CMC: a new potassium bitartrate stabilisation tool

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Introduction

Something major is coming to the Australian and New Zealand wine industries: carboxymethylcellulose (CMC). An application has been lodged by the Winemakers' Federation of Australia with Food Standards Australia and NZ (FSANZ) to include CMC as an approved wine additive. CMC may be an alternative for some existing products and technologies (e.g. cold stabilisation, electrodialysis, mannoproteins, metatartaric acid, etc.) for potassium bitartrate (KHT) stabilisation according to market segment, so an explanation of what it is and how it works would appear warranted.

CMC: carboxymethylcellulose

CMC is a permissible food additive in Australia and NZ, identified as E466 in Standard 1.3.1. It was authorised for use in wine by the International Organisation of Vine and Wine (OIV) initially for white and sparkling wines in 2008, which was amended to include all wines in 2009. The European Union adopted Commission Regulation (EC) No. 606/2009 on July 10, 2009, authorising the addition of carboxymethylcellulose (cellulose gums) to ensure tartaric stabilisation for all wines. CMC is now widely used in Europe, with many positive reports on its efficacy and environmental benefits. Trials by Australian wineries are reported in the WFA application to FSANZ to have positive results.

It is used in food most commonly as a viscosity modifier and emulsion stabiliser, and can be found in such foods as cream, ice cream and toothpaste. It is, in effect, an industrial product produced through the reaction between cellulose and chloroacetic acid under basic conditions, yielding the CMC, sodium chloride and water, as outlined in Figure 1. A side reaction between the base (NaOH; caustic soda) and the acid chloride leads to the formation of sodium glycolate, which is undesirable.

So how does CMC work?

CMC functions in a similar way to mannoproteins (Bowyer and Moine-Ledoux, 2007; Bowyer 2009). It is a physical inhibitor of nucleation and crystal growth, and as such represents a technical alternative to the physically subtractive process of traditional cold stabilisation. Specifically, CMC acts upon the 010 face of a growing crystal, restricting further growth while ensuring that nothing is visible to the naked eye. There is no chemical reaction or chemical modification of the wine so, as with a mannoprotein addition, there is no change in wine pH, tartaric acid (TA), or organoleptic characters, unlike cold stabilisation and electrodialysis (Table 1).

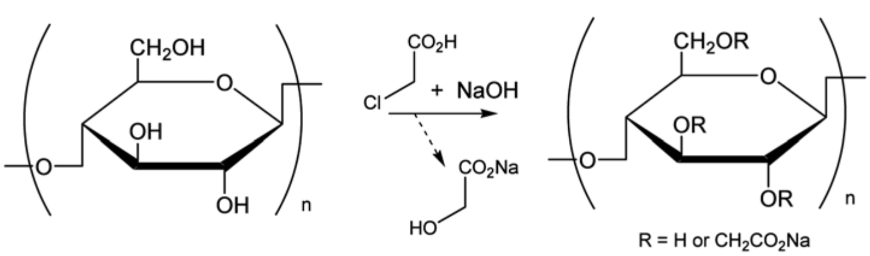


Figure 1. The basic production process for sodium-carboxymethylcellulose (Na-CMC), by treating the glucose polymer cellulose with chloroacetic acid under basic conditions.

Table 1. A comparison of the physiochemical impacts of different potassium bitartrate (KHT) stabilisation techniques on wine

Cotes de Provence 2008	Control	Electrodialysis	MANNOSTAB™	CELSTAB™
% alcohol	11.8	11.8	11.8	11.8
Residual sugar (g/L)	1.2	1.2	1.2	1.1
TA (g/L tartaric acid)	5.03	4.86	5.01	5.02
pH	3.37	3.25	3.36	3.37
VA (g/L acetic acid)	0.10	0.11	0.10	0.11

What are the governing factors in CMC efficiency?

Firstly, it is important to understand that not all CMCs are equivalent. Remember that most CMCs were developed for use in foodstuffs, not in the hydroalcoholic acidic medium of wine.

There are two major variables when it comes to CMCs: polymer length and degree of substitution. It is most likely that FSANZ will mirror the OIV specification should CMCs be approved for use in wine in Australia and NZ.

According to the OIV specification for CMCs to be used in wine, the polymer length (more specifically, the molecular weight) can vary between 17 and 300 kiloDaltons, which is considerable. Polymer length governs the viscosity of the CMC solution. This is an important parameter, as viscosity in turn determines ease of use in the winery. When investigating several CMCs, LAFFORT found, for example, that the viscosity of the raw CMCs varies considerably between producers. Consider the data from the CMC products analysed, presented in Table 2. CMCs A and B were soluble and retained liquidity as 5% and 3% solutions, respectively, but not when concentrated further. CELSTAB™, the LAFFORT-branded CMC, is soluble and remains liquid as a 10 % solution. CMC D, in contrast, set like a jelly at a dissolution rate of less than 1%, which means CMC D therefore is not suitable for use in wine.

