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INFLUENCE OF TANK SIZE ON ALCOHOLIC FERMENTATION, MALOLACTIC FERMENTATION AND SENSORY APPEARANCE OF RESULTING WINES

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INTRODUCTION

Malolactic fermentation (MLF) is well-known as a microbiological tool to change the acidity profile of wines. In contrast to chemical deacidification either of must or wine MLF has also an impact on wine flavour. Although the extract of wines are lowered wines often appear softer, rounder and with more body. Especially this roundness, the mouthfeel and the longer aftertaste pleases more and more also those wine consumers who preferred wines with higher acidity up to now.

Spontaneous malolactic fermentations, performed by lactic acid bacteria, always carry the risk of incomplete metabolisation of malate and/or of production of unpleasant flavours or even synthesis of biogenic amines. Especially bacteria belonging to the genus *Pediococcus* bear those risks. On the other hand bacteria strains of the species *Oenococcus oeni* (= former *Leuconostoc oenos*) are known to be harmless.

In addition, to curcumvent all these risks the use of proved commercially available starter cultures is highly advisable.

Lactic acid bacteria are auxotrophic microorganisms that means that they need a couple of essential nutrients which they cannot synthesize themselves. Among these are vitamins, amino acids, purines and pyrimidines.

Besides the nutritional demands microorganisms respond also to environmental conditions which are in this case treatments of must as well as fermentation temperature.

Height of fermentation tanks might also influence the course of fermentation and the production of flavours, pleasant as well as unpleasant odors.

In this work we investigated the impact of tank size on duration of alcoholic as well as on malolactic fermentation and the sensory appearance of wines finally.

RESULTS AND DISCUSSION

Fermentation characteristics

Pasteurized Pinot gris must was inoculated with a liquid yeast starter culture

(3 % vol) and kept between 18 and 20°C throughout fermentation in 1 x 2,000 L tank (must volume = 1,800 L) and 120,000 L tank (must volume = 110,000 L). Yeast starter culture was selected in the winery years before and is propagated during the harvest season in pasteurized must.

Fermentation started in the large stainless steel tank very rapid. Yet after the 4th day fermentation rate was quite the same in the two tanks. Sugar conversion was completed at the 8th day. (Fig. 1). Residual sugar content was lower than 1 g/L.

Two days after the end of fermentations the tanks were racked. In order to avoid differences in the content of yeast lees prior to malolactic fermentation, young wines were collected intermediately in a storage tank and thereafter subdivided in 400, 4,000 and 30,000 L tanks.

Experimental design was as follows :

Grape variety : Pinot gris, vintage 1996.

Must : centrifuged and pasteurized (80°C, 2 min).

ALCOHOLIC FERMENTATIONS
performed in :
2.000 L tank **120.000 L tank**
young wines were subdivided
and MLF bacteria inoculated :
⇓
MALOLACTIC FERMENTATIONS

(S1) 400 L winery MLF culture
- (S4) 400 L winery MLF culture
- (S5) 400 L comm. MLF cultr. A
- (S6) 400 L comm. MLF cultr. B

(S2) 400 L comm. MLF culture A
- (S7) 4.000 L winery MLF culture
- (S8) 4.000 L comm. MLF cultr. A
- (S9) 4.000 L comm. MLF cultr. B

(S3) 400 L comm. MLF culture B
- (S10) 30.000 L winery MLF culture
- (S11) 30.000 L comm. MLF cultr. A
- (S12) 30.000 L comm. MLF cultr. B

Deacidified control wines :

From each alcoholic fermentation batch 400 L were taken, stabilized with SO_2 and stored. Wines were clarified like other experimental wines, but additionally deacidified.

(S14) 2.000 L ferment. trial
(S13) 120.000 L ferment. trial

Winery selected bacteria starter culture was cultivated in a dry Mueller Thurgau wine and added at 5 % volume to the respective tanks. Commercially MLF cultures were treated according to manufacturers descriptions either by direct inoculation or after a short rehydration step in water.

Control samples remained without inoculation. SO_2 was added after seven days to these. There was no spontaneous MLF detectable before addition of sulphurous acid.

With the exception for the controls, all variants started malolactic fermentation on the second day after seeding. Conversion of malate was more or less complete after 22 days (Fig. 2). Temperatures of the fermenting wines decreased during that time to 17°C.

