A new tank for the production of high quality wines

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Typical Italian wines

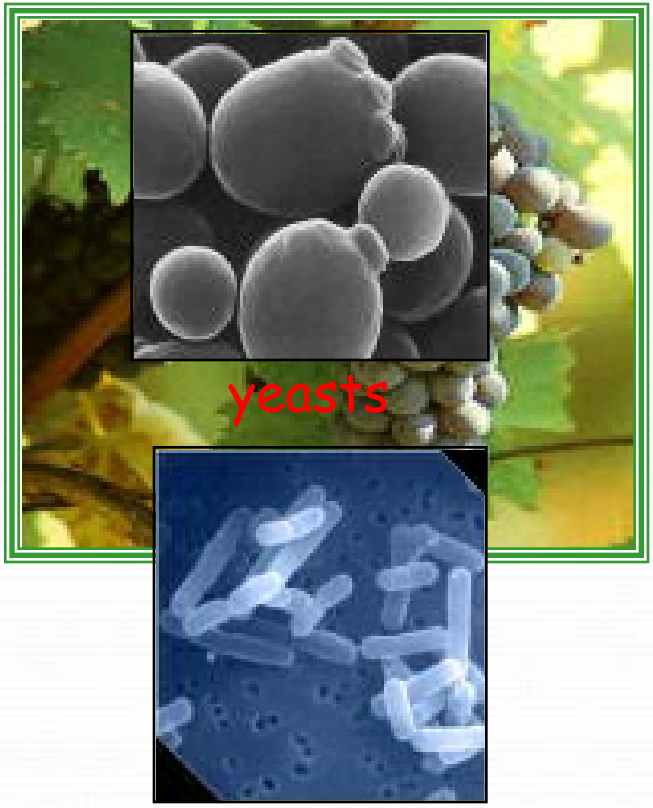
one of the most authentic expression of their own territory

Typical wines: products strongly related to their production area

These wines could be easily identified by keen consumers and have a good commercial success.

The peculiarity of these wines depends on:

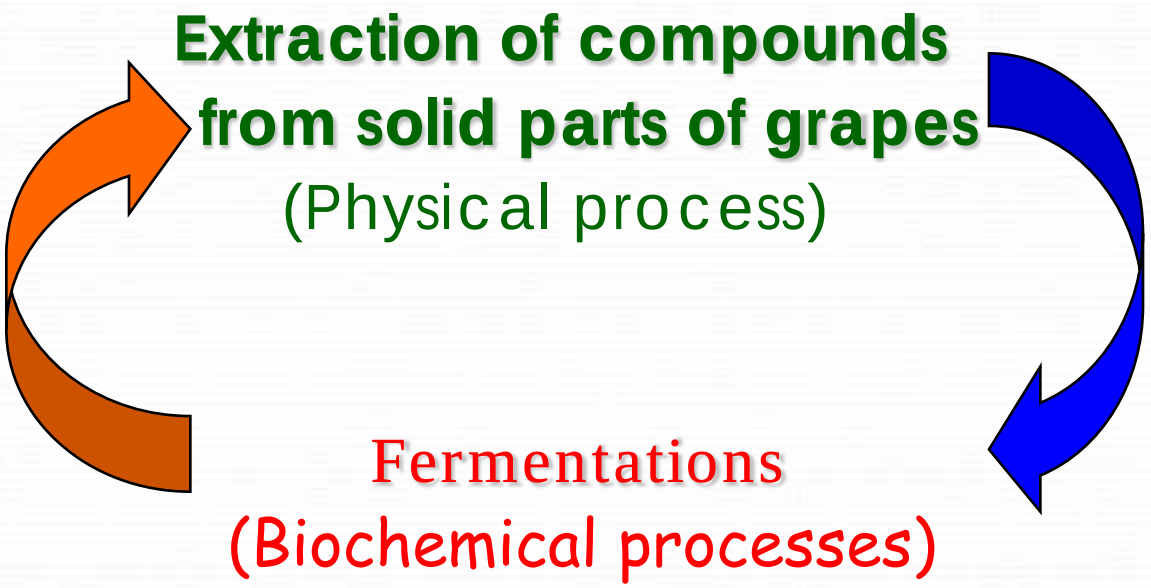
- genetic characteristics of grapes
- environmental factors (vineyard)
- **variability related to the microorganisms involved in the winemaking** (yeasts and malolactic bacteria)
- the winemaking tecniques which can greatly help to "express the quality" contained in the grapes



lactic bacteria

Winemaking process

consists of:



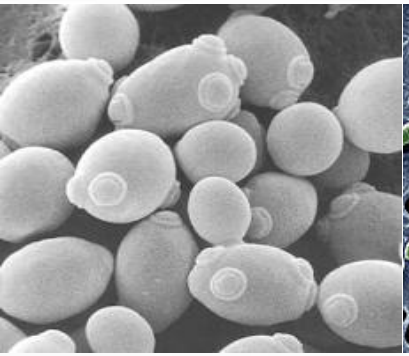
These processes **need different optimal conditions** of development (ex: temperature, ethanol concentration, pO2, etc.)

Red winemaking

Biochemical Processes

Physical-chemical Process

Fermentations (alcoholic and malolactic)



Maceration

Conversion of sugars and malic acid Production of ethanol

Extractions of phenols Color (Anthocyanins) + Body (Tannins)

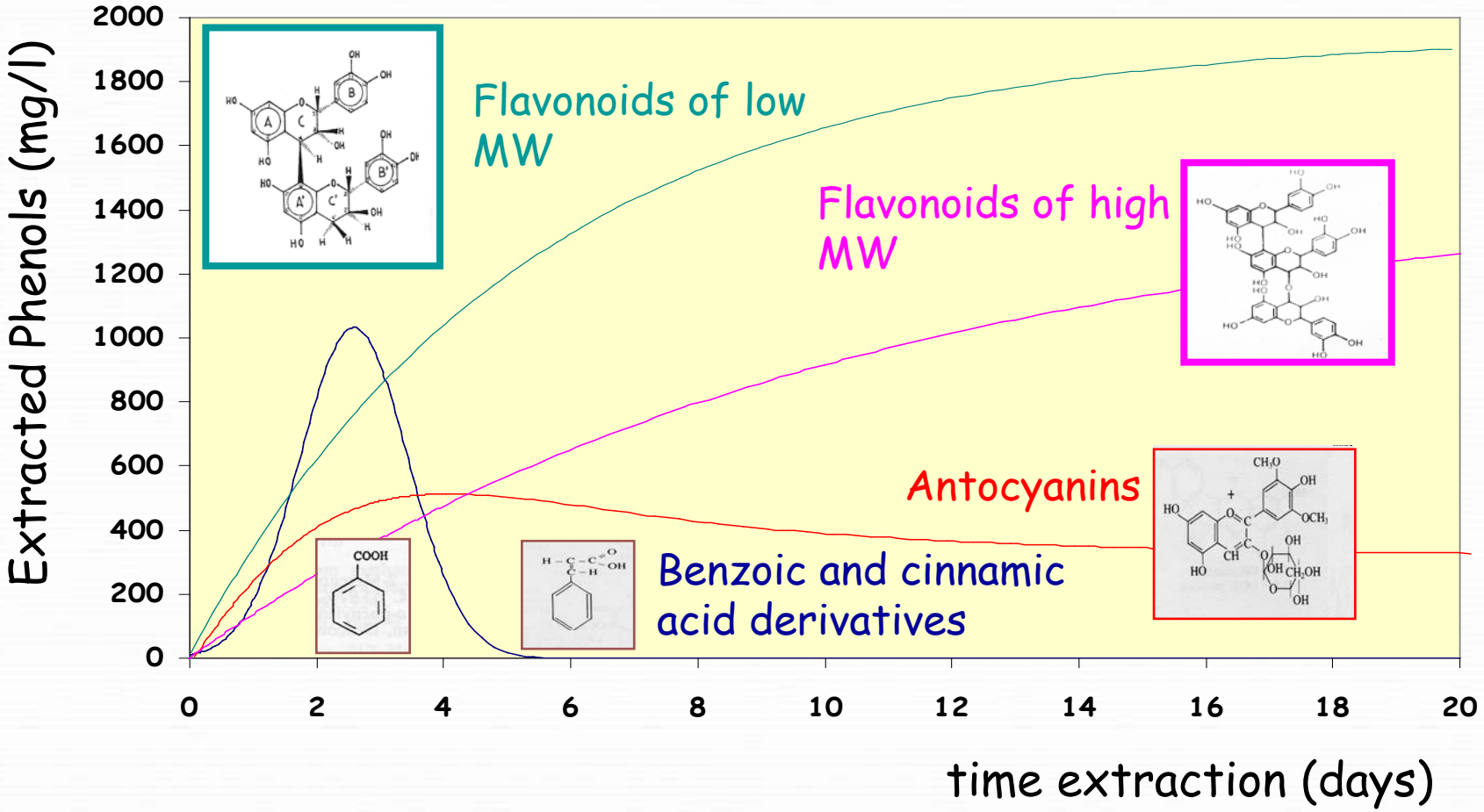
Maceration

Maceration of grape represents a fundamental step of red wine making if a product rich of aromatic and phenolic compounds is desired

The mass-transfer of coloured and aromatic substances from grape to must/wine, is a function of:

- grapes used (genetic and environmental variability)
- extraction time
- temperature employed
- oxygen dissolved in the liquid phase
- medium composition (%EtOH V/V)
- use of specific additives (SO_2, enzymes, etc.)

