosely bound tannin was not detected in sample 1 (dried marc), but in the remaining 19 samples ranged from 4 to 13% of the dry matter content, while highly bound tannin increased with expected exposure to oxidative conditions.

The samples that had been ensiled (1–9) contained higher amounts of 'other organic acids' (acetic, malic, lactic and succinic acids) with acetic acid and lactic acid only found in ensiled samples. Glycerol was most prominent in these samples also. The build up of acids and glycerol is due to the production of acids by bacteria during ensiling, or storage in piles. For the wine industry, these analyses give an insight into the sources of potentially useful compounds: sugars, extractable tannins and organic acids.

Nutritional content – what this means for animals

From the nutritional analysis, a number of carbohydrate, protein and fat concentrations were determined which were in turn used to estimate the metabolisable energy content of the samples (i.e. how much energy is available for productivity – meat production, milk yield or wool growth).

The simple sugars (glucose and fructose) and pectin are readily fermentable in a ruminant animal's digestive system and contribute quite heavily to the available energy, suggesting that available energy is a function of the level of processing the grape marc undergoes as part of the winemaking process. For the fresh grape marc samples (10–20), those with the greatest energy contents are also those with the highest amounts of extractable sugars (white marc, white skin, red

Table 2. Metabolisable energy content of grape marc samples

Sample No	Metabolisable Energy (MJ/kg of dry matter)
1	6.6
2	10.9
3	10.9
4	10.4
5	9.8
6	10.3
7	10.2
8	11.1
9	9.6
10	11.3
11	11.8
12	11.3
13	12.0
14	9.4
15	10.9
16	9.9
17	9.0
18	11.7
19	7.6
20	9.2

sparkling base and red sparkling base skin), with the extracted red marc samples possessing lower metabolisable energy levels.

On the other hand, tissues with high amounts of indigestible or slowly digestible cell wall material (lignin, cellulose) have ultimately lower energy contents. Dried grape marc and seed only samples (samples 1, 14 and 19) contain high amounts of indigestible lignin and also any marc samples that have a lower skin to seed ratio will have reduced energy contents due to the increase in indigestible material in the seed portion.

So even though the energy content of grape marc is variable, it can be estimated roughly from the production and processing that it undergoes.

Effects on methane production

Following the compositional analysis, laboratory fermentation experiments were conducted to link grape marc composition with ability to reduce methane production. Results showed that tannin concentration, tannin composition and overall fatty acid content were the most important factors influencing methane reductions.

Steam distilled red marc and ensiled white marc parcels were then selected for feeding trials with dairy cattle. Further trials with sheep are planned to take place at the University of Melbourne in 2014/2015, investigating two different dose rates of grape marc. Results from these animal trials will be published at the conclusion of the project.

Some practical factors to be considered

There are a number of practical factors that need to be considered before grape marc could be applied on a large scale as a feed supplement in the livestock industry. Some of these, in particular the storage and transport of grape marc, are being investigated in a related AWRI project. Others include the possibility of agrochemical residues being present in grape marc and the importance of complying with phylloxera regulations when transporting marc in affected regions. In addition, on 31 October 2014, the Carbon Farming Initiative Amendment Bill 2014 was passed by the Senate and will take effect once passed by the House as amended. This will establish the Emissions Reduction Fund, which will provide incentives for emissions reduction activities across the Australian economy. The final stages of this project will involve additional animal studies and a more detailed assessment of economic impacts.

Acknowledgements

This work is part of the National Livestock Methane Program (NLMP) which is supported by funding from the Department of Agriculture as part the Filling the Research Gap Program. The NLMP is managed by Meat & Livestock Australia. The evaluation of marc samples with different levels of processing was made possible by access to facilities at Tarac Technologies, Nuriootpa SA.

References and further reading

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