Given that CMCs A and B could not be concentrated to more than 5% and 3% as stock solutions, their use may also have a potential impact on the wine organoleptic characteristics, since the CMC is basically added to a finished wine ready for bottling, and three times the volume of CMC B, for example, (and therefore water) compared ▸

Table 2. A comparison of some carboxymethylcelluloses (CMCs) available on the market and their relative solubilities and effective usage rates

Cellulose gum	10 %	5 %	3 %	1 %	Effective usage rate
CMC A	✗	✓	✓	✓	5 %
CMC B	✗	✗	✓	✓	3 %
CELSTAB™	✓	✓	✓	✓	10 %
CMC D	✗	✗	✗	✗	<1 %

with CELSTAB would have to be added to achieve an equivalent level of stability.

The other parameter that is chief in governing CMC effectiveness in wine is the degree of substitution of the glucose units within the CMC polymer. The OIV specifies that this must be between 0.60 and 0.95, meaning that, on average, slightly less than one alcohol group per glucose unit is substituted with the carboxymethyl group. The degree of substitution has an impact on the solubility of the CMC, in addition to governing the effectiveness of the stabilisation afforded by using the product.

What are the pros, cons and caveats of CMC usage?

Pros

The pros of CMC usage are significant. It is relatively inexpensive and requires minimal electricity (basically just the usage of a pump for homogenisation), which is particularly relevant given the rising electricity costs associated with cold stabilisation and electrodialysis. Environmental impact at the winery is substantially reduced due to the virtual elimination of electricity costs. Product usage for a liquid CMC is quite simple: some wine is used to dilute the required volume of the product, and this is then added to the wine tank with homogenisation. CMCs are suitable for relatively unstable wines, in contrast to mannoproteins which are better suited to aged wines. There is only one recommended dosage: 10 grams per hectolitre.

Cons

CMC product shelf-life can be on the short side, so it is important to ensure your stock rotation and that product you receive is within date. Also, a CMC is clearly not a natural product – it is effectively an industrial chemical made from a natural product (cellulose) with chemical modification. Note that the OIV specifies that oenological CMCs must be of wood origin.

Caveats

Like any technical oenological product, CMCs require some care to be taken with regard to specific wine parameters. To use a CMC, the wine must be 'bottle ready', meaning that usual bottling parameters such as nephelometric turbidity units (NTU), stability and filterability must be within specification. No subsequent physiochemical modifications can be made after CMC addition, including blending, concentrate additions, chaptalisation, acid adjustments or deacidification.

CMCs are not recommended for use in red wines, and only in some rosés (which require checking after CMC addition), as they can precipitate colour. In Figure 2, for example, we can see the results of two series of experiments where a CMC was added to a red wine with storage for six days at -4°C and also at room temperature. At low temperature the CMC precipitated colour, while at ambient temperature it did not. Since transportation and storage conditions are often beyond the winery's control, we do not therefore recommend the use of CMCs on red wines. Note the two samples in Figure 2a which did not show colour loss on cooling, indicated by the red oval. These samples were treated with MANNOSTAB™ as a comparison to the CMC. Measuring the turbidity changes under these conditions also illustrates the danger of using CMCs on red wines (Figure 3).

Since CMCs can interact with proteins a wine to be treated with CMC for KHT

Figure 2. An illustration of the potential for colour loss in red wines treated with carboxymethylcelluloses (CMCs) when chilled. Note the two samples indicated by the red oval, which did not show colour loss – these were treated with MANNOSTAB™, which is a mannoprotein-based potassium bitartrate (KHT) stabilisation agent derived from yeast.

stabilisation must be protein-free. This includes any enzymatic treatments, notably lysozyme, which can generate a haze in the presence of CMC.

Filterability is also an important parameter, and here again not all CMC products are equal. Some CMCs have a dramatic initial effect on wine filterability, causing an instant rise in the clogging index (IC; a decrease in filterability). Figure 4 depicts this, with a comparison between the increases in clogging index observed after the addition of CELSTAB and CMC B to a Provence rosé. Note the rapid initial rise in clogging caused by the addition of CMC 2. Although in this case the clogging index returns to a normal value after 24 hours, attempting to filter this wine when bottling immediately after the addition of CMC 2 may have proved disastrous. In comparison, CELSTAB showed virtually no decrease in filterability, although to be safe we do not recommend any filtering operations at all within a minimum of 24-48 hours after addition.

