wine ingredients News

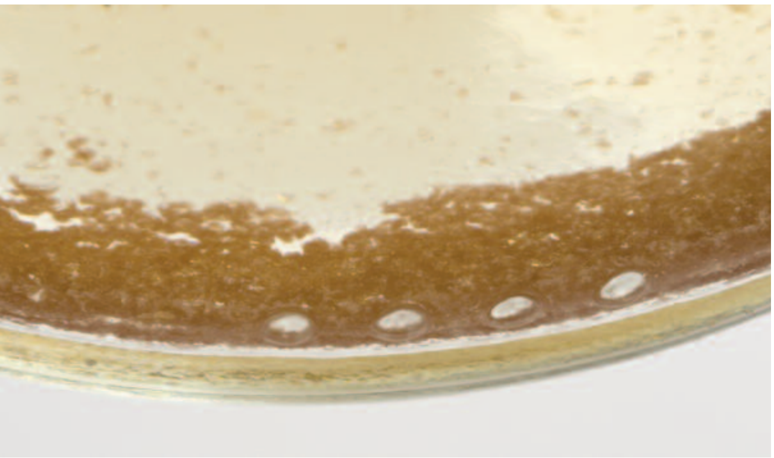
08/2009 ©DSM Food Specialties B.V.

Willem Jan BOSMA,
Willem RUSTER,
Erik VAN DAM,
Triple Value Strategy Consulting
Lange Voorhout 41
2514 EC DEN HAAG
The Netherlands

Céline FAUVEAU,
Blandine LEFOL,
Phil LATHAM,
DSM Food Specialties
Alexander Fleminglaan 1
2613 AX Delft
The Netherlands

Increasing eco-efficiency with a natural alternative for tartrate stabilization in wines

Sustainability leader DSM Food Specialties developed Claristar™ , a specific mannoprotein fraction to prevent potassium tartrate precipitation in wine. Isolated from yeast (Saccharomyces cerevisiae) Claristar is a natural alternative to the current technologies for preventing the apparition of crystals in white and rosé wines. In addition to its stabilising properties, Claristar has a superior ecological performance over other stabilizing alternatives such as cold stabilization and electrodialysis. Claristar eliminates water and energy usage and thus the carbon footprint at this stage in the winemaking process. Moreover, Claristar significantly reduces the ecological footprint from the perspective of the value chain as a whole. For each technology an assessment was made of the impact across the entire value chain (for mannoproteins including Claristar production, logistics etc…) as well as the isolated impact of the stabilization treatment at the winery. In this paper results are presented for both approaches. In the case of Claristar, the main impact on the environment is during its production and transport whereas for the alternatives, the main impact is at the winery during wine treatment. Using mannoproteins for potassium tartrate stabilization fits with the increasing sensitivity to environmental issues in the wine industry.



Wine industry, increasing sensitivity to sustainability

Whereas sustainable wines have obtained considerable attention in the last years, most attention has been given to vineyard management and sustainable grape production. Only recently, more focus is being given to sustainability in the winemaking process. This shift in attention is due to marketing initiatives from wineries, additional governmental pressure, economic reasons and scarcity of resources (mainly water).
There are large variations in interest for sustainability in wine productions from one region to the other. For this analysis, most attention was given to four regions: France, Italy, Australia and the USA (California). The sensitivity to sustainability was determined by analysing industry initiatives, consumers and non governmental organisations pressure. From these regions, the following observations were made:

- **Sensitivity to sustainability is most visible in Australia, USA and to a lesser extent South Africa**

The Australian Wine Industry Stewardship (AWIS) is the main catalyst in Australia and recently expanded its ecological policy from vineyard to wine production.
Australia and USA are home to several large wineries considered leaders in the area of sustainability.
In California, several pilot water and energy efficiency programs are initiated by the Public Utilities Commission and Pacific Gas & Electric Co., including a footprint calculation. Stringent regulations are installed on reduction of green house gases.

DSM Food Specialties
P.O. Box 1, 2600 MA Delft -The Netherlands
TRN 27235314
www.dsm-oenology.com / www.dsm-foodspecialties.com

Unlimited. DSM

Innovative projects are initiated with wine industry associations from California, New Zealand and South Africa, aimed at calculating the carbon footprint of the wine industry.

- **Growing attention to sustainability in the French and Spanish markets**

Key initiatives are both government and private sector driven. Several large players have pro-active environmental policies. At different regional levels, there is a clear shift to sustainability. Champagne and Bordeaux are examples of regions with growing attention on the carbon footprint.

- **The Italian market should be next**

In Italy, sustainability initiatives are so far mostly EU or government driven.