Accumulation of different fraction of phenols in must/wine as a function of extraction time



As reported in: **Andrich G., Zinnai A., Venturi F. " A tentative model to describe the evolution of phenolic compounds during the maceration of Sangiovese and Merlot grapes", Italian Journal of food science, n° 1, vol. 17, pp. 1-14.**

Maceration is a function of oxygen concentration in the liquid phase

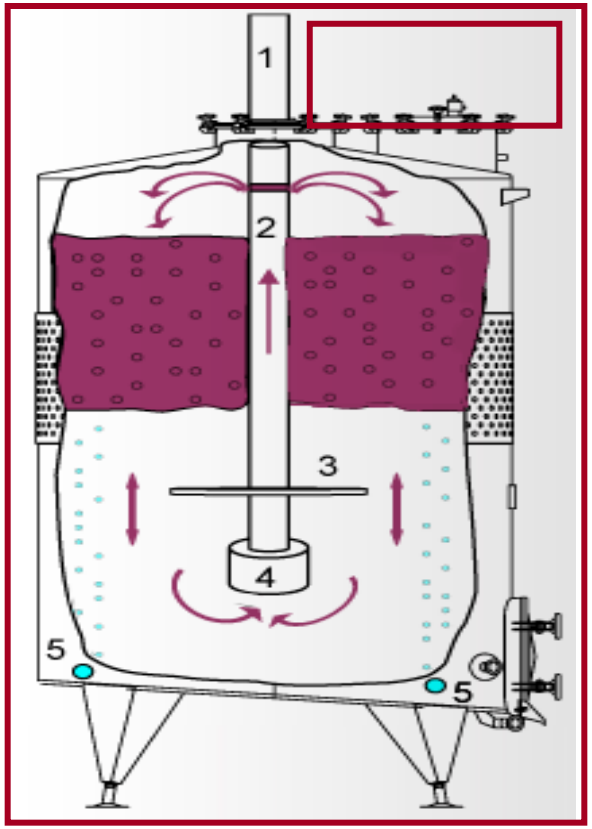
Oxygen can influence winemaking process in different ways that can be positive or negative for the final quality of wine as a function of the phase of the winemaking process

Oxygen is used by yeasts to syntethize essential compound (ex: unsaturated fatty acid, sterols, nicotinic acid)

Much of the oxygen adsorbed by must or wine is consumed in oxidative reactions with phenols

Red wines benefit from limited aeration during the early stages of maturation (ex: to reduce the astringency of tannins and stabilize the color) but excessive exposures may favor the growth of spoilage microrganisms, produce browning and oxidized odor

On these bases, an innovative tank, that could make easier to produce high quality wines able to express the characteristics of their own territory of origin, was set up



Firms involved in the research activity

- **Ghidi metals srl**

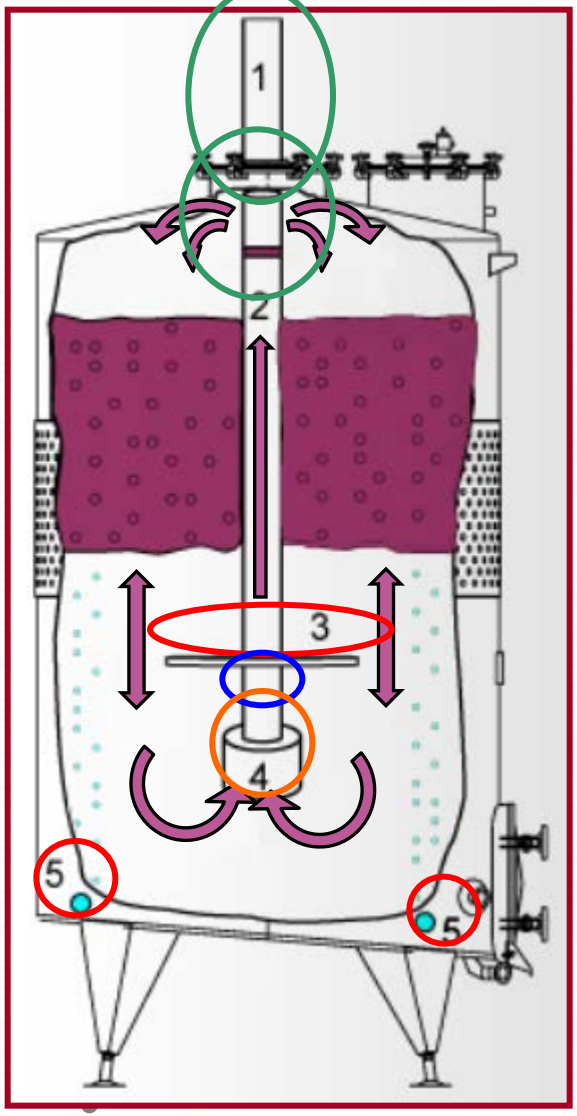
Borgo a buggiano (PT, Italy)

- **Petra Farm**

Suvereto (LI, Italy)

The "Onda tank"

(patent n° PT2009A000018)



Distinctive features:

- **Gas injection (compressed air, nitrogen, argon, CO2) at the bottom of the vat** to mix gently the must/wine and change, according to the phase of the winemaking, the gaseous composition inside the tank. In this way, no pumping over is necessary, during winemaking and, as a consequence:
- No external pumps required,
- No pipes crossing the floor of the cellars
- Very little manpower in every phase of vinification
- Possibility of delaying the beginning of maceration until the concentration of ethanol is sufficient to solubilize the flavonoids which are less soluble in water solution.

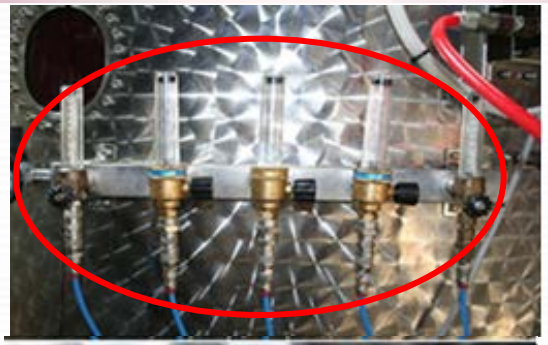
It's possible to move the must/wine without using any pipes crossing the floor of cellar as a close cobweb

It's possible avoid the use of external pumps

Characteristics of the new tank

Gas injection system is composed by:

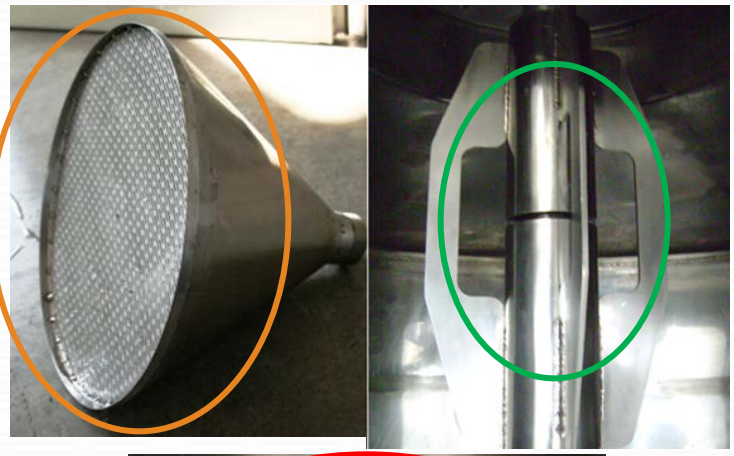
- ✓ A manometer and 5 flowmeters by which it's possible to regulate the volume and the pressure of gases
- ✓ Taps allowing or not the entrance of the gas or gaseous mixture
- ✓ Some probes (5) which inject inside, directly from the bottom, the technical gases (compressed air, nitrogen, argon, CO_2)
- ✓ Control Panel for automatizing the type, the number and the lenghts of the operations

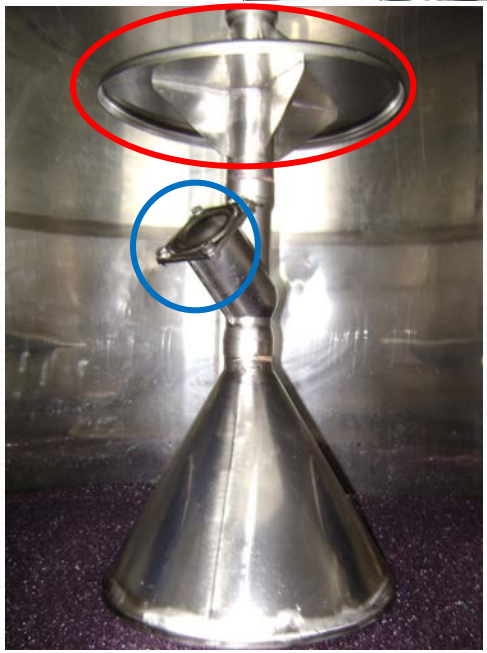


Some devices of the innovative tank

A pneumatic ram that has the function to give a straight "up and down" movement to a pipe having:

- Slits on the upper side through which some liquid part of the must makes a soft shower which wets the upper side of the cap
- A cone with a grid
- A disc, put under the "cap" able to move gently the must (or wine) so that the layer of liquid, that is in contact with dregs of grapes, is continuously renewed
- A valve which allows the ascent of the liquid phase inside the pipe but avoids its reflux





The new tank:

Innovative features II:

- This tank is a "closed system", easy to clean. It makes possible to control the microbial populations even at very low concentrations of SO_2 and reduces manpower requirements because it's fully automated.

- The gentle motion, that is made without exposing the cap to a mechanical stress, makes the must/wine homogeneous, decreases the lees production and increases the extraction of phenols. The injection of technical gases or gas mixtures at the bottom allows to gently move the must/wine and modify, as it needs, the gaseous composition inside the tank.

It's possible the move must or wine even during the night rest

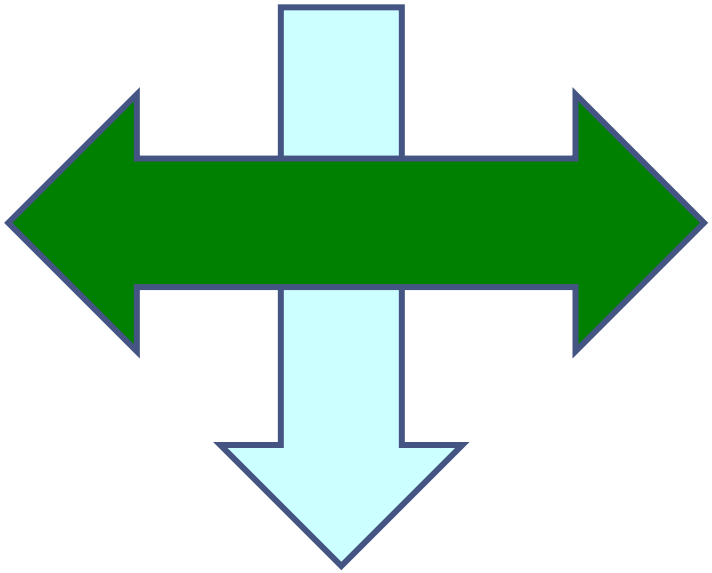
Onda can be used for a lot of operations ……

✓**Great flexibility of use during each phase of winemaking: pre/postfermentative maceration, fermentation, aging, etc)**

✓**Possibility to solve technical problems (ex: slowing or stuck of fermentation, reduced sulfur odors) without expensive manual operations** (ex: addition of nutrients, new yeast inoculum, dèlèstage, etc.).