Tests with clarifying filter sheets in lab scale showed only minor differences in filterability between MLF-wines and/or control wines (Fig. 3). These findings were confirmed with bulk wine filtration.

After clarification and filtration the wines were sulphitized. MLF-wines showed slight but significant better ratios of free/total SO_2 values compared with non- MLF control wines (Fig. 4).

Chemical analysis and sensory impressions

Chemical analysis was focused on different approaches of possible alteration of fermentation bouquet either by tank volume during fermentation and/or by MLF in different tank sizes performed by different MLF cultures. Parallel to these investigations wines were sensory evaluated four months after end of MLF.

It is often said that in big tanks great losses of volatiles occur due the extracting effect of evolving carbon dioxide. As fermentation temperature was consequently kept between 18 and 20 °C, ethanol content of the wines fermented in 2.000 L volume and in 120.000 L volume differed only for about 0.3 g/l, what was within inaccuracy of analytical method.

Preference tests showed no significant differences between the two fermenting wine volumes. Also investigation of key volatiles making up the fermentation bouquet showed only small differences (Fig. 5).

With the exception of diacetyl, nearly no chemical compounds is known as sensory basis for the different flavour impressions of MLF-wines. On the other hand potential influence of lactic acid bacteria on fermentation bouquet were already described, yet only in small scale experiments.

We checked changes in the amount of flavour compounds with the following results. Fermentation in 2.000 L volume and subsequent malolactic fermentation in 400 L tanks gave rise to significant decreases of some components, expecially for higher alcohols like 2-methylbutanol and 3-methylbutanol. Also acetates like ethylacetate were affected. The influence of the different bacteria strains is easily visible (Fig. 6).

Comparing the same malolactic fermentation volume, i.e. 400 L of young wines coming from different wine production scales, showed that the lowering effects of the inoculated bacteria strains were more pronounced in wines coming from 120.000 L alcoholic fermentation (Fig. 7). These results were consistent with increasing malolactic fermentation volumes. Figure 8 shows the respective results. Up to now we cannot explain this difference which is obviously due to the differences in tank volume during alcoholic fermentation. Maybe that the forced movement in large tank volume enables yeast cells to incorporate more must constituents with the result that malolactic bacteria respond in this way to the losses of nutrients. On the other hand it is also possible that yeast cells secrete some metabolites during large scale fermentation which affect metabolism of *Oenococcus oeni*.

Sensory descriptions of the wines comparing MLF-wines and deacidified wines showed following characteristics :

– selected winery MLF culture : fresh, fruity, round with flavours of pine apple, apricot and vanilla ;
– commercial MLF culture A : less fruity, vegetative, but more body, buttery, burnt sweet :
– commercial MLF culture B : less fruity, less body, buttery, light bitter taste :