Methods for potassium tartrate stabilization in wine

Common procedures to avoid the presence of crystals in wines either remove the potassium bi-tartrate crystals or prevent their formation. See Table 1 for alternative methods. The most commonly used technique is cold stabilization. This process involves chilling and keeping wines at low temperature (e.g. up to a week at -4° C) to induce the formation of crystals. This process can be accelerated by adding cream of tartar which plays the role of crystallisation initiator. Once formed, the crystals grow and are removed by racking and/or filtration.

Alternative	Description
Cold stabilization	• Dominant technology. • Cooling of wine for long period (up to a week) at -4° C to cause potassium tartrate precipitation. Crystals are then removed by filtration. • Cooling period can be shortened by adding KHT crystals. • Requires refrigerated tanks. • Risk of oxidation leading to a potential organoleptic loss.
Electrodialysis	• Involves recycling wine between electrode plates. The electric potential difference applied between these plates force molecules migration through a selective membrane and thus removes ionic material from the wine. • Requires installed base (equipment investment).
Mannoproteins	• Inhibition of potassium tartrate crystal nucleation. • Liquid solution is mixed with wine before bottling.
Metatartrate	• Prevents tartrate crystal formation and growth. • Added to wine before bottling. • Limited efficiency in time.

Table 1: *Alternatives considered in eco-efficiency analysis.*

Tartrate stabilization ecological footprint analysis from a value chain perspective

- **Methodology**

The main ecological impact of Claristar is in its production and distribution, thus outside of the winery. For the alternatives, cold stabilization and electrodialysis, the main ecological impact is at the winery level. Both these techniques do require energy and water use at the winery whereas Claristar is simply added to the wine. Therefore, an ecological footprint analysis was carried out across the whole lifecycle. Calculations were based on the Eco-Indicator '99 method (a damage oriented method for Life Cycle Impact Assessment, Goedkoop, M.; Spriensma, R) . This analysis identifies the categories with the largest contribution to the total environmental impact.

The ecological impact of various tartrate stabilization alternatives was compared on the basis of the functional unit: to stabilise 1 hectolitre of wine. System boundaries were defined to encompass the environmental impacts of the whole lifecycle for each technology: Cold Stabilization, Electrodialysis and Claristar (for a dosage of 100 ml/hl of wine). Metatartrate was not considered in this study as it only allows for temporary stability and thus not considered to be a comparative technique for long term stability.

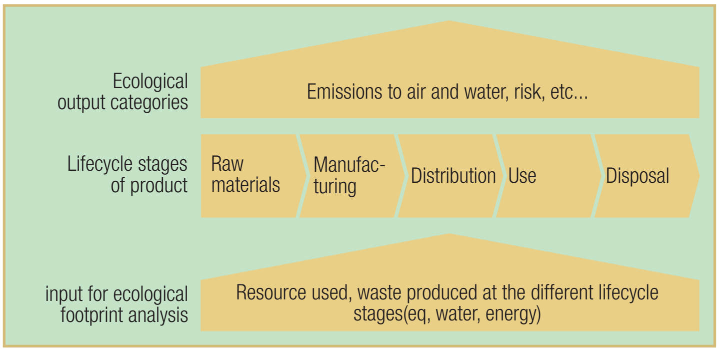


Figure 1: *Ecological footprint from a value chain perspective.*

The ecological impact was determined for the 6 categories which contribute to more than 99 % of the ecological footprint: energy usage, water usage, carbon footprint, land use, fine particles and toxic potential.

The European average electricity mix was used for determining the different impact categories (eg CO_2 emissions). In addition, the Claristar savings of water usage, energy usage and emissions to water (in terms of COD) were also determined at the winery.

Water usage

Water usage represents water depletion across the lifecycle. The main impact in this category is caused by direct water use (at the winery and/or at the production plant), water loss during water transport (in the value chain of water) and water use in the electricity value chain.

Energy usage

Energy consumption represents the energy use across the value chain. The main impact is caused by direct energy use at the winery or at the DSM Food Specialties production plant, production of raw materials, transport to the winery and the electricity value chain.

Emissions to air (in CO_2-eq)

The main impact in emissions to air (or carbon footprint) in terms of CO_2-eq across the value chain is caused by direct energy use at the winery or at the DSM Food Specialties production plant, production of raw materials, transport to the winery and in the electricity value chain.

Toxicity potential

The toxicity potential (or human toxicity) is calculated using the classifications for hazardous materials under EU law. The relevant data are readily and quickly retrievable, and the classification method is recognized and widely used. The main impact is caused within the electricity value chain.

Fine Particles

Fine particles (or particulates matter) are found in the form of tiny particles of solid or liquid suspended in a gas or liquid. Their main impact is on the electricity value chain.

Land-use

This category includes the use of land during the life cycle of a product. The main impact is caused by agricultural products (e.g. molasses which are used for yeast production upstream in the manufacture of Claristar).

