Winemaking

Central membrane press technology – a comparative study

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Draining and pressing are key winery processes during vintage. These processes play an important role in determining a winery's cost effectiveness, process efficiency and product quality.

The yield of quality juice obtained per tonne of grapes processed is a key factor in cost effectiveness. For most wineries, the cost of grapes makes the largest contribution to the cost of goods sold. Every litre gained at draining and pressing provides potential extra revenue at no extra grape cost.

Process efficiency is determined by speed and reliability of operation. Equipment that can carry out draining and processing operations more quickly will provide throughput benefits, and allow capital cost reductions for similar process capacity. Draining and pressing can be a bottleneck during vintage. The rate at which juice and wine are extracted from skins is a key measure of draining and pressing efficiency.

Product quality is a key issue during draining and pressing, especially when white fruit is being handled. Juice is in contact with the skins during these processes. There is considerable opportunity for the extraction of phenols and the development of brown colour during draining and pressing. Generally, winemakers seek to minimise the extraction of phenols and the development of brown colour during the production of premium white wines.

Della Toffola produce a range of airbag presses with a central inflatable membrane. A number of claims are made for these presses, indicating superior performance to side membrane presses. The following diagrams show the difference in press configuration between central membrane and side membrane presses. (See Figures 1 and 2).

A trial was conducted during the 2003 vintage to compare the performance characteristics of a Della Toffola PE 12 central membrane press, which has a nominal capacity of 1200kg of crushed grapes, with a conventional side membrane press of similar capacity.

The trial was carried out by Provisor Pty. Ltd. at the Hickinbotham Roseworthy Wine Science Laboratory located at the Waite Campus of the University of Adelaide, following a protocol developed by Scorpex Wine Services.

Fig.1. Central membrane press.

Fig.2. Side membrane press.

The protocol was developed to compare the performance of the presses in the following areas:

- Total juice extraction/tonne.
- Extraction/tonne from each stage of the pressing cycle.
- Juice extraction speed.
- Phenol concentration of the juice from each pressing cycle stage and the combined final juice from all pressing stages.
- Brown colour of the juice from each pressing cycle and the combined final juice from all pressing stages.
- Moisture level in the marc at the completion of pressing.

In addition, comments about the ease of use, safety, cleaning and emptying characteristics of the presses were recorded.

Grapes

Approximately six tonnes of Colombard grapes grown at Berri, in the Riverland area of South Australia, were used for the trial. The grapes were hand harvested at 12.3 degrees baumé. No sulphur dioxide was added. After picking, the grapes were randomised into 12 separate lots of approximately 500kg. The harvested grapes were transported to a cool store and cooled to approximately 10ºC. The grapes were then removed from the cool

store and transported to the winery at the Hickinbotham Roseworthy Wine Science Laboratory in Adelaide.

Prior to processing, each container of grapes was accurately weighed. Subsequent weighing of the empty container after crushing gave an accurate net weight of the grapes used in each trial replicate.

During the trial, three separate cycles were carried out in each press, ensuring that results in triplicate were obtained. Prior to the commencement of processing, each of the 500kg lots was paired with another lot to give the six one-tonne batches required for the three press cycles carried out in each press.

Processing

The grapes were destemmed and crushed using a Toscana Enologica Gamma cage destemmer/roller crusher at a rate of approximately three tonnes/hour. An equal amount of sulphur dioxide was added to each batch of grapes at crushing as a 10% w/v aqueous solution of potassium metabisulphite. The must was pumped to the presses without cooling or addition of pectinolytic enzymes.

The presses were operated to cycles selected by Provisor staff to reflect the manufacturer's recommendation, considering the application carried out in this trial. While the press cycles were not identical, it was considered that the conditions of use gave a reasonable basis for performance comparison.

Each cycle was selected to give three juice fractions - free run/light pressings (FR/LP), medium pressings (MP) and heavy pressings (HP).

