Innovation and sanitisation during dehydration

ITALY IS RECOGNISED as leading the way in the production of wine made from partially-dried grapes. The so-called 'raisining' process is simply a loss of water from the bunches after harvest. The timeframe between the harvest and the end of the desired dehydration is determined by the producer and varies based on the desired wine style. During this time, the bunch goes through a process of cellular ageing and it is clear that what was once, and is still often today, considered a simple weight loss, is actually a very complex process. In recent years this has been the subject of interesting scientific studies mainly linked to the production of Amarone.

The use of ozone (trioxygen, O_3) has shown excellent results both in terms of microbial control and economic and environmental sustainability. More detail on the assessments to be made on the air distribution system in order to apply this gas has been provided by Rinaldo Botondi and Fabio Mencarelli from DIBAF-Postharvest Laboratory, Tuscia University, Viterbo.

THE DEHYDRATION OF GRAPES

Wilting, raisining, drying and dehydration are all terms used to indicate the same water loss process, but recently Tonutti and Mencarelli (2013) tried to codify the process by defining, with the term dehydration, the loss of water in environments where the environmental parameters are carefully controlled. This is extremely important because any metabolic process, and consequently the modification of the metabolites, closely depends on such environmental factors that in this case are temperature, relative humidity and ventilation.

The control of these factors enables us to predict what can happen in the grapes during water loss thanks to scientific results obtained in recent years. Yet this prediction is actually quite presumptuous, since each grape type put in certain dehydration conditions will act in a different way because its formation took place in the field in response to a certain farming environment and therefore it will respond to the dehydration environment in a different way.

This is the reason the modelling of this process, from a grape quality point of view, is difficult and becomes almost impossible the longer the process is (because two types of stress influence the berry, water and ageing) and the less accurate the environmental control of the dehydration is. In underground cellar conditions, where everything is controlled, the daily variation is minimal; in drying rooms without control, but conditioned by the external climatic environment, the daily variation in weight loss is extremely variable and this significantly influences the metabolism.

TEMPERATURE AND HUMIDITY

But what is meant by a 'long process'? Table 1 shows what we consider to be the timing of the process for wine grapes and also the extent of the process, that is to say the quantity of weight lost (mainly water).

The values for the extent of the process are not random, because they are the result of observations carried out during the years of experimentation; 10-15% of the weight loss of the bunch is mainly loss of water from the stem, above this value and up to 20-25% the berry begins to significantly demonstrate water stress and modifies its metabolism and therefore the phenolic and aromatic fraction. Above 30% moves towards the slow death of cells and therefore everything that occurred is photographed in that moment and only chemical degradation phenomena take place.

But the temperature, in relation to the relative humidity, plays an important role in these modifications. If we look at Table 2, which shows the air's water capacity, that is to say the capacity of the air to absorb water vapour (in grams per square metre) of air in the temperature conditions and relative humidity (RH) indicated, and we follow the numbers in bold, we can see that the same extent of water loss can be had at 15 °C and 40% RH (3.2) and at 25 °C and 50% RH (3.4), or at 15 °C and 60% RH (2.1) and at 30 °C and 70% RH (2.1).

From a technical point of view it is absolutely true but, from a metabolic point of view, losing water at 15 °C or at 30 °C is completely different, especially when we talk about cellular ageing. The careful maintenance of dehydration conditions is fundamental for predicting a metabolic response, but this careful control is also useful for avoiding the onset of fungal and bacterial diseases on the grapes during dehydration.

Table 1. Timing and extent of the dehydration process

SPEED of the process
• Very fast (5-10 days)
• Fast (2-3 weeks)
• Slow (4-8 weeks)
• Very slow (2-5 months)

EXTENT OF THE PROCESS
10-15% weight loss
• 20-30%
• >30%

Table 2. Water vapour absorption capacity of the air

Relative humidity %	Temperature °C							
	10	15	20	25	30	35	40	45
10						8.2	9.2	9.9
20					6.0	7.3	8.0	8.6
30				5.0	5.6	6.2	6.6	6.9
40	2.7	3.2	3.7	4.2	4.6	5.1	5.5	6.1
50	2.2	2.6	3.0	3.4	3.7	3.9	4.1	
60	1.8	2.1	2.3	2.6	2.9	3.1		
70	1.3	1.5	1.7	1.9	2.1			
80	0.9	1.0	1.1	1.2				
90	0.5	0.5	0.7					

SANITISATION OF GRAPES

The presence of Botrytis cinerea on grapes subject to the dehydration process is very frequent, since temperatures are often unsuitable, the relative humidity is frequently high and there is not enough ventilation, in terms of even distribution of the air, to avoid dangerous stagnation of humid and warm air. But after Botrytis cinerea fungi may establish themselves, producing oncogenic toxins such as ochratoxin. Therefore the microbiological quality of the starting grapes and the sanitisation

> In large plants, the ozone distribution must be done with several exits positioned in strategic points of the plant, though always on the ceiling.

of the dehydration environment are two indispensable points for optimising dehydration.

