Technical notes

Reusing grape marc for livestock feed

The AWRI recently completed a project investigating the practicalities of using grape marc as a feed additive in the livestock industry. This was an extension of an earlier project which aimed to understand the tannin composition of different types of grape marc and its potential for reducing methane emissions when fed to livestock (Hixson et al. 2013, 2014).

Previous research showed that grape marc, when used as a feed additive, has anti-methanogenic properties. Trials completed by DPI Victoria (now Agriculture Victoria) found reductions in methane of up to 20% (Moate et al. 2014). The tannins, anthocyanins, fats and oils present in grape marc are thought to be responsible for the methane suppression properties. These components are susceptible to oxidation and can degrade over time. As such, for grape marc to be successfully used in the livestock industry, it is important to understand the best storage methods to preserve its nutritional and methane suppressing properties.

The project evaluated ways in which grape marc can be processed, prepared and stored for use in commercial settings, with the goal of achieving both reduced methane emissions and improved farm productivity when using grape marc as a livestock feed additive.

Finding effective storage options

Grape marc is known as a difficult feed product to handle, mainly because of its propensity to grow large quantities of mould. Its use in commercial settings has previously been limited by handling and storage issues. Poorly stored grape marc can show signs of mould growth on oxygen-exposed surfaces within 48 hours. Current industry practice for storing grape marc is to use above-ground stockpiles; however, silage (storing it covered in an oxygen-deficient environment) was also thought to be a potentially effective option.

A range of storage options were tested to see if they could prevent mould growth and minimise degradation. These included small-scale silos and a series of commercially available mould inhibitors that were mixed into the marc. The treatments trialled were:

- No additive control
- *Lactobacillus* bacteria
- Acidification using organic acids
- Ammonification using urea
- Basification using caustic soda.

In addition, the acidification treatments were also sprayed onto the surface of marc samples to see if they could act as a surface barrier against oxidative mould formation.

Visual inspection showed that the acidification treatments were most effective in preventing mould, particularly when applied as a surface spray. To further assess the efficacy of each treatment in preserving grape marc, the tannin content was determined. All treatments, except for caustic soda (and to an extent urea), showed similar tannin levels over a 60-day storage period.

Overall, all the mini silos, including the untreated controls, showed negligible mould growth when compared to what would be expected in stockpiled grape marc.

A further experiment was set up to test the efficacy of anaerobic storage without additives on inhibiting mould growth. Two 30 kg grape marc samples were stored side by side; one stockpiled exposed to air and the other stored anaerobically. The temperature of a marc stockpile is a good indication of mould growth, due to the heat generated by increased microbial activity. Figure 1 shows the temperature of the two samples over a 30-day period.

The stockpiled marc showed a prolonged heating event in the first week of storage, and after seven days this sample had deteriorated significantly (showing mould formation and almost negligible moisture content). The temperatures of the anaerobically stored sample, however, tracked with ambient temperatures over the 30-day period and this sample maintained its visual quality.

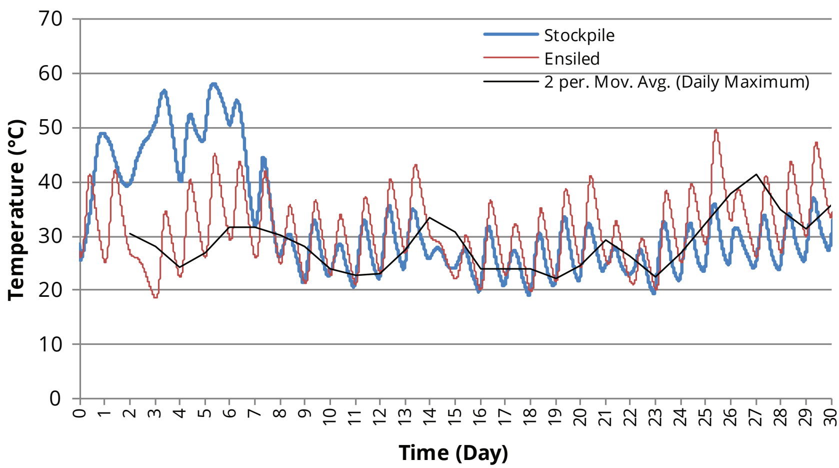

Figure 1. Stockpiled vs ensiled grape marc showing the impacts of storage conditions on temperature.

Scaling up the storage

Ensiling grape marc was shown to be effective on a bench scale; however its performance when storing larger quantities on farm-scale needed to be confirmed. Two commercially recognised approaches were investigated (underground bunkering and grain bag storage) for storing grape marc over extended periods (> six months). These trials were set up as demonstrations of how storage of marc might work in commercial settings, rather than rigorously controlled scientific trials. The experimental design reflected the types of storage and types of marc available at the demonstration sites.

Two 15-tonne grain bags were established, one containing steam distilled grape marc (GM-SD) and the other steam distilled and crimped (seeds crushed) grape marc (GM-C). The marc in the grain bags was highly compressed and sealed tightly, giving watertight and near anaerobic storage conditions. Two types of unprocessed marc (white and red) were trialled in the underground bunkers, which each contained around 400 tonnes of marc. In this type of storage, the marc was more open-packed and the bunkers were not completely watertight. The samples were periodically monitored for tannin and nutritional content over the storage period.