Case studies

Table 3 outlines some case studies on actual wines. All of the French wines were of relatively high instability (DIT >17 %), with good filterability (CI <50). The Australian wines from Margaret River were 2010 wines of moderate instability. All of the wines were tested using a Stabilab (©Eurodia) instrument to determine degree of tartaric

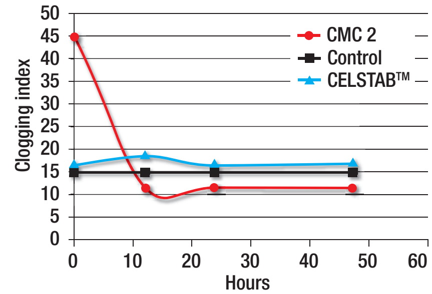
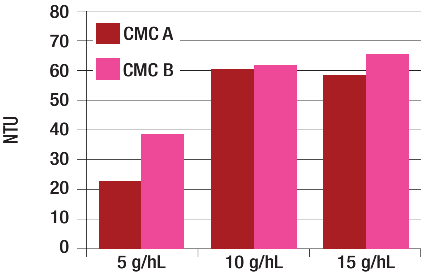


Figure 4. Clogging index (a measure of the level of clogging that a wine shows when passed through a filtration membrane) as a function of time in a rosé treated with two different carboxymethylcellulose (CMC) products: CELSTAB™ and CMC 2.

instability (DIT), and then checked using the Stabilab ISTC50 program, in which a wine is destabilised by dissolving more KHT and then measuring the conductivity drop observed over a period of time when chilled to -4°C. A result of <3 microsiemens variation in conductivity indicates a successful treatment. This test was then compared with the OIV standard test of six days at -4°C.

Summary

CMCs represent significant cost, energy and environmental savings in wine production for selected wines. They function in almost exactly the same way as mannoproteins in terms of KHT stabilisation, and are based on cellulose, ▶



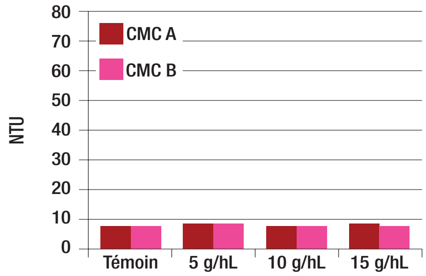


Figure 3. Turbidity increases in accordance with colour loss in red wines treated with two carboxymethylcelluloses (CMCs) when chilled (left) compared with ambient temperature storage (right). Témoin = control.

Table 3. A comparison of some wines of high instability (DIT >17 %) treated with CELSTAB™ at 100 parts per million. CI = clogging index; ISTC50 is a wine stability check program of the Stabilab™ instrument, copyright Eurodia.

Wine	Turbidity (NTU)	CI	Degree of tartaric instability (DIT %)	Stability check (Stabilab ISTC50 in mS)	Pass six days at -4°C?
Vin de pays Hérault Rosé 08	1.3	18	17	3	✓
Table wine White 08	0.2	10	23	3	✓
Table wine Charentes Blanc 08	4	20	20	2	✓
Bordeaux Rosé 08	5	35	18	0	✓
Margaret River Chardonnay 2010	-	-	12.6	2	✓
Margaret River Sauvignon Blanc/Semillon 2010	-	-	10.8	0	✓

yet are an industrial chemical. Organoleptic impact is minimal or nil provided the CMC is of high quality and, beyond some technical parameters that must be observed, it is relatively straightforward to use. It is important to ascertain the quality and suitability of any CMC product prior to usage in wine (as they are produced through industrial modification of a polymeric product) because they can vary considerably in their physical and chemical parameters, and it must always be remembered that most CMCs are used in the food industry, and are not specifically made for application in wine.

The WFA application was formally accepted by FSANZ on May 27 and formal assessment is expected to commence in January next year. Since the food additive is already permitted in the Code, a minimal public health and safety assessment is needed and the risk management options are anticipated to be straightforward. This means we can expect to have CMCs approved for use in wine in a shorter time than average. ■

References

Bowyer, P.K. and Moine-Ledoux, V. (2007) MANNOSTAB: the award-winning new potassium bitartrate stabilisation product. Australian & New Zealand Grapegrower & Winemaker, June, 57-62.

Bowyer, P.K. (2009) Technical update: MANNOSTAB – for potassium bitartrate stabilisation. Australian & New Zealand Grapegrower & Winemaker, 550, 105-106.

Products discussed in this article are available in Australia through LAFFORT by phoning (08) 8260 7974, and in New Zealand from LAFFORT New Zealand by phoning 0213 22290 or emailing Greg Wilkin: greg@laffort.co.nz; visit www.laffort.com

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