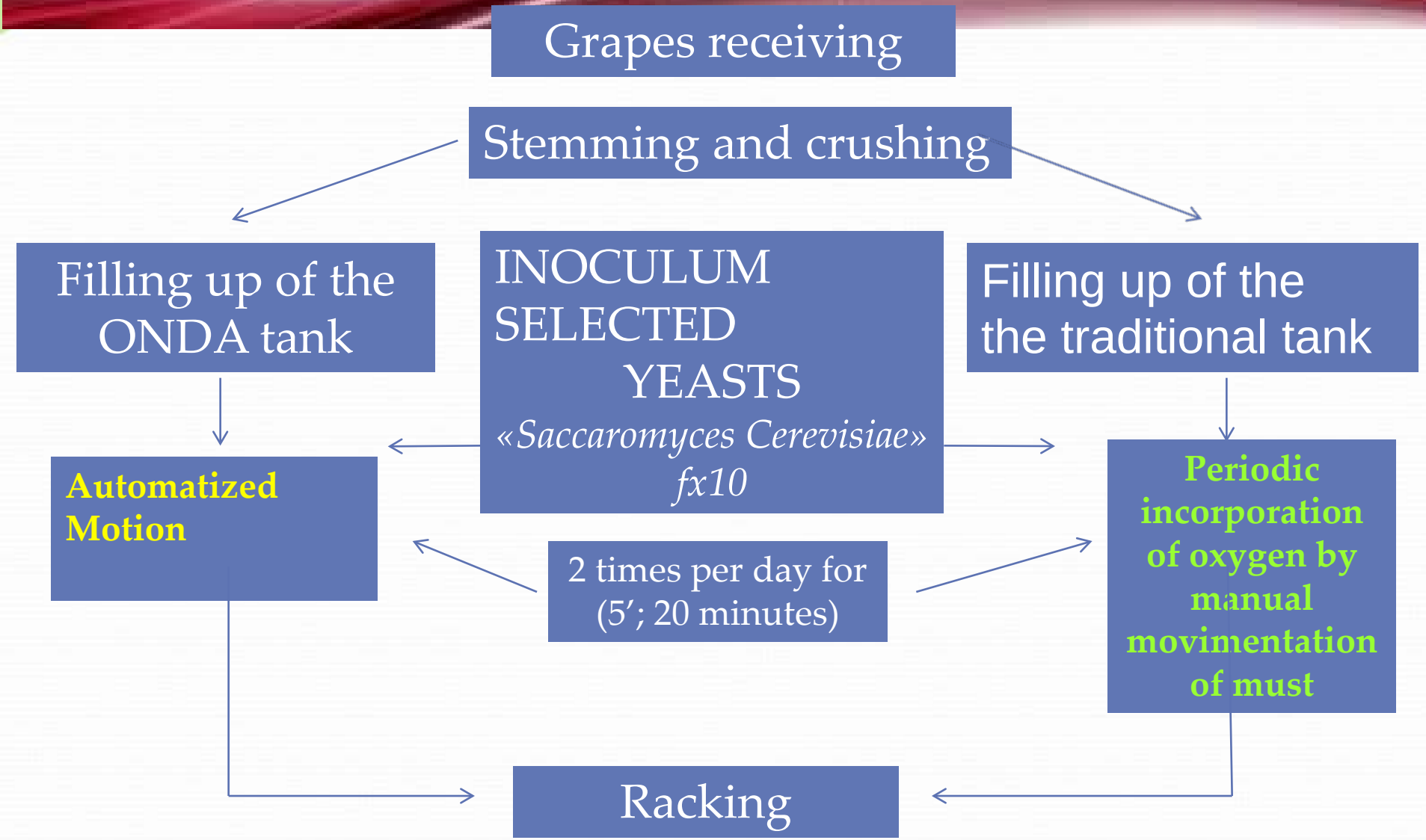
AIM OF THIS EXPERIMENTAL ACTIVITY

verify the efficiency of the prototype of Onda tank



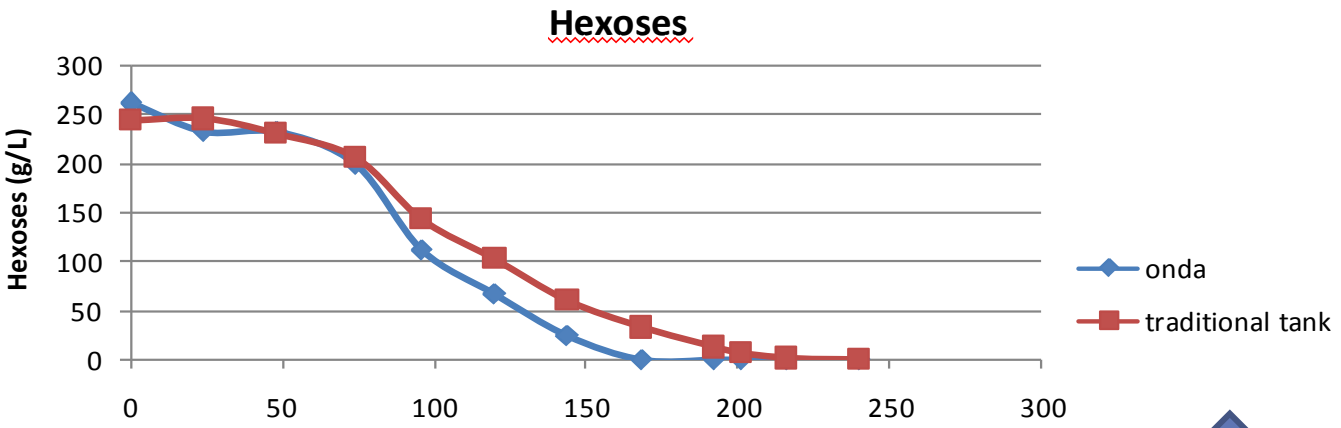
comparing the wines obtained by Onda with those coming from the traditional vinification

Experimental Protocols

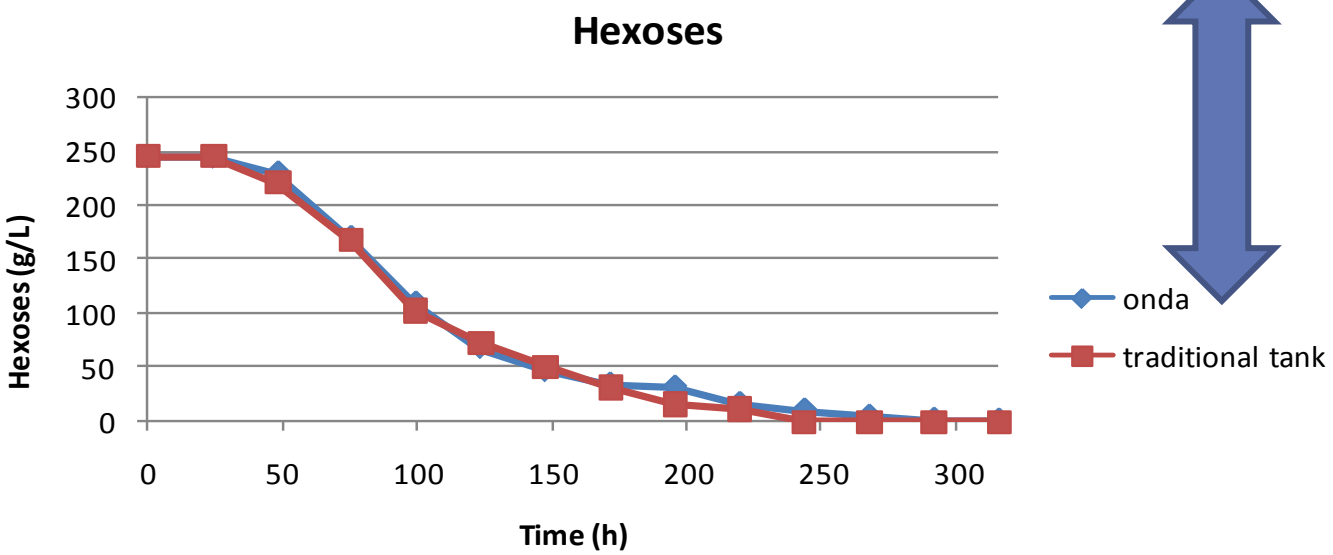


Development of the alcoholic fermentation

- Merlot



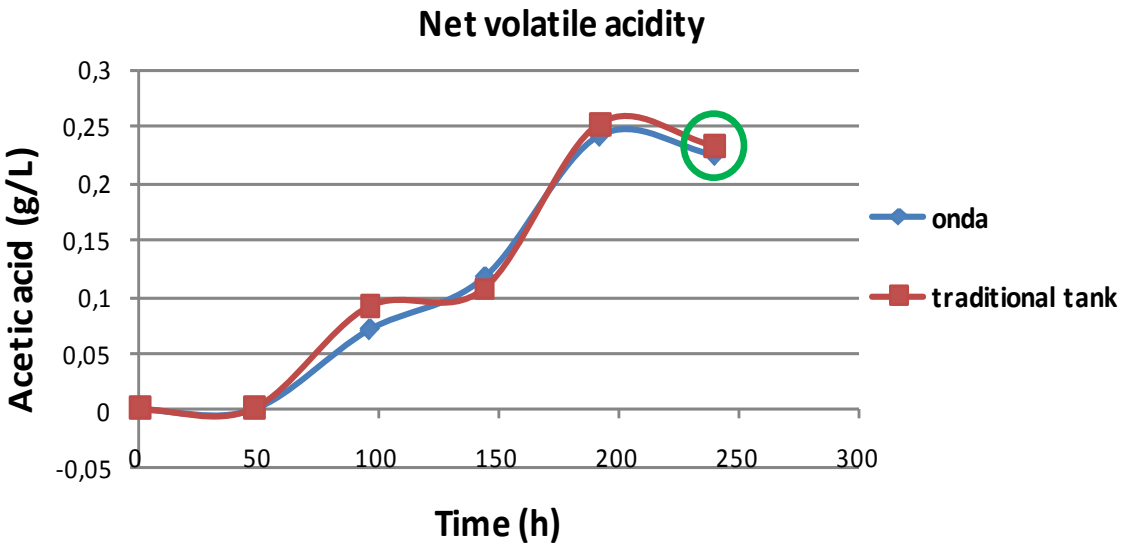
- Cabernet Sauvignon



Development of volatile acidity

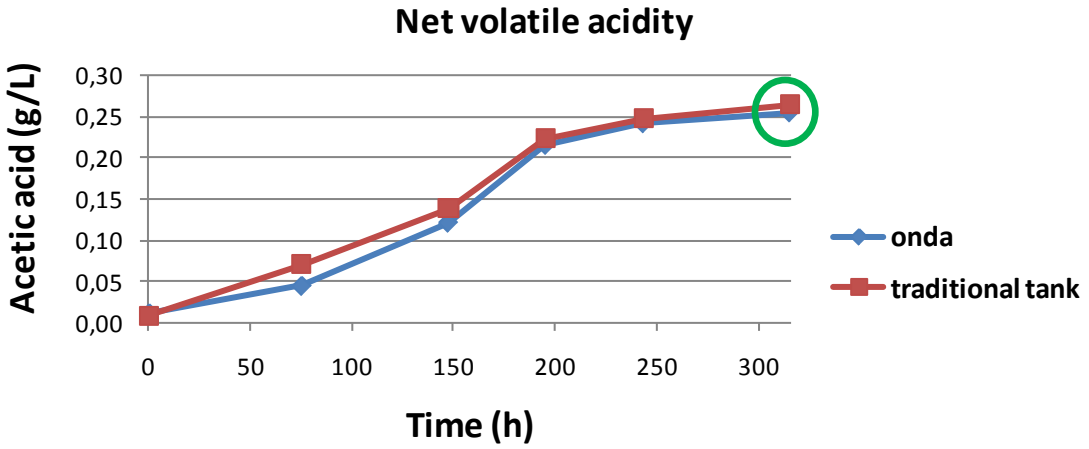
➢ Merlot

	Total sulfur dioxide [mg/L] ± i.c.	Free sulfur dioxide [mg/L] ± i.c.
Onda	53,±2	21±2
Traditional tank	53±2	21±2