In Valpolicella, in drying rooms for Amarone grapes, 40% of Botrytis is in asymptomatic form, that is to say that the fungus just waits for suitable environmental conditions to develop and, in other areas where drying is totally without control, the situation is even worse.

From a study we carried out in Tuscany a few years ago, in a traditional drying room and in a carefully controlled one for the production of Vin Santo, the total microbial load in the former was 2,500-3,000 CFU/m^3 whereas the second was 300-350 CFU/m^3, but above all the concentration of fungi was significantly reduced from 2,000 to 100 CFU/m^3.

If the concentration of microbial flora becomes particularly high, operators may have allergic reactions, which may also develop following the unfortunately frequent use of sulphur bentonite, an anticryptogam wettable powder classified as Xi, an irritant, usable in agriculture under Health Ministry Regulation no. 4425, which is sprinkled on the drying grapes being dried (an inadvisable practice also for the grape quality) in order to contain the fungal development, with a dual antiseptic and drying action. On the other hand, increased consumer attention towards the healthiness of wine, and therefore also the attention of OIV towards all synthetic chemical additives, among them sulphur-based products, has driven research to identify alternative solutions and today the Italian company PC Engineering's international patent involves a postharvest grape sanitizing treatment called Purovino for the production of sulfite-free wines.

ASSESSMENT OF THE SANITISATION ACTIVITY OF OZONE DURING GRAPE DEHYDRATION

In our research activity on the dehydration/drying of grapes, we wanted to assess the sanitisation efficacy of ozone during the dehydration of grapes. A first test was carried out on Pignola grapes, also assessing the more metabolic aspects, and in another test a sweet dried grape wine was produced without the addition of sulfites.

A feature of ozone is that, when it reacts, it decomposes without leaving any toxic residue and, unlike for example chlorine or electrolysed water, which may produce trihalomethanes, carcinogenic compounds in reaction with organic matter, ozone does not generally produce such compounds.

Many cold storage plants in California have installed equipment that generates a constant low dose of ozone (100 ppb during the day and 300 ppb during the night) resulting in a reduction of the diffusion of grey mould and prolonging the preservation of table grapes for several weeks.

It has also been observed that postharvest treatments of grapes with ozone stimulate the biosynthesis of certain phenolic fractions and also act on the cell wall, favouring the extraction of such substances.

From tests carried out on Sauvignon grapes, ozone stimulates the glycosidation of aromatic compounds and therefore, during fermentation, these compounds may be freed, increasing the aromatic concentration of the wine.

As with all gaseous treatments, the effect depends on the dose and the duration. Concentrations that are too high contain a risk for the operator and are also harmful to grape quality, ▸

VINE TALK

Using bipyridyls as part of your resistance strategy

It appears last month's column on prolonging glyphosate use in vineyards generated a fair bit of discussion. Many properties are now entering the critical timeline modelled by researchers Paul Neve and Art Diggle, who predicted that after 12 to 15 years of continuous glyphosate use, the probability of resistance would begin to increase.

It led to enquiries on herbicide 'double-knock' and also the best use of GRAMOXONE® 360 PRO and SPRAY.SEED® under vines. Both are non-selective contact bipyridyl herbicides that belong to the herbicide Group L. Where each one should be used really depends on the weed spectrum. GRAMOXONE 360 PRO is better suited to areas where annual grasses are more prevalent. SPRAY.SEED, which is a mix of the paraquat in GRAMOXONE 360 PRO and diquat, should be used where more annual broadleaf weeds are present - for example capeweed or erodium species.

Being contact herbicides, water volumes and spray coverage are very important with these products. Calibrated sprayers with flat fan jets, adjusted to a height that gives a double overlap of the spray at the top of the weeds, are ideal. Spraying pressures should be in the range of 200 to 300 kPa. Select nozzles that give droplets in the 200 to 250µ volume median diameter range at these pressures. Speed of travel should be in the range of 6 to 10 km/hr. Good weed coverage while spraying is essential, so adjust the water volume according to density of weed growth.

Interesting results are being seen in broadacre areas where they are noticing improved results when these contact herbicides are applied in lower light conditions, such as just before nightfall. The bipyridyls quickly destroy green plant tissue on contact and the speed of the cell destruction is largely influenced by the intensity of light; the higher the light intensity the faster the reaction.

Spraying at dusk does two things; it slows the speed of cell damage and often also extends the drying time of the droplet on the leaf. Longer drying time allows the active ingredient more time to absorb into the leaf. A slower speed of cell damage can enable the active to move more within the leaf. Paraquat has the ability to move down and away from the site of application and while this translocated movement may be small, it can be very important. So spray at the end of the day if you can. It may increase your control over the weeds, for example from five days to six or seven, and the final results will often be better.

