FERMENTATION TECHNOLOGY

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A revolutionary new method of red wine fermentation

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Summary

Fermentabag™ is essentially a fermentation within a plastic bag. The technology will change the way red wines are fermented. It is ideal for small operators or batch-type experiments. Capital outlay is greatly reduced meaning that the current exponential expansion of winegrapes globally can be dealt with in a cheap cost-effective way. Most labour costs are eliminated, as is the need to pump over or "plunge" the ferment.

Trials have been progressively conducted over the past few years leading to a series of breakthroughs that have subsequently led to a highly-developed fermenting bag with a system of "auto-irrigation" of the cap and very effective venting of generated fermentation gas. A combination of co-extruded nylon and polyethylene has proved to give best results, with optimum tensile and food grade properties. Further development with plastics will reveal other beneficial properties that can be incorporated to enhance the use of Fermentabag™.

Introduction

The Hickinbotham family winemakers have been involved in plastics development for the wine industry from early days with Ian Hickinbotham being instrumental in the development of the wine cask. Stephen Hickinbotham developed Cab Mac, the process of carbonic maceration in plastic bags within palletised containers (IBCs). This process was rapidly taken up by the Australian wine industry and abroad. Fermentabag has been progressively developed over the past few years, resulting in a viable, cost-effective method of processing grapes with the potential to change the way winegrape fermentations are conducted.

Method

Fermentabag™, like most IBC bags, are pre-folded to the dimensions of the IBC, or like, container. This means that the bag is laid flat on the base of the IBC and folded out to occupy the floor. (This may seem trivial, but if the bag is folded out correctly, it will fill evenly and completely without the need to manipulate the contents in any way.) The plug is then removed from the middle opening (either 2" or 3" BSP), and a hose from the must pump is attached.

Importantly, the bag will not easily cope with air being pumped into it. If the must pump is too fast for the crusher it will need to be slowed by start/stop or through an electric phase invertor. Alternatively, an air release point can be incorporated, or the bag can be periodically disconnected and the air expelled from the interior. ▶

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Fig. 2. Inventor/winemaker Andrew Hickinbotham releasing air from the bag via a simple air release point

Fig. 3. Three typical IBCs in the background filled to within 5% of capacity with chimney apparatus attached, ready to start ferment, with a fourth IBC in the foreground being filled with must.

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Fig. 1. One likely connection from bag to must pump via an air release attachment. Note the unfolding of the bag as it is progressively filled.

The bag is now filled directly from the crusher, by the must pump. As the bag is a sealed container, any major additions to the must, such as acid, yeast, oak chips etc., should be carried out at the crusher. The low level of oxygen exchange through the layers of plastic should also be compensated for by a higher addition of DAP, or alternative yeast nutrient.

There is an optimum fill level for the bag to allow for distension of the plastics. However, in practical terms the bag should be filled to around of 95% full as shown in Figure 3.

With all primary additions complete, all that remains is to attach the chimney apparatus (Figure 4), and open the gas exchange vents on either side of the filling point. At this point, prior to the onset of fermentation, the chimney will sag over and lay horizontal. The IBC should then be placed in a protected area under shelter to avoid any mechanical damage to the plastics. Pre-ferment maceration can also be achieved by limiting the level of yeast seeding, or seeding at a later time through the chimney apparatus.

Once fermentation has ceased the Fermentabag™ apparatus is sealed and set aside to macerate. The length of post-ferment maceration is a choice of the winemaker.

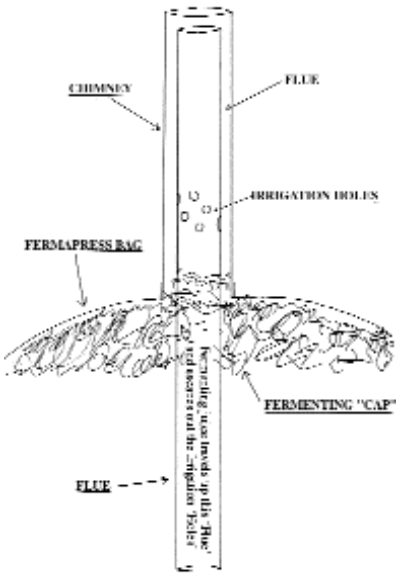

Fig. 4. Configuration of the "chimney" apparatus, showing inner flue and outer chimney configuration. The inner flue extends below the cap allowing fermenting juice to travel up the flue and out the holes, thereby irrigating the cap.