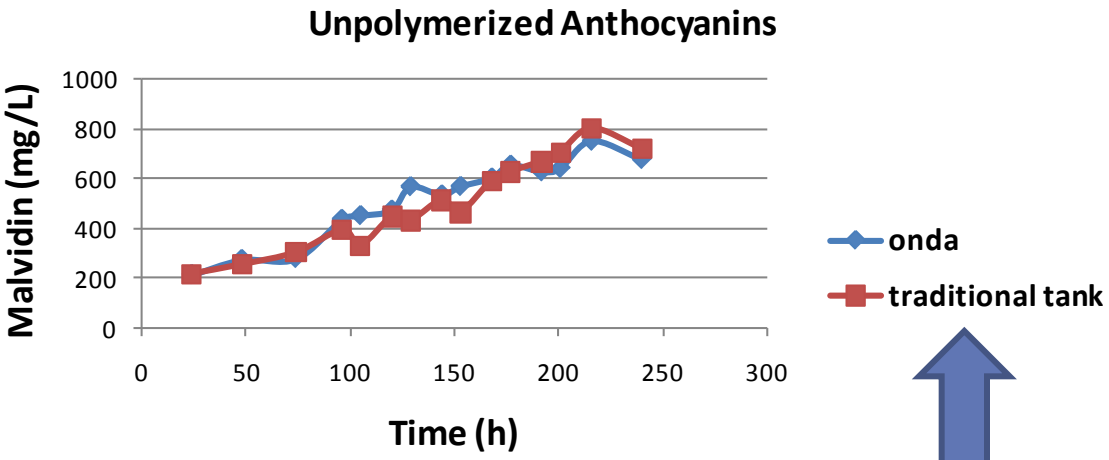
➢ Cabernet Sauvignon

	Total sulfur dioxide [mg/L] ± i.c.	Free sulfur dioxide [mg/L] ± i.c.
Onda	55±2	23±2
Testimone	56±2	22±2

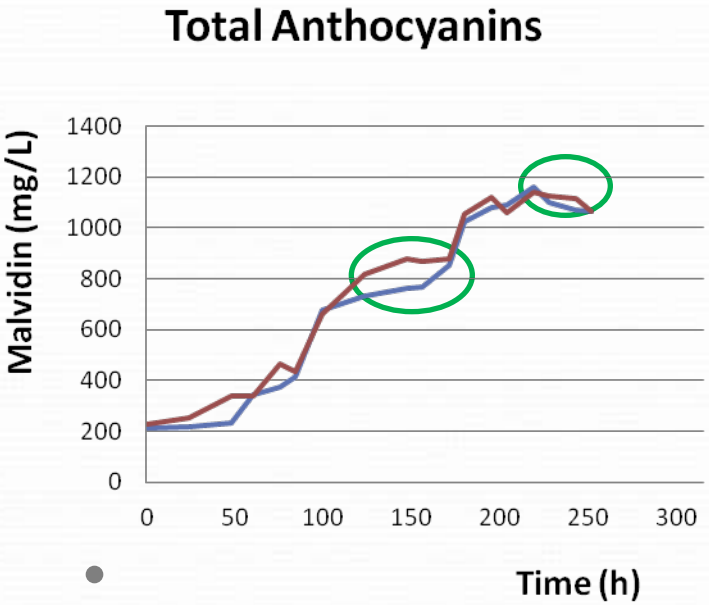


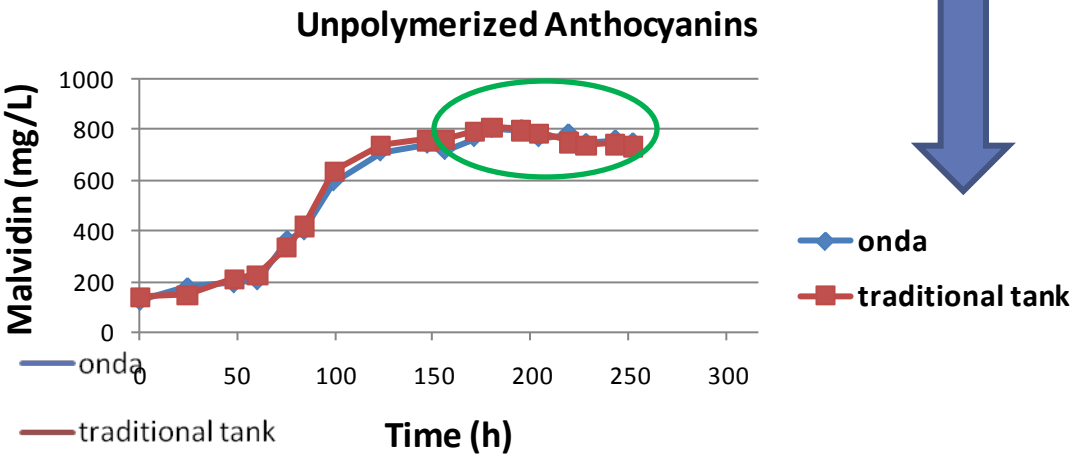
Development of the concentration of unpolymerized anthocyanins

- **Merlot**



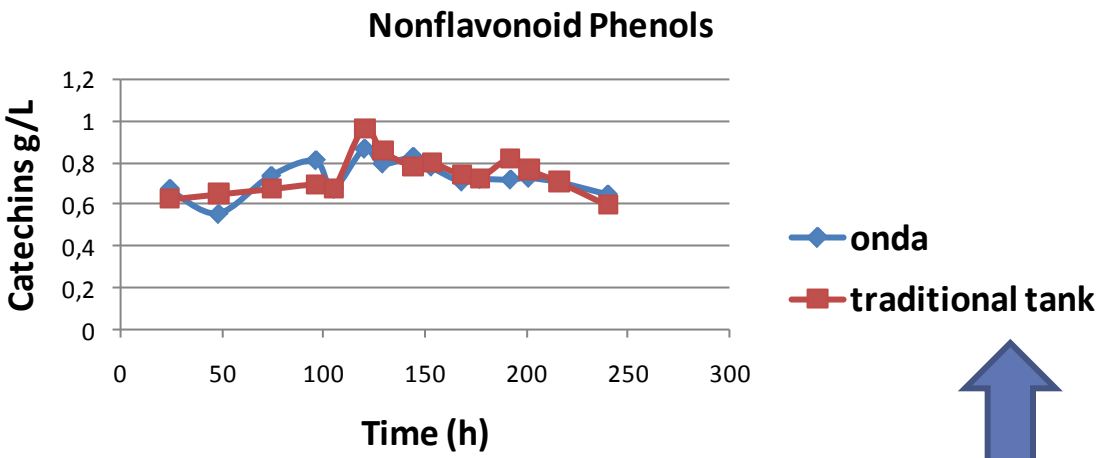
- **Cabernet Sauvignon**



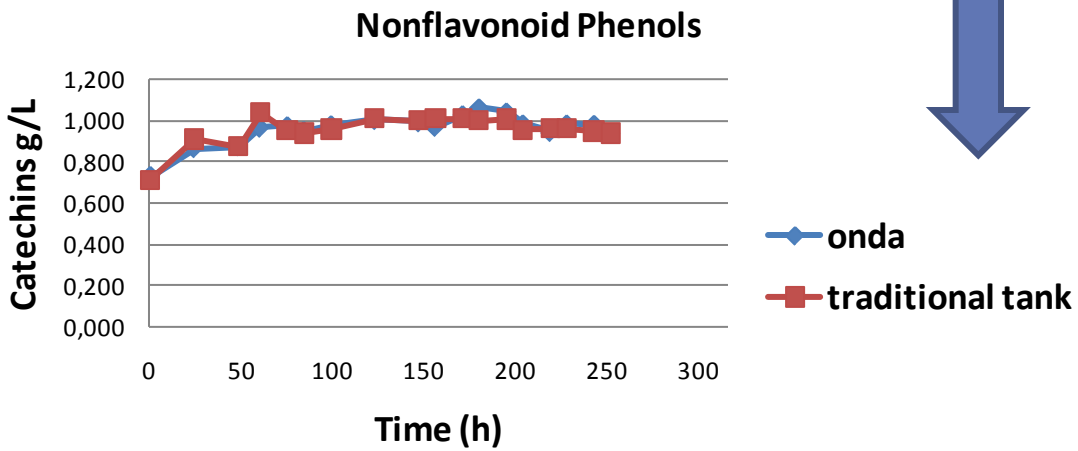


Development of hydrolizable phenols as a function of time of fermentation

- Merlot



- Cabernet Sauvignon



Conclusions

It was compared the experimental results obtained using both the Onda® tank and the traditional one, adopting the same protocol of winemaking used for traditional vinification (and not the best operative conditions for Onda®).

In the experimental conditions adopted, the Onda® tank had the same behaviour of the traditional tank even if **less energy**, **less water** and **less manpower** were used.

These experimental results represent the starting point for the future activity, having the aim to select the best operative conditions for Onda® as a funtion of the characteristics of the grapes which will be harvested in Montalcino (September 2014, SIENA, Italy)

"Special mention for the innovation in enology and viticulture – Simei Enovitis 2011".