Sulphur dioxide was added to both presses in equal amounts during each pressing cycle as a 10% w/v aqueous solution of potassium metabisulphite.

The presses were emptied and cleaned at the completion of each pressing cycle.

Monitoring and sampling

During each press cycle, individual juice fractions were diverted to a calibrated vessel and the volume measured. A one-litre sample was taken from each fraction.

At the completion of each pressing cycle, the juice fractions were combined. Two one-litre samples were taken from this combined juice. All samples were frozen for subsequent analysis. A one-kilogram sample of the final marc was also taken at the end of each press cycle and frozen.

Juice analysis

A frozen juice sample from each press stage and from each combined juice lot was thawed. A representative aliquot of each sample was centrifuged to remove all suspended solids. The absorbance of each sample at 280 nanometres and 420 nanometres was measured to assess total juice phenol concentration and brown colour, respectively. Analyses were carried out at the Australian Wine Research Institute.

It should be noted that accurate determination of suspended solids derived from grape processing was prevented by the development of potassium bitartrate crystals in the samples from this trial when they were frozen.

Marc analysis

The moisture content of marc samples from each press cycle was determined at the Australian Government Analytical Laboratory.

Analysis of data

Data from the trial was analysed for difference using a one tail test at P=0.05.

Results

Yield - extraction of juice per tonne of fruit crushed

Table 1 shows that there was an increased yield on average from the central membrane press in the first two pressing stages. There was also an increased yield overall from the central membrane press. This trend is demonstrated in Figure 3. The difference in overall yield from the two presses is significant at P<0.01.

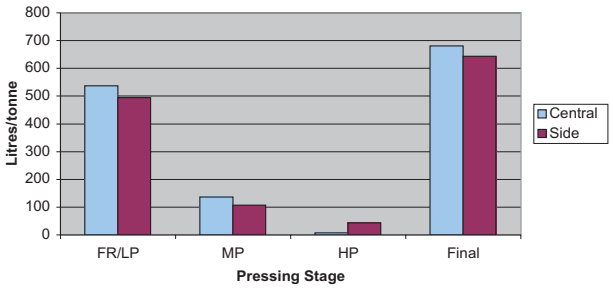

Fig. 3. Yield (litres/tonne) vs pressing stage, central and side membrane presses.

Juice extraction speed

The yield of juice over time was monitored during each pressing cycle. Figure 4 summarises the average results that were obtained for each press.

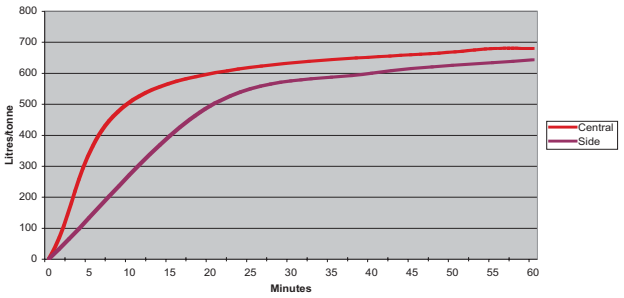

Fig. 4. Litres of juice/tonne extracted over time.

Juice extraction from the central membrane press was considerably faster early in the pressing cycle. The time taken to extract the first 600 litres of juice by the central membrane press was approximately half that taken by the side membrane unit.

Table 1. Volume of juice extracted per tonne of grapes.

Press	Replicate	FR/LP litres/tonne	MP litres/tonne	HP litres/tonne	Combined litres/tonne
Central membrane	1	533	149	9	691
	2	540	126	9	675
	3	538	132	4	674
	Mean	537	136	7	680
Side membrane	1	475	112	47	634
	2	518	88	40	646
	3	488	117	42	647
	Mean	494	106	43	643
Difference between central and side membrane result		Significant at P<0.05	Significant at P<0.05	Significant at P<0.001	Significant at P<0.01

Juice analysis - phenols

The concentration of phenolic materials in each juice sample was estimated by measuring the optical density of a clarified sample at 280 nanometres. The results are expressed in Table 2.