Fig. 5. Commencement of ferment. The chimney rising along with the "cap"

However, our results have shown this to be a very effective technique to soften the wine. Periods of up to six weeks are happily achieved without detriment to the wine. During this time the cap slowly settles to the bottom of the Fermentabag, allowing the alcohol to fully extract the soft tannins that maceration achieves.

Pressing is the next issue, and this is conducted by sealing off one of the secondary ports and connecting the other to a water source. Whilst the majority of wine can be rapidly extracted into another container by a relatively high flow water source, it is imperative that the pressure of water is not high. After the majority of wine has been extracted, the Fermentabag should either be subsequently connected to a limited pressure device, or the balance of material, i.e., the cap and

seeds, transferred to a conventional press to finally extract the last 5-10% of wine from the skins.

Results

Depending on ambient temperature and the level of yeast addition, the ferment will commence sometime within 48 hours. The most notable phenomenon is the raising of the chimney and the bulging of the bag as the cap rises within the ferment forcing the plastics to distend (see Figure 5). The bag, being composed of nylon, has extremely high-tensile strength and can, therefore, effectively withhold, to a limited extent, the pressure of the rising skins or cap.

The dome shape to which the bag distends is created by the force of fermentation and ensures continual irrigation of the skins of the cap by fermenting juice being lifted by the generated gas. The chimney structure positioned at the apex of the dome also provides a clearly defined avenue of escape of fermentation gas to the atmosphere. The bag should not be restrained in any way to either prevent the escape of gas, or to mechanically prevent the bag from distending. The IBC units are not stackable during this stage.

If the temperature of fermentation rises and the speed of fermentation increases there is a likelihood that the fermenting juice may be carried right up and spill over the outside edge of the chimney. Practical experience has shown that a simple extension of the chimney will prevent further loss of juice, as would refrigeration of the ferment. Further distension of the plastics (to equilibrate the pressure generated by the ferment) will also prevent any damage occurring to the IBC container.

The configuration of the chimney apparatus is such that when enough pressure is generated within the ferment, a second inner "flue" situated within the first tube (Figure 4) allows easier access for gas to escape from underneath the mass of compressed skins, or fermenting cap. In travelling up the 'flue' the gas also carries with it fermenting juice, thereby creating the Ducellier principle. The difference between the pressure being generated inside the fermentation vessel and the strength of the nylon layer of plastic incorporated in the Fermaenta-bag™ will determine the amount and distance of fermenting juice being carried up the inner tube and spilling out the 'irrigation holes' half way up the 'flue'. Thus, also further irrigating the 'cap'.

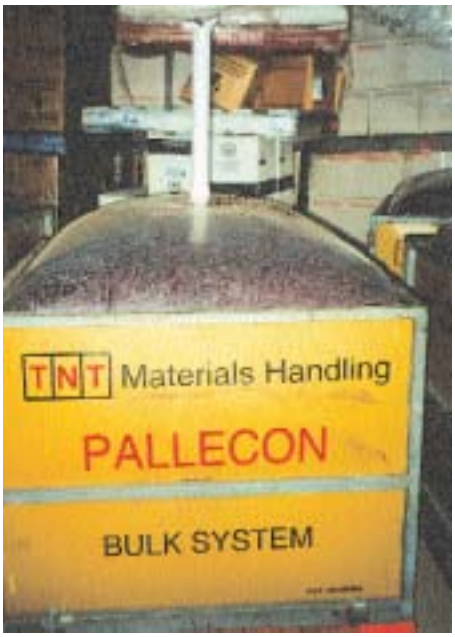

Fig. 6. Fermapress bag now fully distended, showing auto irrigation of the cap as gas is continually generated by the fermenting juice, and liberated at the point of least resistance, the chimney.