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Acknowledgements

We would like to thank the enologist **Augusto Graziano** of **Petra** farm and all the students who contributed with their enthusiasm to realize this project:

Luca Parasecoli, Alessio Fraate, Lostia Marco, Gabriele Graia, Marco Fabbri, Marco Boccella under the supervision of dr.ssa Chiara Sanmartin

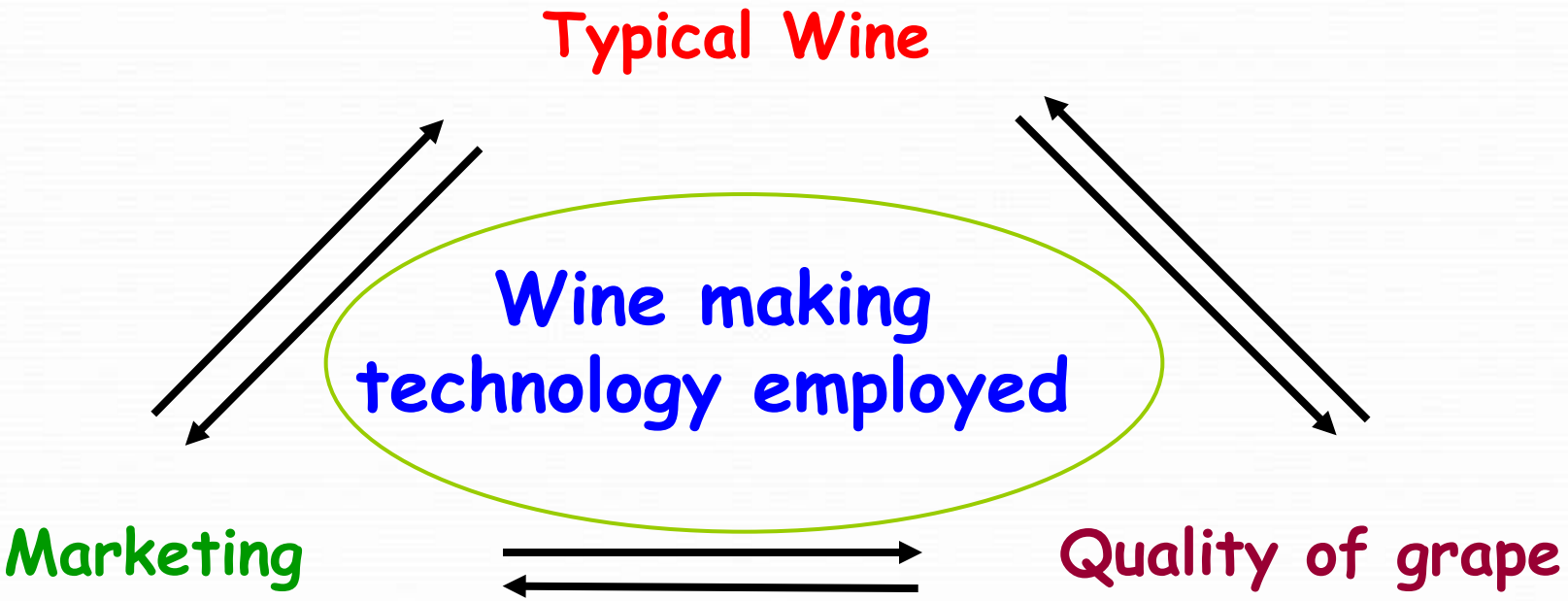
Onda Tanks … in progress

First version
V 5 hL

Second version
V 50 hL

Last version
V 50 hL

Change of system → **Optimization**



Maceration of grape represents a fundamental step of wine making if a product rich of **aromatic** and **phenolic** compounds is desired.

SUMMARIZING …

- **1. VERSATILITY**

With just one tank it's possible to carry out the maceration pre/post fermentative, alcoholic fermentation, aging (also on fine lees), maturation of white and red wines.

2. GREAT REDUCTION OF MANPOWER

Onda® makes superfluous the use of pumps and pipelines associated with them which cross the wine cellar and require a large amount of labor, not only for handling but also for the subsequent cleaning steps. A single operator, in few minutes, can plan and manage the whole winemaking process, maturing or ageing, even for several tanks at the same time.

3. **GREAT REDUCTION OF THE STRESS FOR THE MUST**

Thanks to the ram with the submerged disc and to the must processing and replacement system the cap is not subjected to a mechanical stress (as it happens for example in punching-down and processing and replacement by means of pumps etc): in such a way there is a lowproduction of lees.

MOREOVER …

- **4. GREATER EXTRACTIVE POTENTIAL**
  With **Onda®** the cap is always delicately wet and the processing and replacement of the liquid of the must makes homogeneous the liquid part located under the cap, which is over saturated with extracted substances, with the one which is closer to the bottom of the tank where this component is smaller.
  Onda® allows to maximise the extraction process.

  5. DECREASING DRAWING-OFF TIME
  During fermentation the cap is not mechanically stressed though being constantly moistened, this makes the skins to be well separated resulting with a decreasing drawing-off time.

AND STILL …

- **6.POSSIBILITY TO CARRY OUT LONG TERM MATURATION**
  EX.: the insufflation of inert gas from the bottom (nitrogen or argon) allows to bring in suspension, the lees deposited on the bottom, also, in the case of sulphuric bad smell, Make a "delestage" to facilitate the extraction of proteins from yeast cells in lysis became simple and unexpensive.

7. EASY CLEANING

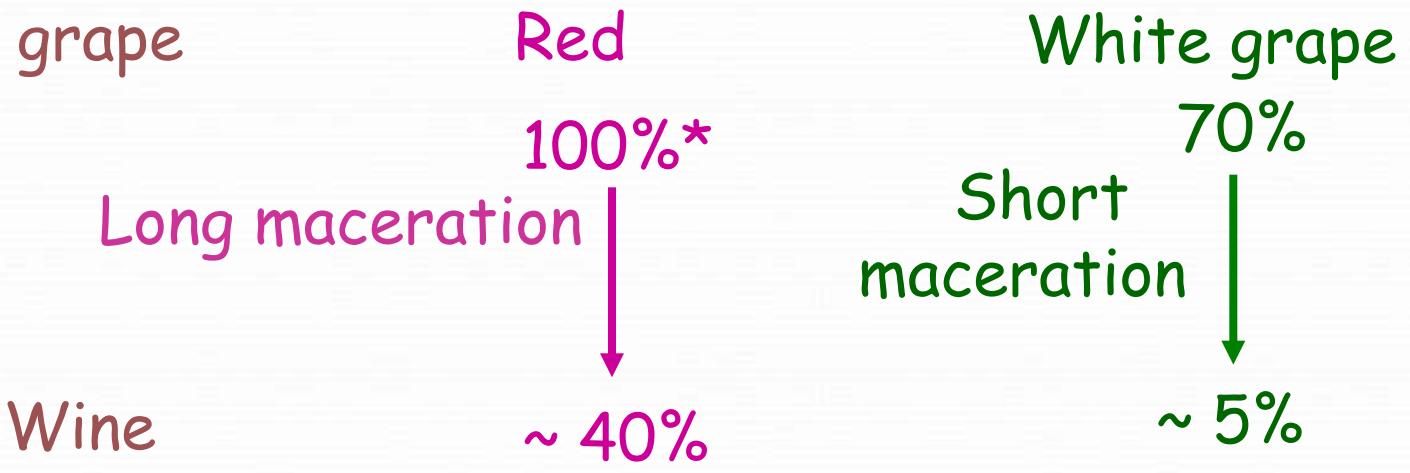
Onda® is free from hollow spaces inside and the whole of its components are equipped with a rapid dismantling system: this makes the cleaning of the tank easy and rapidly performed.

8. REDUCED MAINTENANCE

The **Onda®** system is very simple: it reduces maintenance expenses and the probability of malfunctioning. Even the check valve placed on the pipe is not subjected to blockages because is equipped with a protection grate and self emptying device in case some skins or grape-seeds got inside.

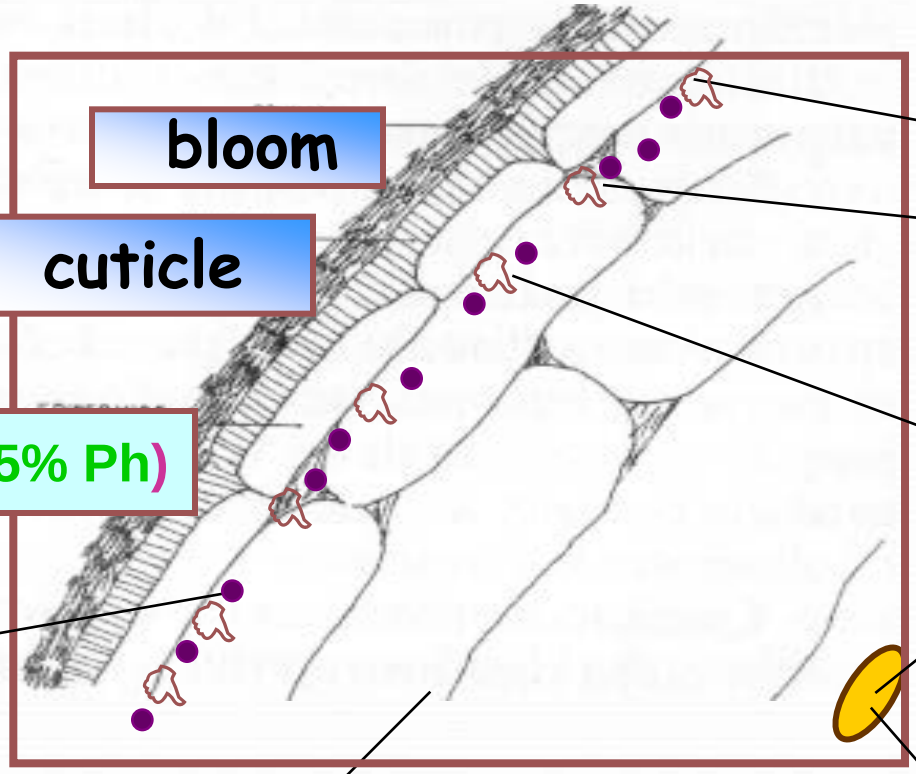
Phenols content of the grape:

Grape	Total amount
red	~ 6000 mg/Kg
white	~ 4200 mg/Kg



* assuming this value = 100%

Structure of grape skin



bloom

cuticle

Skin (35%; 25% Ph)

Anthocyanins

Aromatic substances

Tannins

flesh

grape seeds

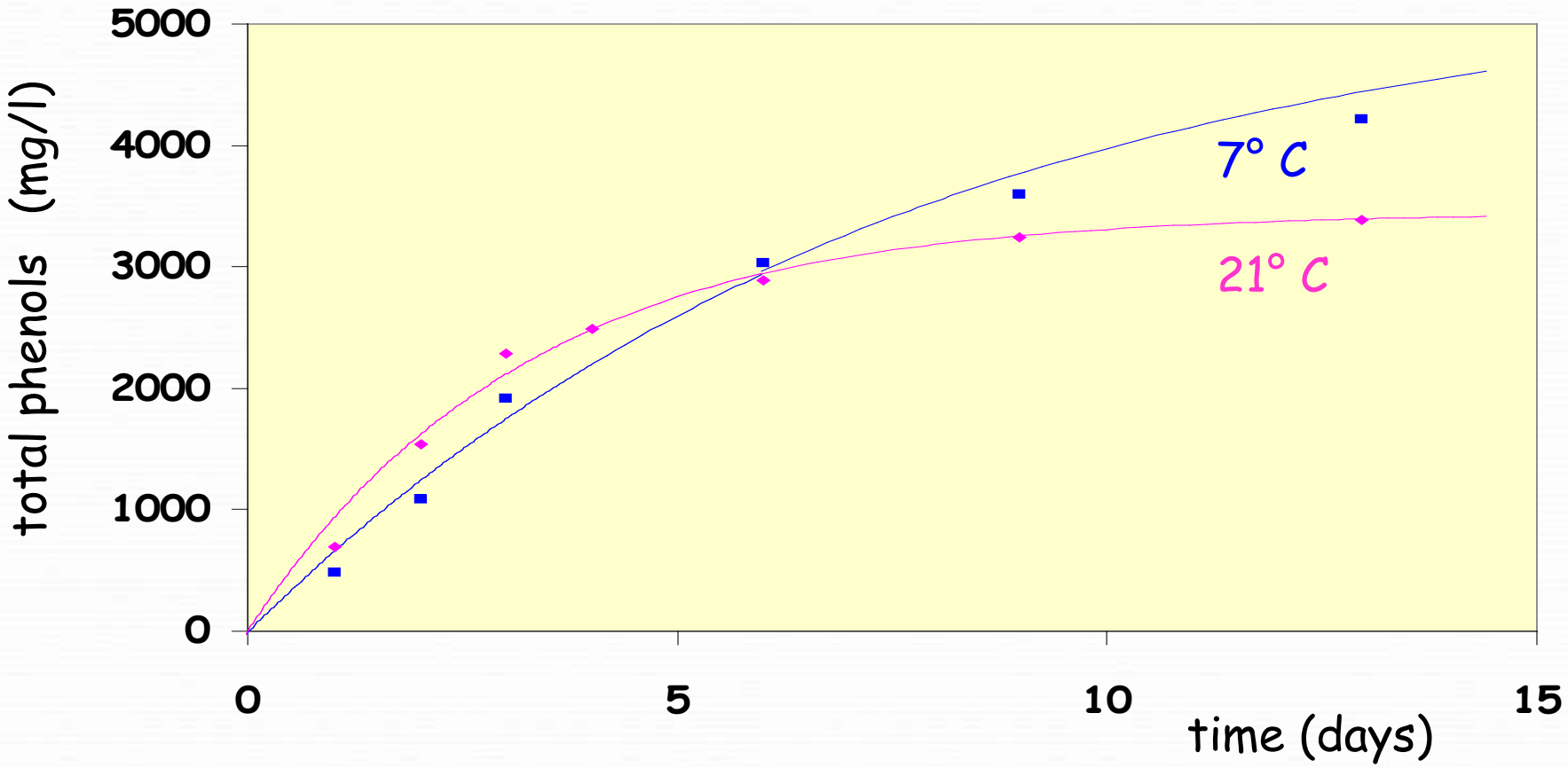
Evolution of yield and selectivity of different phenolic extracts with diffusion time