• Comparison of the ecological footprint of different tartrate stabilization technologies from a value chain perspective

The 6 main ecological parameters were compared for each technology across the entire value chain. The results presented below were calculated using input data sourced from several (research) papers and Claristar manufacturing data (from DSM Food Specialties). The results presented here for mannoprotein tartrate stabilization of wines are product specific and only apply to Claristar as they take into account DSM Food Specialties unique production process. Further data was acquired from Lifecycle Analysis software, SimaPro, and the established Ecoinvent database.

Water usage

The higher water requirements of electrodialysis and cold stabilization were due to direct water use at the winery and the water usage during the generation of electricity. Water consumption for Claristar was based on the water use at its production plant and the production of raw materials.

Europe (per hl stabilized)	Water l	Energy MJ	Carbon Footprint kg CO_2-eq	Toxic potential kg 14DCB	Particle g PM10	Land use m^2
Cold Stabilization average winery	14,33	21,23	0,99	3,07	1,28	0,016
Cold Stabilization, large, energy efficient winery	9,17	11,73	0,55	1,70	0,71	0,009
Electrodialysis (1)	30,54	11,06	0,58	1,69	0,75	0,011
Electrodialysis (2)	14,99	6,05	0,32	0,86	0,40	0,006
Claristar™ mannoproteins	6,80	6,17	0,28	0,43	0,30	0,05

Remark : *(1) including energy requirements for pre-clarification and bentonite fining for white wines, which has to be performed separately when using electrodialysis.*
(2) excluding energy requirements for pre-clarification and bentonite fining for white wines.

Table 2: *Environmental impact of different tartrate stabilization technologies from a value chain perspective.*

Energy usage

The higher amounts of energy used for electrodialysis and cold stabilization were mostly due to the direct electricity use at the winery.

The energy use of Claristar was a total amount of energy used during the production of raw materials, production of Claristar and the transport of Claristar to the winery.

Energy use converted to CO_2-equivalent emissions

Claristar has a significantly lower carbon footprint than alternative technologies regardless of winery size and efficiency. The higher impact is directly linked to differences in energy usage of the different technologies.

Toxic potential

Claristar has a substantially lower toxic potential because of its lower energy requirement. The generation process of electricity results in hazardous materials causing toxic potential.

Fine particles production

The process of electricity generation produces fine particles. Claristar has a substantially lower impact on fine particles production because of its lowest requirement for electricity compared to other alternatives.

Land use

The surface of land used for Claristar was shown to be high in comparison to that used for cold stabilization and electrodialysis because of the use of molasses. Molasses are a by-product from the processing of sugar beet and are used as a carbohydrate source for the production of yeast upstream in the Claristar manufacturing process.

However, the footprint in absolute terms is only 0.05 m^2 of land used per hl of stabilised wine.

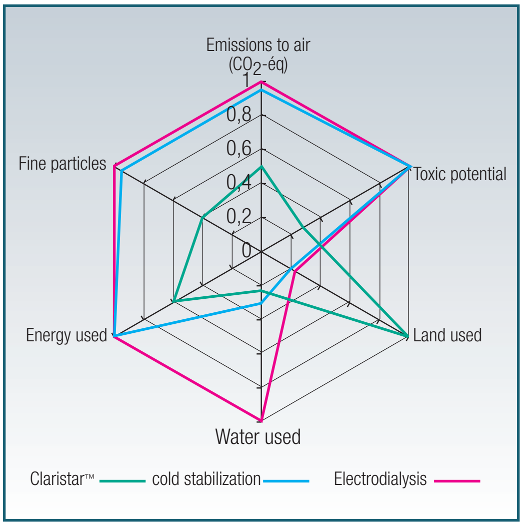


Figure 2: The ecological profile of various alternatives for tartrate stabilisation.

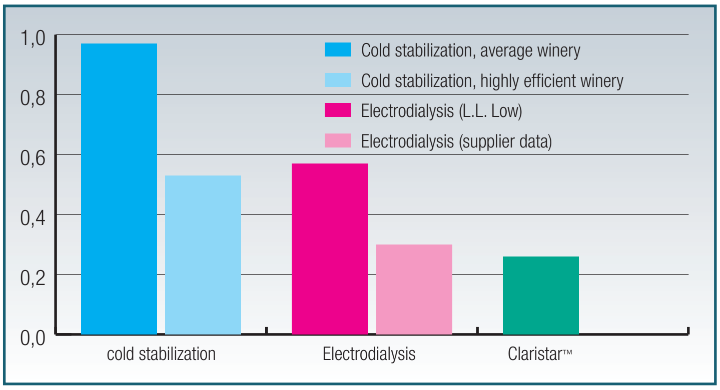


Figure 3 : CO$_2$ emissions for tartrate stabilisation technologies accross the value chain (Europe).