Figure 1 **Decrease of Must Weight.**

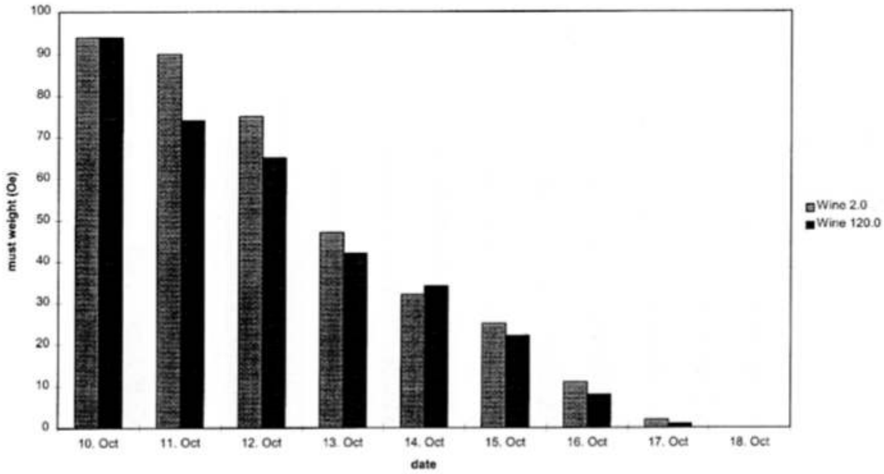


Figure 2 **Decrease in Total Acidity.**

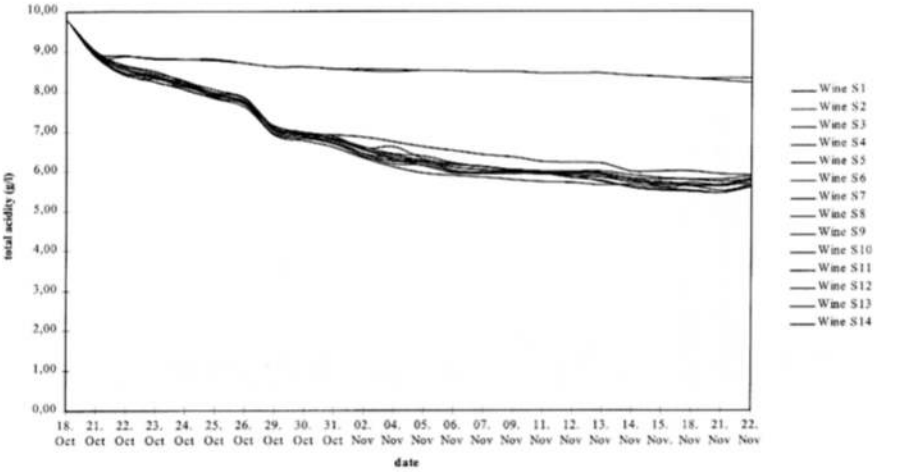


Figure 3 **Filterability of MLF and non-MLF wines.**

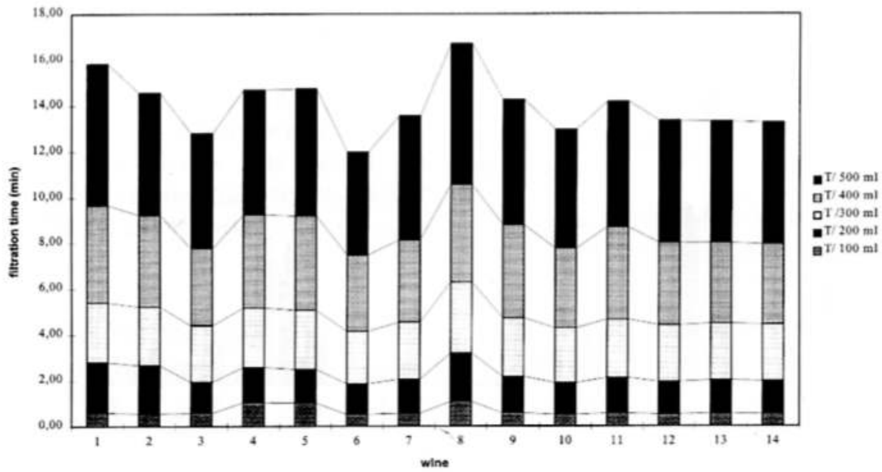


Figure 4 **Free and Total SO_2.**

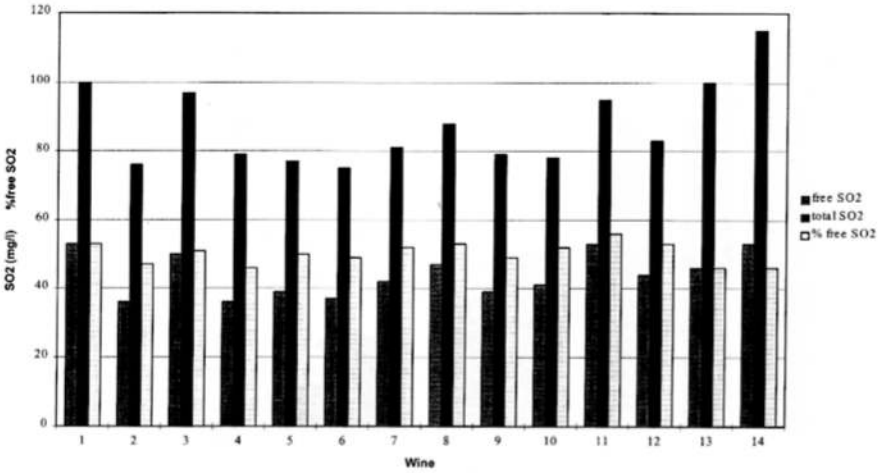


Figure 5 **Volatiles of young wines.**

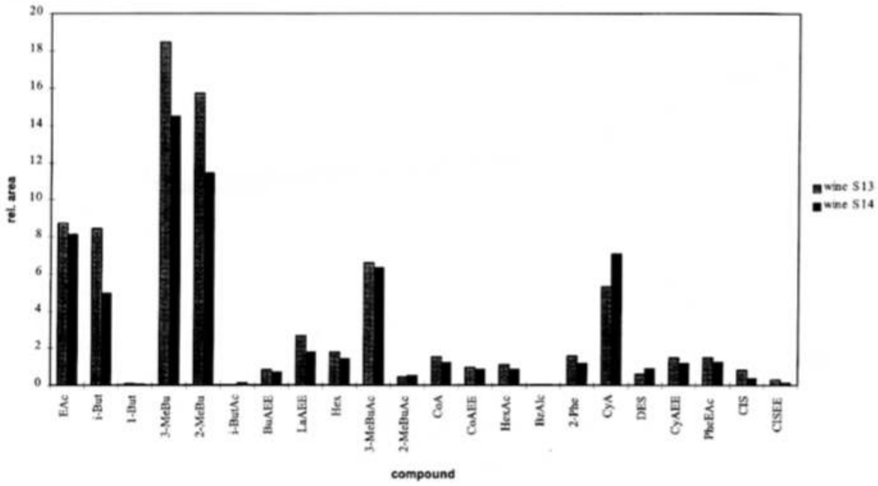


Figure 6 **Comparison MLF/non-MLF wines (400 L).**

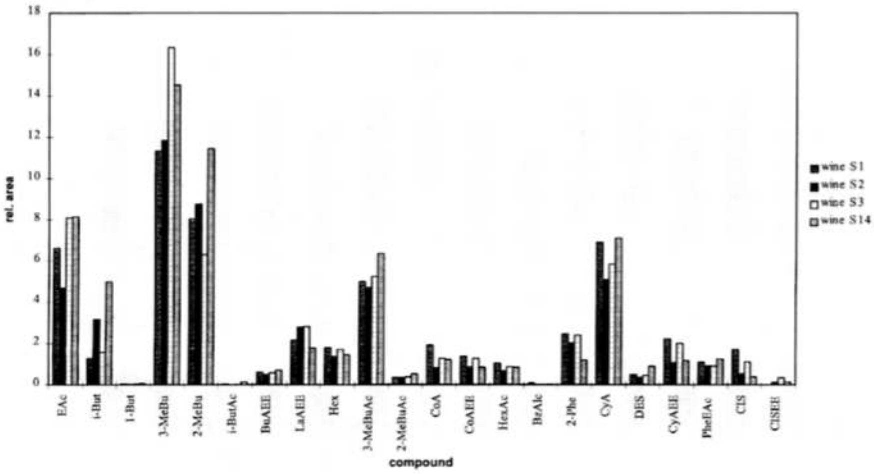


Figure 7 **Comparison MLF/non-MLF wines (400 L).**

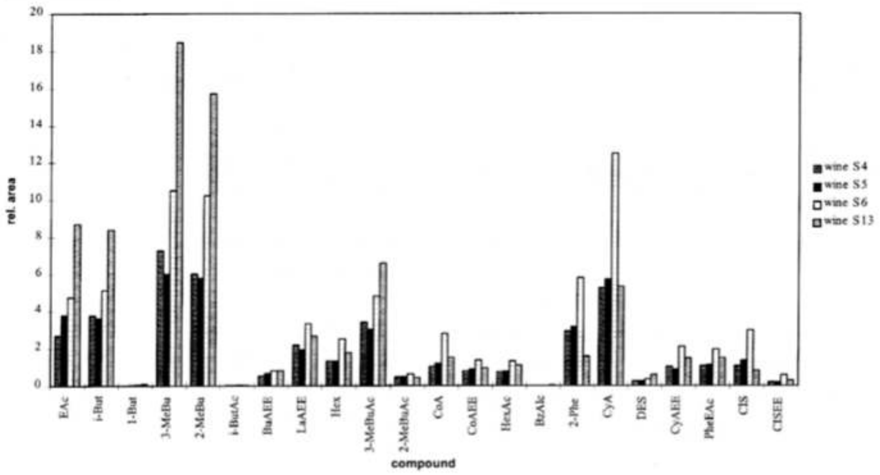
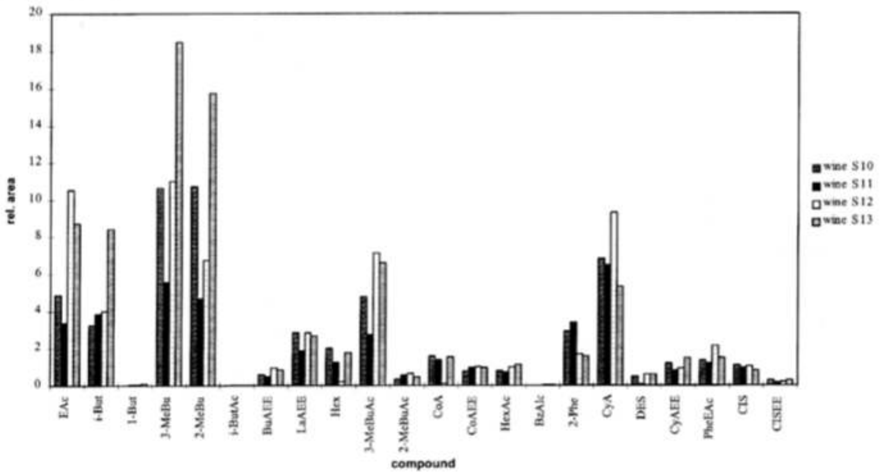


Figure 8 **Comparison MLF/non-MLF wines (30,000 L).**



– deacidified control wines : varietal character more pronounced, acidic, bitter, not round, lack of complexity.

The taster panel always ranked MLF wines higher than deacidified wines. Within the group of MLF wines, wines produced with selected winery culture obviously contributed more to positive addressed sensory impressions than the commercial strains. This showed that sensory improvement of commercial bacteria starter cultures should the aim of future work.