time (days)	1	5	14	20
$PF_{tot,t=t}/PF_{tot,t=\infty}$ %	26.4	78.4	99.7	99.8
benzoic and cinnamic acid derivatives	19.2	0.7	0	0
anthocyanins	28.0	21.2	10.2	9.2
tannins of low MW	38.6	54.1	55.9	56.2
tannins of high MW	14.2	24.0	31.3	34.6

Maceration is a function of Temperature

To describe the evolution of diffusion of the different phenolic fractions with **temperature**, the same grape (Sangiovese) was macerated at 21° and 7 °C (cold maceration).

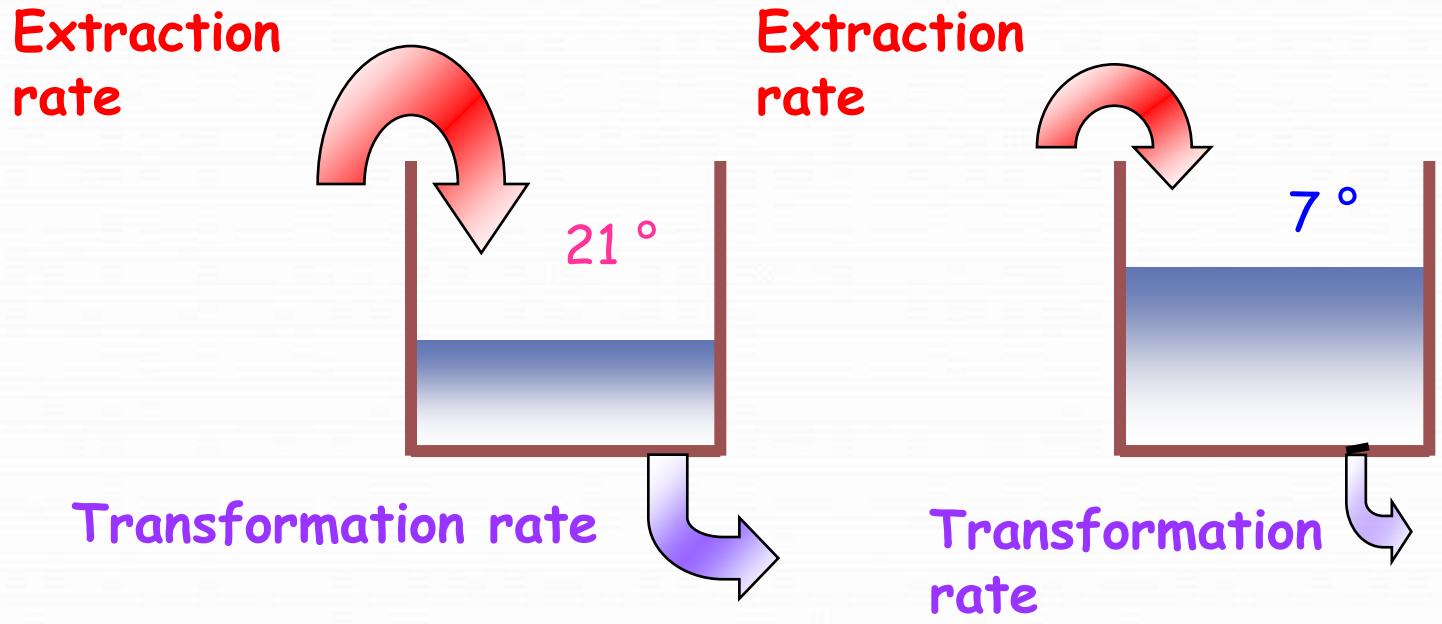
Extraction of phenols (Ph_{tot}) during the maceration of Sangiovese grape as a function of temperature adopted



Temperature [°C]	K_{Phtot} $[days]^{-1}$	$Ph_{tot,\ t=\infty}$ [mg/l]	r^2
21	0.31	$3.52 \cdot 10^3$	0.96
7	0.13	$5.51 \cdot 10^3$	0.94

$$Ph_{tot,t=t} = Ph_{tot,t=\infty} \cdot (1 - e^{-kPhtot \cdot t})$$

Then temperature could so affect the accumulation of phenols in the must/wine:

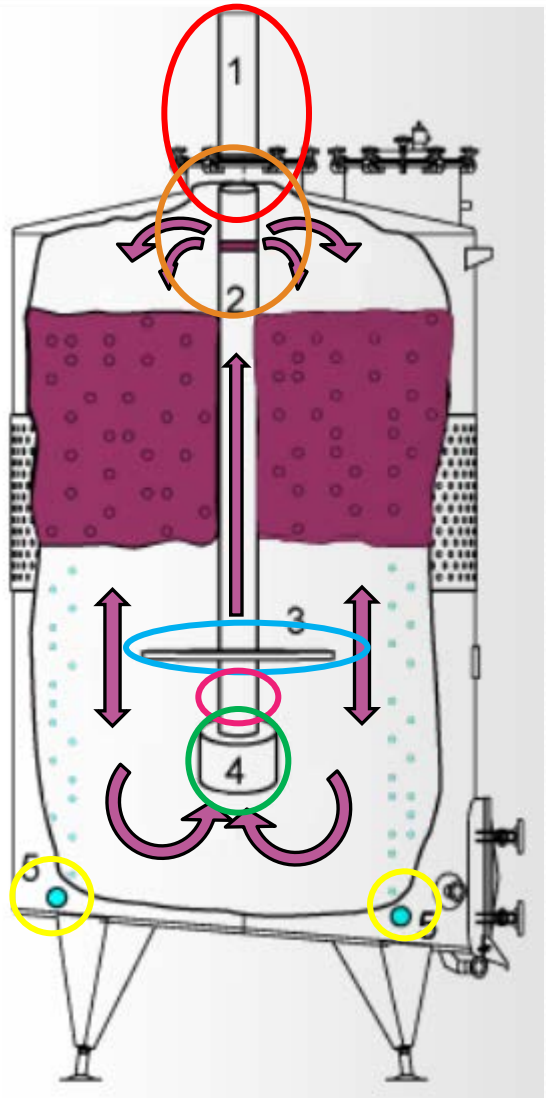


accumulation = f (extraction rate – transformation rate)

extraction rate (7°) < extraction rate (21°)

transformation rate (7°) <<< transformation rate (21°)

The “Onda tank”



tema

Ancora vantaggi operativi ….

- versatilità del serbatoio che può essere utilizzato nelle diverse fasi della filiera di vinificazione, sia in rosso che in bianco, grazie al sistema di iniettori di gas che consentono di preservare la componente cromatica e aromatica del mosto/vino e può favorire estrazione delle mannoproteine programmando un bâtonnage automatico;
- possibilità di utilizzare i gas tecnici, da soli o in opportune miscele, per modulare l'andamento delle fermentazioni e delle fasi di affinamento, proteggendo il vino dai processi ossidativi e riducendo il quantitativo di solforosa;
- In analogia ad altri vinificatori automatici si evita la contaminazione incrociata tra mosti che può decorrere con l'utilizzo comune di attrezzature enologiche;
- A differenza di altri serbatoi automatizzati il vinificatore onda® è di facile pulizia.

Good Wine … for everyone

"Quickly, bring me a beaker of wine So that I may wet my brain and say something clever."