Bipyridyl's bind strongly to clay particles in the soil. That's an agronomic strength because they are deactivated as soon as they contact clay in the soil and provide no residual activity. However, they can also bind to clay particles suspended in the spray solution and this will reduce efficacy. If you can see dirt in your spray water, chances are it will negatively impact on the spray result.

Finally, if the intent is to use a 'double-knock' as a resistance strategy, both herbicides should be applied at the registered rate to effectively control weeds. Apply glyphosate or SPRAY.SEED first, then wait around seven days before applying the second application of SPRAY.SEED. To ensure a really robust eradication of some difficult to control weeds, such as marshmallow, stinging nettle or erodium, the addition of a Group G herbicide spike mixed with SPRAY.SEED is very effective.

Vine Talk is compiled by Dave Antrobus, Syngenta Solutions Development Lead
dave.antrobus@syngenta.com
0429 133 436

the same applies for long treatment times with moderately high concentrations. The treatment with ozone on Pignola grapes being dehydrated at 10 °C and 50% RH, 1.5 m/sec of air flow, proved to be particularly effective in reducing the microbial load of fungi, bacteria and yeasts from a concentration of 103 CFU (asymptomatic), also using only an initial treatment for 18 hours at 1.5 g/hour, and therefore leading to a 35% weight loss in grapes. The initial treatment followed by a daily treatment of four hours with lower doses of ozone gave the same results from a microbiological point of view, but significantly penalised the phenolic and anthocyanic content.

In the other experiment, in collaboration with CREA - Velletri, the test was carried out on Grechetto grapes destined to make Cannellino wine and, also in this case, initial and final treatments were done with ozone.

The dehydration parameters used were the same and the test lasted 33 days, reaching a drop in weight of about 45%. Also in this test the grapes at the end of dehydration were in perfect condition and, vinified without the addition of sulphur dioxide, gave a final product that was still stable after one year, with a total of 7 mg/l of sulphur dioxide and a volatile acid of 0.51 g/l.

SYSTEM CONSIDERATIONS

Ozone is a heavier gas that air and therefore tends to stratify lower down, moreover, it has a short persistence (after acting it rapidly turns into oxygen) and therefore it needs to be constantly supplied to maintain an adequate concentration.

It is extremely important, therefore, in both small and large plants, to arrange for the gas to enter inside the dehydration structures, having first carefully measured the air distribution bearing in mind that between the crates there must be a minimum air speed of 0.5 m/s.

The late Professor Ferrarini carried out a study on a large drying plant in Valpolicella, highlighting the very poor quality of the air distribution through the platforms with the plateaux (trays) of grapes. The resorting to the use of large ventilators (1.5 m diameter) on the ground, with huge flow rates (7-8.000 m3/hour), has an insufficient capacity to guarantee an even air distribution but causes really inadvisable 'crosses' of airflows for an even drying.

But also in small tunnels, the problem of air distribution remains. In fact, we can see that, despite the presence of suction fans on one side of the tunnel, the air distribution is uneven, entailing different temperatures and RH at the different heights of the platforms with grapes. In view of a more and more difficult air regulation, therefore, it is important that the line of ozone insertion is connected to the flow of cold air for its distribution inside the distribution channel, taking advantage of the heaviness of the ozone coming out.

In large plants, the ozone distribution must be done with several exits positioned in strategic points of the plant, though always on the ceiling.

We must consider that, while small dehydration plants can guarantee a certain gastightness thanks to a good thickness of insulation, though not having a barrier against vapour that is to say not being waterproof, in large dehydration plants, especially in open-closed systems like the ones in Valpolicella, there is no 'gas tightness' and also little insulation, hence there could be high leaks of ozone and therefore a reliable alarm system with sensors in various positions is needed.

CONCLUSION

Ozone for the sanitisation of grapes may be a valid and healthy alternative to the use of sulphur bentonite when the environmental conditions of the drying environment are not carefully controlled.

From the point of view of the plant, especially large plants, there must be a perfect distribution of the gas, an accurate measuring system in different locations, a reliable alarm system and detailed safety signs indicating the risks for the operator, which is why the treatment must be done during the night.

For small and medium plants (70-500 m^3), built with appropriate insulation and with careful management of the environmental conditions, the treatment is a real and valid alternative with contained costs.

Also for old-style drying systems without control of environmental parameters, as is often required by DOC regulations, night treatment with ozone in environments with closed windows can save a large amount of grapes and above all avoid the production of oncogenic mycotoxins.

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Established in Milan in 1895, Unione Italiana Vini is the historical association of Italian wine firms: its core business, further to a lobbying activity, is focused on high quality services to the wine industry: analysis laboratories, supply chain checkup, SIMEI exhibition, sustainability program Tergeo.

Articles shared between the two publications focus on technical and economic issues, in order to give each readership a broader vision both on Italy and Australia/New Zealand.

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