Figure 2 represents the tannin concentration over a six-month period for the scaled-up storage trial. The steam distilled grape marc maintained a consistent tannin concentration

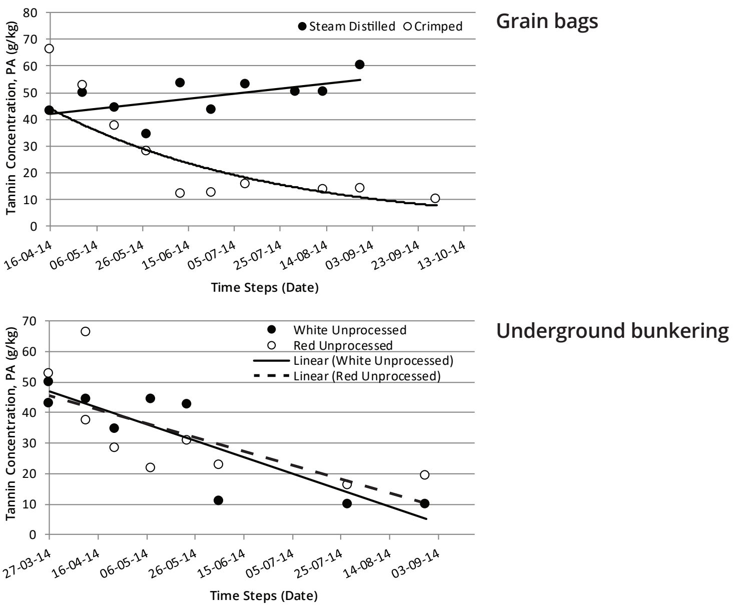

Figure 2. Tannin analysis conducted on the scaled up storage mechanisms; (top) grain bags, and (bottom) underground bunkers.

and composition over the length of storage (compositional data not shown). Steam distilled and crimped grape marc showed a rapid decline in tannin concentration over the initial two months of storage, likely due to greater exposure of the seed tannins from the crimping process. In the bunker silos, the tannin content of both types of grape marc declined over the storage period, possibly due to temperature variations experienced in this type of storage.

Both storage mechanisms showed consistent nutritive profiles over the trial period; however there was an observed decline in metabolisable energy after about three months of storage. This effect was likely driven by the deterioration of pectin, an easily broken down non-structural carbohydrate, along with impacts from the environment.

Overall, this phase of this project showed that ensiling grape marc in grain bags (highly compressed and in a watertight environment) is a suitable way to maintain the quality of steam distilled grape marc over an extended period, inhibiting mould formation without the use of an additive and maintaining tannin levels. These results suggest that feeding of steam distilled and crimped marc to livestock is best achieved through ensiling steam distilled marc and then crimping immediately before feeding.

Feeding trials

Having tested a range of storage options, the next phase of the project looked at incorporating grape marc use into a commercial livestock operation. Livestock producers are interested in whether the feed additive affects how much the cattle eat, what impact it has on productivity (measured through weight gain, muscle and fat measurements) and effects on methane production.

A pilot feeding study followed by a full-scale feeding trial was established at the Tullimba Research Feedlot owned by the University of New England. The pilot study was designed to develop handling practices for grape marc, to give an indication as to optimum grape marc inclusion rates, and incorporate the grain bag storage mechanism into the feedlot's operations. The aim of the full-scale feeding trial was to expand on the results of the pilot feeding trial, assessing the potential opportunity to substitute grape marc silage for other silage forms (maize silage was chosen as the reference) in Australian feedlots near grape-processing areas. Additionally, through use of GreenFEED Technology, the trial investigated the methane suppressing capabilities of each silage material. Two grape marc varieties (steam distilled and steam distilled and crimped) were included into the trial at 10% of the feed ration and compared against maize silage.

No effects were seen on the feed intake of the cattle for any of the silage types. There was also no effect on the average daily weight gain or feed conversion ratio of the cattle or on the final live animal assessments of body composition.

There was a tendency for silage type to affect methane production by the cattle ($P<0.1$), with methane production being lowest for steam distilled and crimped grape marc (Table 1). The magnitude of the effect was about that expected based on previous studies (4.1–13.4%, Beauchemin et al. 2008) and is likely due to the high oil and tannin content of the grape marc.

Table 1. Daily methane production from cattle consuming a feed ration containing 10% silage as maize, steam distilled grape marc (GM-SD) or steam distilled and crimped grape marc (GM-C). Numbers shown in brackets are standard deviations.

	Daily methane production (g/day)
Maize silage	186 (7.4)
GM-SD	178 (7.4)
GM-C	161 (7.4)
Difference (p-value)	0.07

Overall, the full-scale feeding trial showed grape marc to be an effective substitute for maize silage, causing no decline in feed intake, feed efficiency, growth rate or body composition of feedlot steers.

Implications for Australian agriculture

This work has developed protocols for effective use of grape marc in commercial livestock settings. The problems associated with mould formation have been addressed and anaerobic storage and/or the use of acidic barrier sprays are effective. On farm storage can be achieved in a number of ways depending on infrastructure and cost restrictions, allowing for grape marc to be used year-round, and particularly to be stored from the time it is produced until needed.

The work has shown that grape marc can be used as a feed supplement for Angus cattle in a feedlot, although limitations should be placed on the inclusion rate, with 10% proving beneficial in this project. Live weight gain can be maintained, compared with a control diet containing maize silage, and slight reductions in methane can be achieved. However, due to the limited reductions in methane observed, it is unlikely that enough methane abatement could be achieved using grape marc to warrant the development of an Emission Reduction Fund methodology and participation in an auction.

Livestock producers that are using grape marc should also be aware that there is potential for agrochemical residues to be present in grape marc.

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References and further reading

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