- Aristophanes

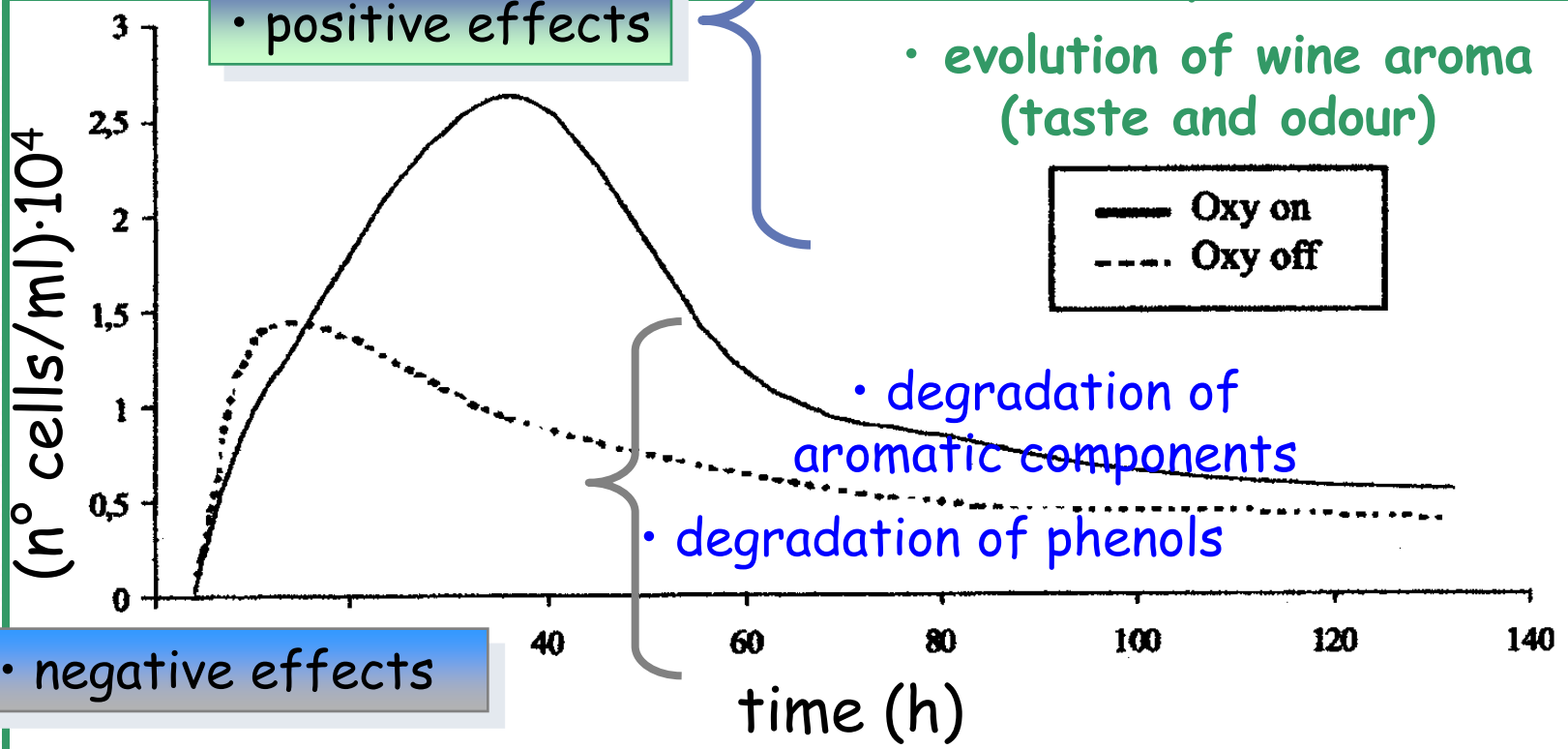
"Wine is the most healthful and hygienic of beverages."

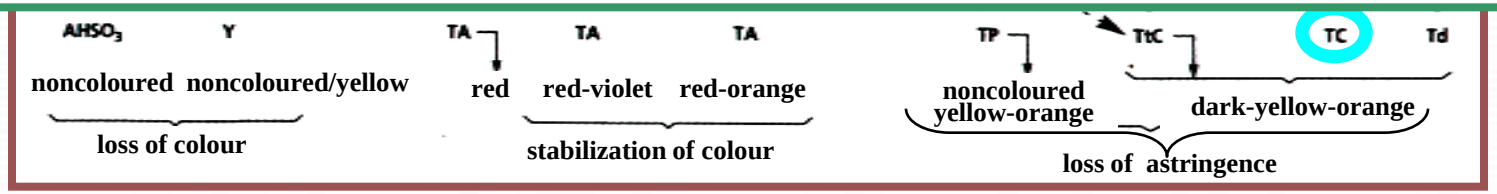
-Louis Pasteur

Oxygen dissolved in the must/wine can induce:

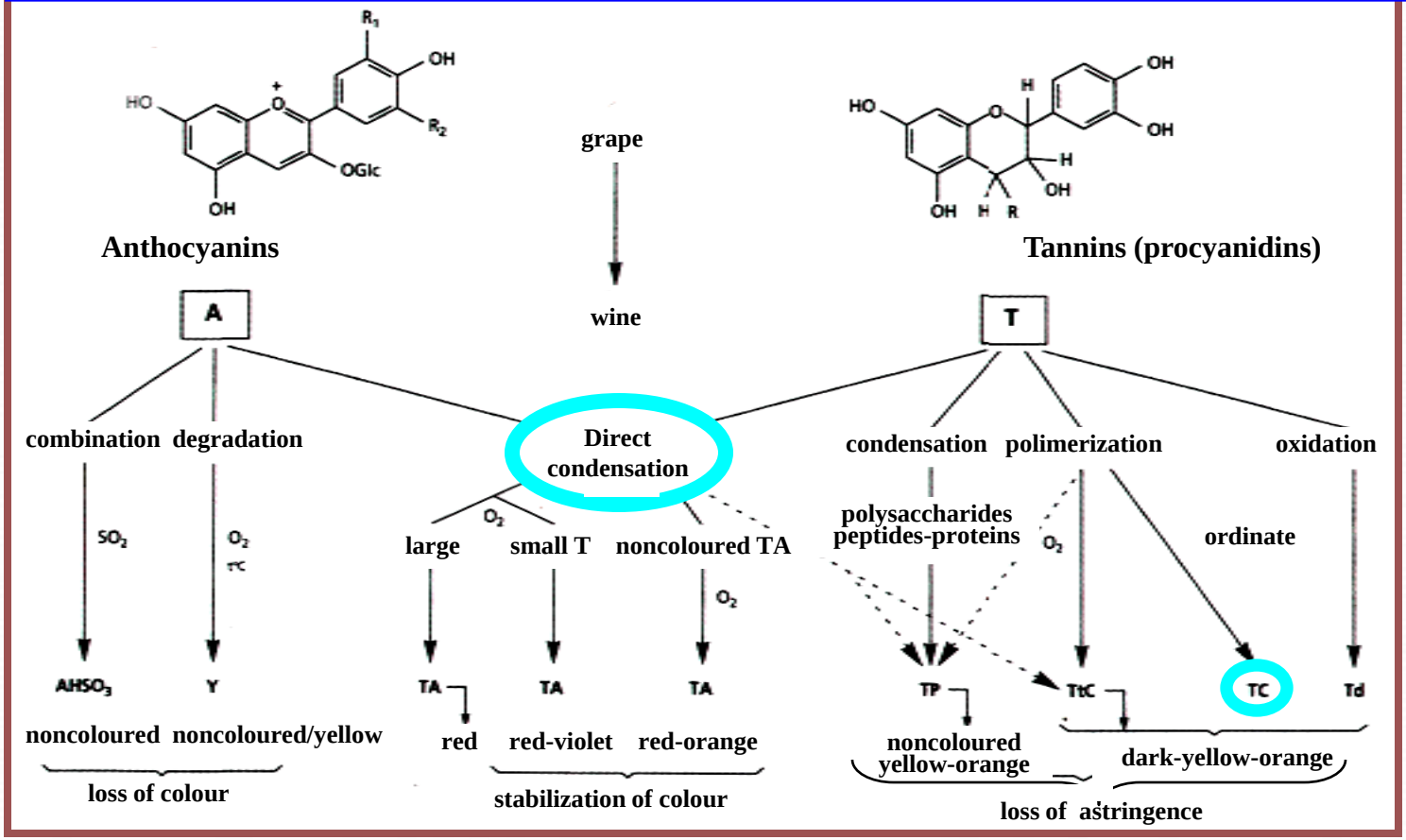
Wine composition depends on oxygen concentration in the liquid phase

- positive effects
  - yeast growth
  - polimerization involving phenolic compounds
  - evolution of wine aroma (taste and odour)
- negative effects
  - degradation of aromatic components
  - degradation of phenols





Evolution of phenolic compounds during red wine aging

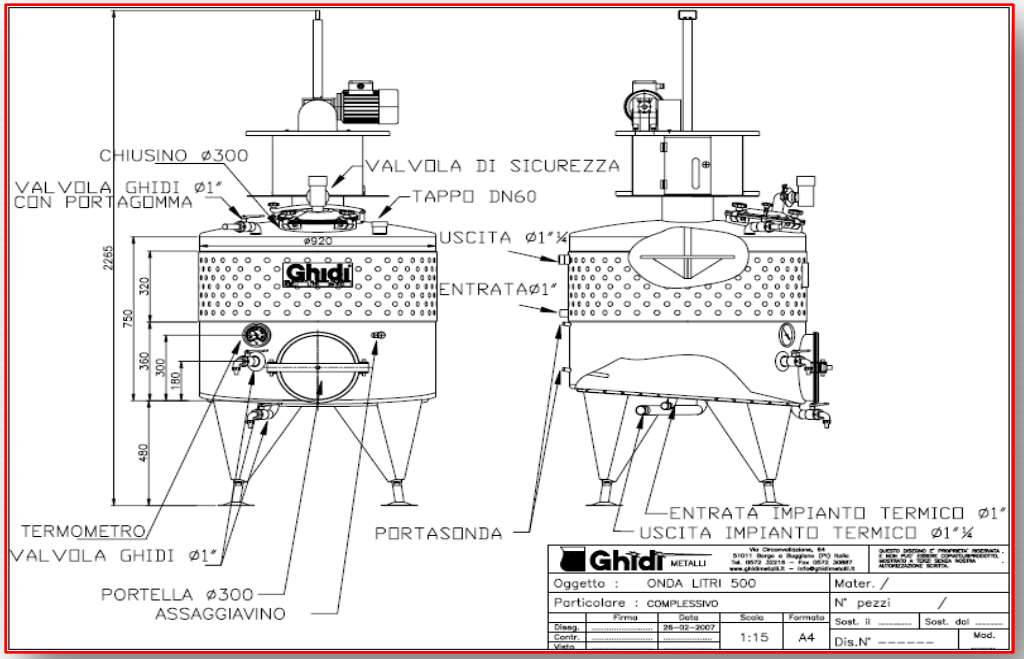


Y= degradation products of anthocyanins (phenolic acids);
TA= tannins-anthocyanins condensation;
TP= tannins-proteins/tannins-polysaccharides condensation
Tt C high condensed tannins; CT condensed tannins; DT degraded tannins

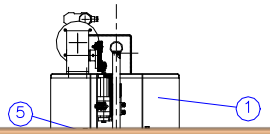
The composition of grapes used

Analytical data	Mean Values ± i.c. (merlot)	Mean Values ± i.c. (cabernet)
Total sugars (hexoses; g/L)	244 ±1	228±1
Titrable Acidity (g/L)	4,91±0,10	5,04±0,05
pH	3,62±0,07	3,38±0,04
Phenols data	Potentials	
Total phenols (g/L Catechin) d.o. 280nm	7,86±0,04	7,01±0,4
Total Anthocyanins(g/L malvidin)	1,16±0,0003	1,30±0,04
Proanthocyanins (g/L Catechin)	2,46±0,06	2,12±0,17
Hydrolizable phenols (g/L Catechin)	0,49±0,09	0,39±0,07