Wineries environmental performance

Several papers (eg L.L. Low et al, 2008 ; Escudier 2002) compare the environmental performance of tartrate stabilization methods at the winery. The savings in terms of water and energy use are summarized in the table below. It is assumed that the lower value in the table is applicable to larger wineries such as the large southern hemisphere winery used as a reference in the literature (yearly production of 1 million hectolitres). For example lower values for cold stabilization can also be explained by energy recovery systems (using cooled stabilized wines to cool wines to be stabilized), insulation or other energy efficient systems put in place by the winery. The higher value in the table was provided by equipment suppliers. This higher value was assumed to be associated with medium size wineries (eg yearly production of 20,000 hl).

Reducing water use at the winery

The use of mannoproteins completely eliminates water consumption as well as waste water effluents (eg in terms of COD) at this stage in the winemaking process.

Reducing energy use at the winery

Using mannoproteins for tartrate stabilization of wine eliminates energy use and carbon footprint at this stage of the winemaking process.

	Cold stabilization	Électrodialysis	Claristar™
Energy use	3,7 -6,7 Mj/hl	2,9 Mj/hl	Negligible
Water use	3,8 - 5 litres/hl	20,7 litres/hl	Negligible

Table 3: Environmental impact of different technologies evaluated at tartrate stabilization step at the winery.

Conclusion and Future

Claristar mannoproteins are a natural ingredient enhancing wineries' environmental performance in potassium tartrate stabilization.
In this assessment, compared to the dominant technology, it reduced energy usage, improved carbon footprint and minimised water usage and waste both at the winery and from a value chain perspective.
Water use was reduced with 25 to 50 % and energy use and carbon footprint with 45 to 70 %, depending on the scale and efficiency of the winery.
DSM Food Specialties is committed to deliver top performing and sustainable solutions to the wine industry. DSM Food Specialties will be looking for customers to co-create sustainable solutions to optimise alignment with customers' requirements and desires.

• About the Authors

Triple Value Strategy Consulting is an independent strategy consultant that focuses on sustainability, business strategy and innovation. It has a longstanding track record on conducting eco-efficiency analysis across industry sectors. The results presented in this report are based on a systematic examination of sustainability parameters in order to provide comparison between winemaking practices (www.triple-value.com).

DSM Food Specialties, the Company behind the development and manufacture of Claristar, is a global supplier of advanced ingredients for the food and beverage industries. It recognises the increased importance of sustainability across many industries, including the wine business. DSM Food Specialties wants, when possible, to offer its clients eco-efficient solutions, i.e. competitively priced products which progressively reduce ecological impact to a level at least in line with the Earth's estimated carrying capacity.

• References

- *Bouissou, D et al. VigneVini 11, 2007 pp123-127. Un Nuovo ingrediente per la stabilizzazione tartarica*
- *Escudier, J. L., (2002).New physical techniques for the treatment of wine : electrodialysis. Available at www.vinidea.net/files/1/escudier4engoct02.pdf (accessed on May 26th 2009)*
- *DSM: data were provided by marketing, R&D, manufacturing, sourcing and utility managers. For information on Claristar, see www.Claristar.com*
- *Ecoinvent v2 database (by Swiss Centre for Life Cycle Inventories). This database contains up to date information on nearly 4000 industrial processes.*
- *www.etcc-ca.com*
- *http://www.ameridia.com*
- *Supplier data, confidential communications and publications; this is in the range of an medium sized winery with average efficiency*
- *Lin Lin Low, et al. International Journal of Food Science and Technology. 2008. 43. 1202-1216. Economic evaluation of alternative technologies for tartrate stabilization of wines.*
- *California's Energy-Water Nexus: Water Use in Electricity Generation, D. Larson et al, 2007.*

A case study for Product Carbon Footprint assessment, Thema 1

Additionally to the results presented in this article, in 2008, DSM participated in the German Product Carbon Footprint Pilot Project. This project was initiated by the Öko-Institute (Institute for Applied Ecology), the Potsdam Institute for Climate Impact Research (PIK), Thema1 and WWF. Other corporate partners included BASF, Henkel, Tetra Pak and Deutsche Telecom.

DSM chose to submit Claristar to the case study. By doing so, the carbon part of the comprehensive eco-efficiency analysis was further substantiated and validated in terms of system boundaries, the carbon footprint at each stage of the value chain, the sensitivity of results to changes in assumptions and carbon footprint reduction options.

The results of these case studies were presented on January 26, 2009 in Berlin and were well received in terms of seminar participation and media attention.

For more information about this project and for the results of the Product Carbon Footprint assessment for Claristar, see www.pcf-projekt.de.