Functionalized Mesoporous Silica is a viable alternative to bentonite for wine protein stabilization

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BACKGROUND AND AIM

The presence of grape-derived heat unstable proteins (TLPs and chitinases) can lead to haze formation in white wines [1], an instability prevented by removing these proteins by adding bentonite, a hydrated aluminum silicate that interacts electrostatically with wine proteins leading to their flocculation. Despite effective, using bentonite has several drawbacks as the costs associated with its use, the potential negative effects on wine quality, and its environmental impact, so that alternative solutions are needed. **This project aimed at evaluating the effectiveness of functionalized mesoporous silica (FMS) in removing heat unstable proteins from white musts and wines, as well as its impact on wine composition.**

PROTEIN REMOVAL

The protein profile and concentration of treated and untreated wines (**Table 2**) showed that the stabilizing effect of FMS was extremely similar to that of bentonite, and that it was attributable to the effective removal of both TLPs and chitinases in a dose dependent mode.

Table 2. *Protein content assessed by RP-HPLC and expressed in mg/L.*

Treatment	Sauvignon Blanc 2019		Friulano 2019		Zibibbo 2019		Manzoni bianco 2019		Sauvignon Blanc 2022		Traminer 2022	
	TLPs	Chit	TLPs	Chit	TLPs	Chit	TLPs	Chit	TLPs	Chit	TLPs	Chit
Unfined wine	179	69	32	10	52	1	64	7	65	15	88	29
FMS	17	7	11	0	9	0	11	2	10	1	9	1
Na-Bentonite	26	3	10	2	6	0	17	1	14	2	12	2

IMPACT ON WINE COMPOSITION

Table 3 shows that FMS did not cause modifications on wine composition in terms of organic acid profile, ethanol content (not shown), glycerol, volatile composition (not shown), and elemental content that, on the other hand, was always modified by bentonite fining that always led to an increase in Fe and Al (**Table 4**).

Table 3. *Organic acid composition of the three wines treated with 4 fining regimes (n = 3).*

	CITRIC ACID (g/L)		
WINE TYPE	Untreated	Bentonite	FMS
Grüner Veltliner	0.22	0.22	0.18
Traminer	0.12	0.11	0.11
Manzoni	0.04	0.04	0.04
	TARTARIC ACID (g/L)		
	Untreated	Bentonite	FMS
Grüner Veltliner	2.70	2.68	2.40
Traminer	1.81	1.71	1.80
Manzoni	1.65	1.64	1.67
	MALIC ACID (g/L)		
	Untreated	Bentonite	FMS
Grüner Veltliner	2.95	2.92	2.02
Traminer	0.11	0.06	0.10
Manzoni	0.09	0.08	0.07
	LACTIC ACID (g/L)		
	Untreated	Bentonite	FMS
Grüner Veltliner	0.17	0.16	0.17
Traminer	3.51	3.22	3.44
Manzoni	3.05	3.07	3.11
	GLYCEROL (g/L)		
	Untreated	Bentonite	FMS
Grüner Veltliner	7.77	7.72	7.83
Traminer	10.95	9.20	10.82
Manzoni	10.73	10.71	10.97

EXPERIMENTAL

FMS treatments were benchmarked against a commercial Na-Bentonite in a series of experiments conducted on heat unstable white wines of different origin, vintage and variety, and on different scales (from few mL to 10 hL). The stabilizing properties of the fining agents were determined by analyzing the protein profiles of treated wines (by RP-HPLC), and by assessing protein stability via heat tests [3]. In addition, the treatments impact on other wine parameters (e.g. organic acid profiles, metal content, macromolecules, lees formation, sensory analysis) were determined.

FINING RATES

For each wine, the dose of bentonite and FMS needed to reach full protein stability was determined by fining rate trials (**Table 1**).

Table 1. *Heat test of wines unfined, treated with Na-Bentonite or FMS. Wines considered heat stable with ΔNTU values < 2 .*

Treatment	Sauvignon Blanc 2019		Friulano 2019		Zibibbo 2019		Manzoni bianco 2019		Sauvignon Blanc 2022		Traminer 2022	
	NTU	g/hL	NTU	g/hL	NTU	g/hL	NTU	g/hL	NTU	g/hL	NTU	g/hL
Unfined wine	38	0	7.3	0	15.4	0	9.7	0	93	0	193	0
FMS	0.7	130	1.2	25	1.6	70	1.9	90	1.8	60	1.5	110
Na-Bentonite	1.8	120	1.1	20	1.8	80	1.7	100	1.8	60	1.4	100

FMS allowed to reach wine heat stability at addition rates in line with those of bentonite, with a small variability attributable to differences in wine composition.

ELEMENTAL ANALYSIS

Table 4. *Element analysis on a Sauvignon Blanc fined with two types of bentonite and FMS at addition rates sufficient to fully stabilize it.*

Element	Control wine	Wine after bentonite A (1g/L)	Wine after bentonite B (1.3 g/L)	Wine after FMS (1.5 g/L)
Ca (mg/L)	64	67 +4%	71 +11%	60 -6%
Na (mg/L)	6.6	16.1 +151%	11.4 +73%	6.3 -5%
Fe (mg/L)	0.20	0.40 +100%	0.26 +30%	0.18 -10%
Al (μg/L)	227	1741 +669%	499 +120%	223 -2%
Ba (μg/L)	27	255 +840%	180 +560%	25 -7%
Si (mg/L)	4.9	10.6 +116%	5.2 +6%	4.9 =

IMPACT ON WINE SENSORY QUALITY

A sensory analysis conducted by triangle test (**Table 5**) on two white wines (Sauvignon blanc and Traminer, both vintage 2022) stabilized with FMS or bentonite at similar addition rates (see **Table 1**) revealed the lack of significant differences between the two stabilization treatments.

Table 5. *Results of the triangle tests, n = 39 responses.*

TEST	TOTAL ANSWERS	CORRECT ANSWERS	P-Value	Significance
Sauvignon BENT (0.6 g/L) vs Sauvignon FMS (0.6 g/L)	39	13	0.5599	**Not significant**
Traminer BENT (1.0 g/L) vs Traminer FMS (1.1 g/L)	39	17	0.1184	**Not significant**

In general, FMS, a material currently under OIV scrutiny for approval for winemaking, showed to effectively stabilized wines at addition rates similar to those of bentonite, without causing major compositional modification, nor detectable sensory impacts → FMS is a candidate to become a viable bentonite alternative.

References

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