SUMMARY AND CONCLUSION

1. Temperature-controlled alcoholic fermentations in 2,000 L and 120,000 L tanks showed similiar kinetics of sugar fermentation. There had been minor sensory differences in the resulting wines. The wines were ranked at same level in a preference test.

2. MLF wines were addressed as more complex and rounder than wines deacidified to the same level of acidity. MLF-wines were also always preferred within a preference test.

3. No differences in malate degradation could be detected between the commercial strains and the winery pure culture.

4. Selected population of lactic acid bacteria (*Oenococcus oeni)* which was kept as liquid culture prior to inoculation of the wines was significantly better ranked than wines produced with the commercial starter cultures tested.

5. Preference of liquid MLF-culture was independent of fermentation volumes of former grape musts and also of young wines undergoing MLF.

6. No significance could be found that smaller fermentation volumes produced better sensory impressions.

7. Efforts should be undertaken to meet the positive characteristics of selected liquid cultures also with dried commercial starter cultures.

Especially the last point should draw attention on the obvious differences in the metabolic behavior of dried bacteria cultures compared with liquid cultures. Production of sensory appealing compounds is most probably coupled with growth phase of bacteria.

As cell counts of bacteria starter cultures mostly develop poorly during malolactic fermentation this might be a reason why after high density inoculation of young wines with commercial bacteria strains which is necessary to ensure a rapid onset of MLF, the formation of pleasant complex flavours is quite restricted.

Legend to the figures 5 - 8 : Abbreviations

EAc = Ethylacetate
i-But = iso-Butanol
1-But = Butanol-1
3-MeBu = 3-Methylbutanol
2-MeBu = 2-Methylbutanol
i-ButAc = iso-Butylacetate
BuAEE = Butyric Acid Ethylester
LaAEE = Lactic Acid Ethylester
Hex = Hexanol
3-MeBuAc = 3-Methylbutylacetate
2-MeBuAc = 2-Methylbutylacetate
CoA = Capronic Acid
CoAEE = Capronic Acid Ethylester
HexAc = Hexylacetate
BzAlc = Benzylalcohol
2-Phe = 2-Phenylethanol
CyA = Caprylic Acid
DES = Diethylsuccinate
CyAEE = Caprylic Acid Ethylester
PheEAc = Phenylethylacetate
CIS = Caprinic Acid
CISEE = Caprinic Acid Ethylester