The average juice phenol levels from the central membrane press were lower at each press stage and in the final combined juice. The differences were significant for the heavy pressings and the final combined

Table 2. Phenols: optical density of each press fraction at 280nm.

Press	Replicate	FR/LP Absorbance units	MP Absorbance units	HP Absorbance units	Final Absorbance units
Central membrane	1	5.5	9.1	9.7	6.9
	2	6.7	11.3	11	7.5
	3	6.8	10.8	11.3	7.3
	Mean	6.3	10.4	10.7	7.2
Side membrane	1	7.8	10.6	11.4	7.9
	2	6.4	12.8	14.2	7.7
	3	6.9	12.4	14.1	7.9
	Mean	7.0	11.9	13.2	7.8
Difference between central and side membrane results		Not significant at P=0.05	Not significant at P=0.05	significant at P<0.05	significant at P<0.05

Table 3. Brown colour: optical density of each press fraction at 420nm.

Press	Replicate	FR/LP Absorbance units	MP Absorbance units	HP Absorbance units	Final Absorbance units
Central membrane	1	0.241	0.604	0.632	0.289
	2	0.472	1.058	0.681	0.529
	3	0.439	0.832	0.816	0.551
	Mean	0.384	0.831	0.710	0.456
Side membrane	1	0.621	0.860	0.792	0.398
	2	0.346	1.568	1.592	0.553
	3	0.372	1.333	1.470	0.452
	Mean	0.446	1.254	1.285	0.468
Difference between central and side membrane results		Not significant at P=0.05	Not significant at P=0.05	Not significant at P=0.05	Not significant at P=0.05

juice. This trend is demonstrated in Figure 5.

Although the differences in the FR/LP and MP phenol results are not statistically significant, the differences in the volume of these fractions obtained from the two presses must be taken into account when considering the phenol level of the final combined juice. Weighting caused by the volume factor is likely to be the cause of the statistically significant difference in the final juice phenol levels.

Juice analysis - browning

The degree of browning in the juice from each fraction was estimated by measuring the optical density of each sample at 420 nanometres. The results of these analyses are given in Table 3.

These results, also shown in Figure 6, indicate that the juice from the central membrane press had a lower average brown colour at each pressing stage and in the final combined juice. The differences between the averages, however, are not statistically significant at the P=0.05 level.

Relationship between juice browning and phenol levels

The differences in browning shown by the samples taken from this trial could be due to more oxygen contact, lower SO_2 or higher phenol levels.

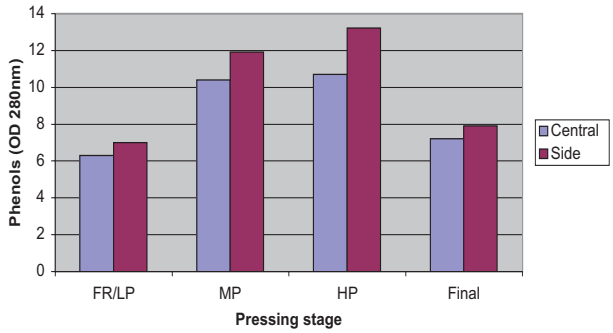

Fig. 5. Average juice phenol levels at each pressing stage.

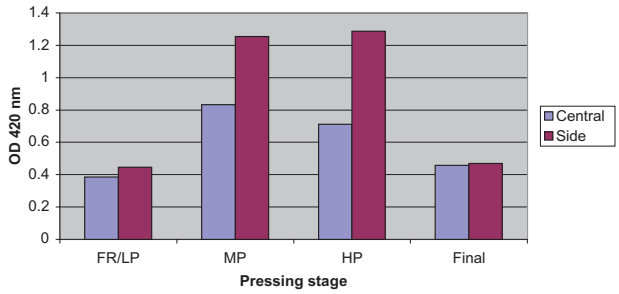

Fig. 6. Average juice browning at each pressing stage.