As a solution to excessive fermentation temperature and build-up of gases, we added further openings between the layers of plastics, effectively opening each layer to the exterior. This has a twofold benefit. First, it allows for a temperature control system for the ferment. Simply by pumping hot or cold water between the layers of plastic, temperature control is very simply achieved. The fact that the circulation of the water is not 100% efficient makes little difference in such a small

Table 1. Cost analysis of Fermapress vs. conventional fermentation ▶

techniques for 5000 litre batch.

	CONVENTIONAL	FERMENTABAG™
Pallecon hire 2 weeks x 5 units	$ 105	367 7 weeks
Stainless steel (amortised 5 yrs)	$ 750	550 5 bags
Labour to plunge/pump over	$ 240	N/A
Press (amortised 10 yrs)	$2500	N/A
COST PER LITRE	**$0.71**	**$0.18**

volume of ferment. Secondly, it allows for rapid evacuation of any carbon dioxide being trapped between the layers of plastic.

Discussion

Viability of the Fermentabag™ process is illustrated in Table 1. The cost of production of Fermentabag™ wine is around $0.18 per litre, making the process economically effective and allowing small producers to compete with larger producers on production issues. The Fermentabag™ apparatus would allow larger producers to conduct trials of viticultural practices or winemaking techniques with larger parcels, in a simple and cost-effective manner.

Clearly, the strength of the outside layer of 'nylon copolymer extruded plastic' will be a major issue in the further development of the Fermentabag apparatus. Trials to date have utilised numerous grades and combinations of plastics. The optimum level of tensile strength of this outer layer is one that will restrict the distension of the bag to such an extent that the Ducellier principle built into the chimney apparatus will be engaged to assist irrigation of the cap. It will also allow for effective pressing of the grapes.

Because the plastics used are of different polymeric origin, they naturally have different levels of oxygen and carbon dioxide transmission. Carbon dioxide can pass through polyethylene freely and quickly, but cannot pass through nylon as easily. In our initial trials we have had to deal with an almost anaerobic environment for our fermentations. Venting between the layers of plastic allows carbon dioxide passing through the polyethylene layer to be quickly and rapidly evacuated, thereby effectively overcoming this problem. Passage of water between the layers will also assist escape of gases from within.

The fact that the Fermentabag apparatus can be completely closed to the air allows for very effective pre and post-ferment maceration. Post-ferment maceration provides an environment for the wine to be passively softened, without use of fining agents, resulting in a better quality wine. Most wineries do not have this luxury as their fermentation equipment must be re-used continuously throughout the vintage. Post-fermentation maceration is limited by the wineries' capacity to conduct red wine ferments at the same time. Fermentabag apparatus will allow wineries to leave parcels of fruit to macerate until such time as they are able to finish them off.

Fermentabag™ was designed as a dual purpose apparatus – both fermentation and pressing to be conducted in the same vessel. To date, we have achieved extremely good results with the fermentation aspect of Fermentabag™. Further work and research is still required to achieve a simple and effective pressing technique. The present application is to use the two ports that are already installed between the layers of plastic, as detailed above. An effective pressure-limiting device will need to be incorporated into the Fermentabag™ to limit the pressure of application. Alternatively, a material lid made from neoprene or suchlike material can be attached to the top of the IBC unit and a higher pressure achieved to extract more wine. Under no circumstances should the lid of the IBC unit be used to create a pressure vessel.

It is important that there be no back pressure on the Fermentabag™ or damage will occur. Fermentabag apparatus should be level, if not higher than, the receiving tank to avoid back pressure restriction. The duration of pressing will be longer as the pressures involved will need to be far less than those currently used in conventional presses. However, being completely closed to the air the system can be set aside and allowed to run for an indefinite period. If suitable time is allowed, at pressures low enough to prevent damage to the bag, then theoretically the grapes will be pressed as well as any