Fermentor "ONDA®" -Ghidi metalli- patent

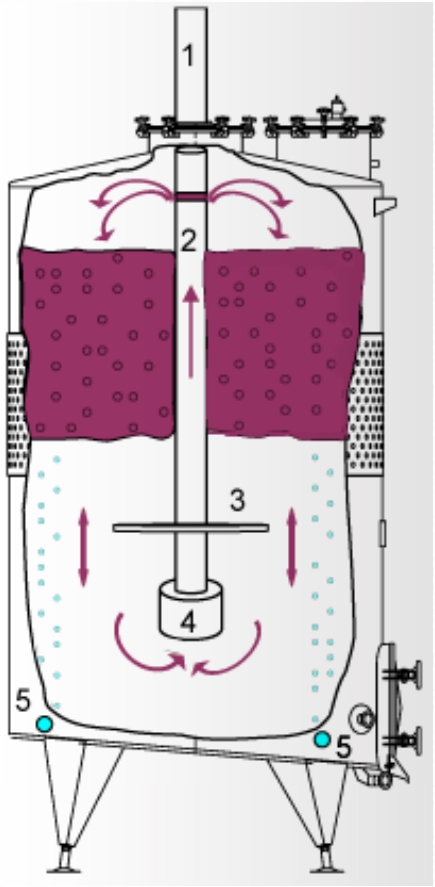


Movimentazione delle vinacce → Cinematismo a biella e manovella → Gruppo motoriduttore



Funzionamento

- Posizionamento del piatto sotto il cappello di vinacce
- Moto sussultorio del piatto (rimescolamento della massa)
- Estrazione delicata delle componenti dalle bucce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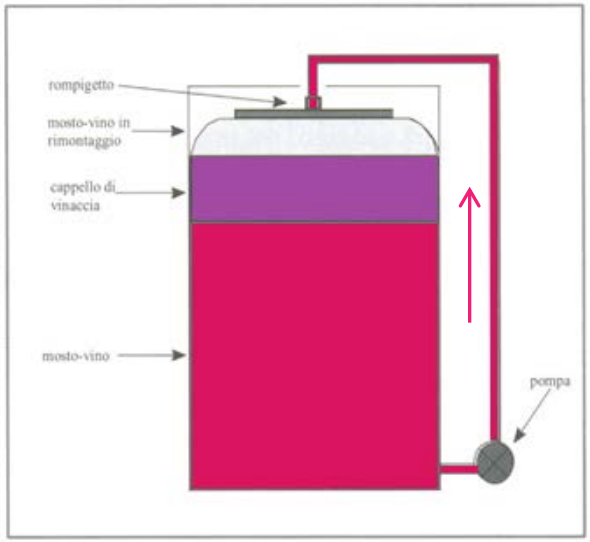
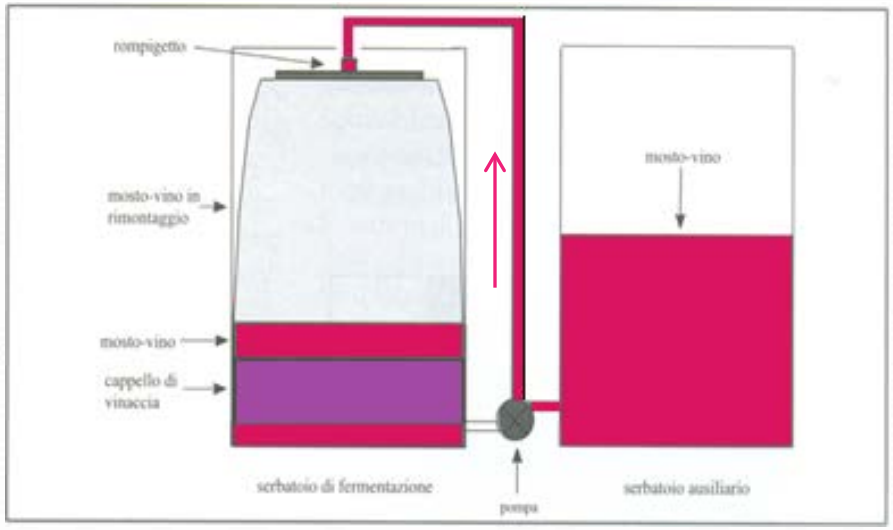
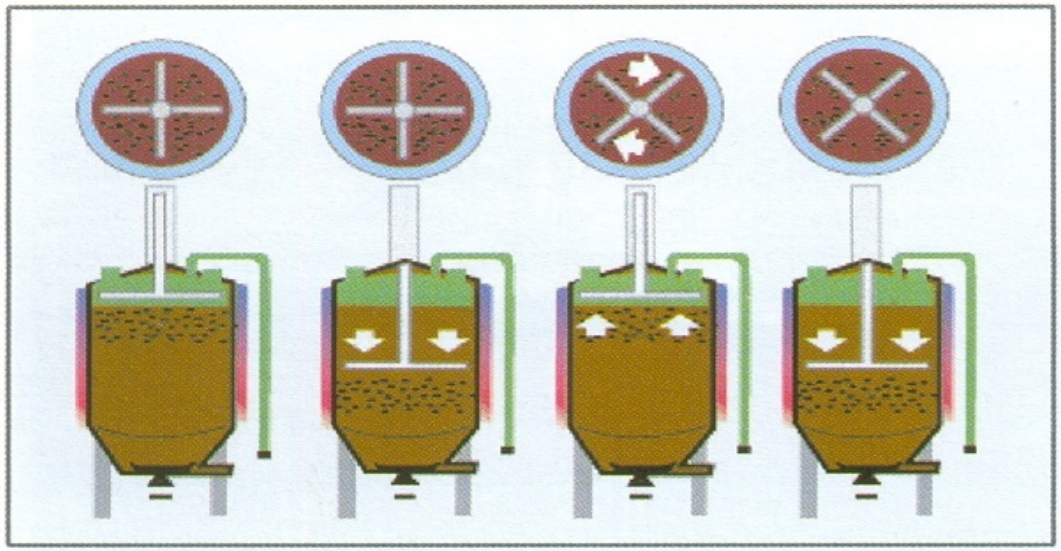
Sistemi tradizionale per la movimentazione della massa

Rimontaggio



Déléstage



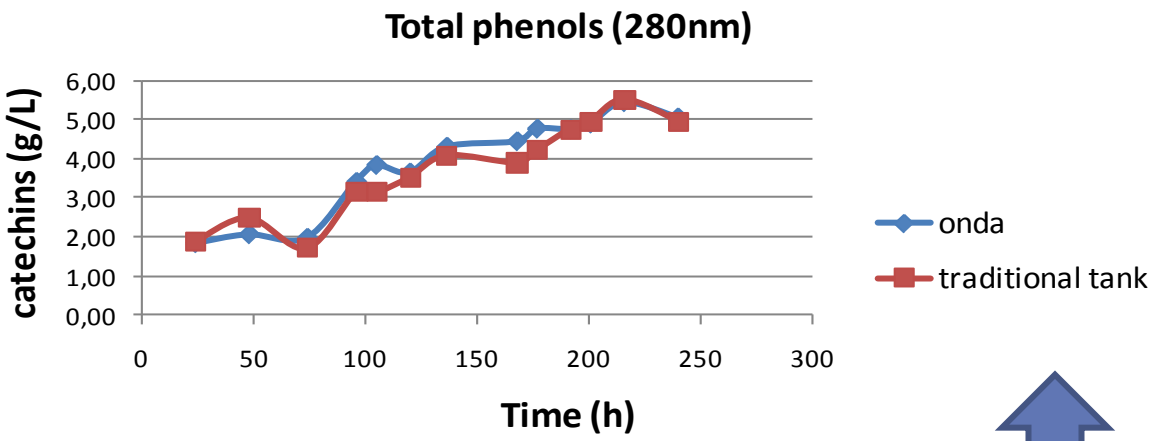


Follature

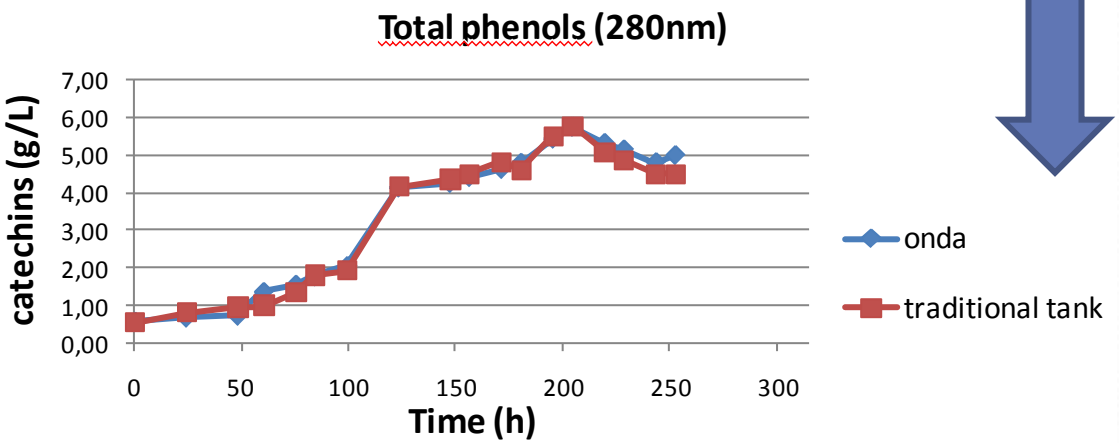
- **Gas injection (compressed air, nitrogen, argon, CO2) at the bottom of the vat (fig.1)**
- **Punching down and mixing the cap material with the fermenting wine without using pumps (fig.2)**
- **Great flexibility of use during each phase of winemaking: pre/postfermentative maceration, fermentation, aging (also on lees), storage of red and white wines.**
- This tank is a "system closed" , easy to clean. It makes it possible to control the microbial populations even at very low concentrations of SO2 and reduces manpower requirements because it's fully automated.
- The gentle motion makes the must/wine homogeneous, decreases the lees production and increases the extraction of phenols. The injection of industrial gases or gas mixtures at the bottom allows to gently move the must/wine and modify, as it needs, the gaseous composition inside the tank.

Development of the phenolic composition (280nm)

- Merlot

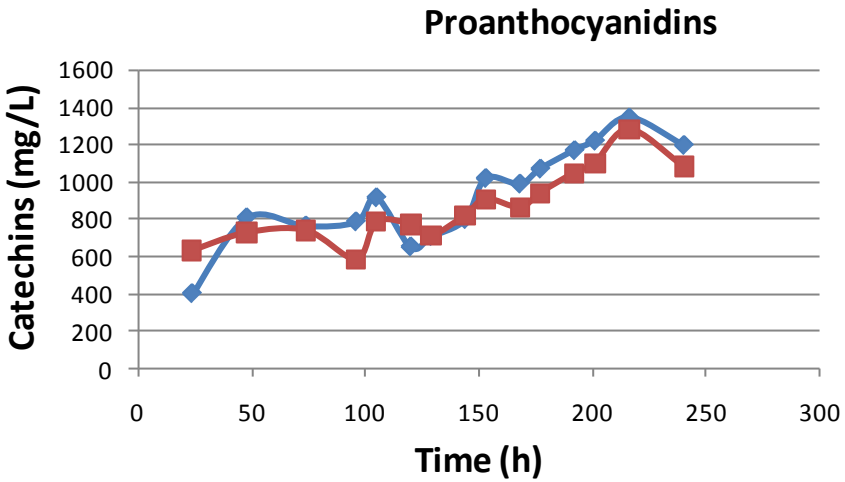


- Cabernet Sauvignon

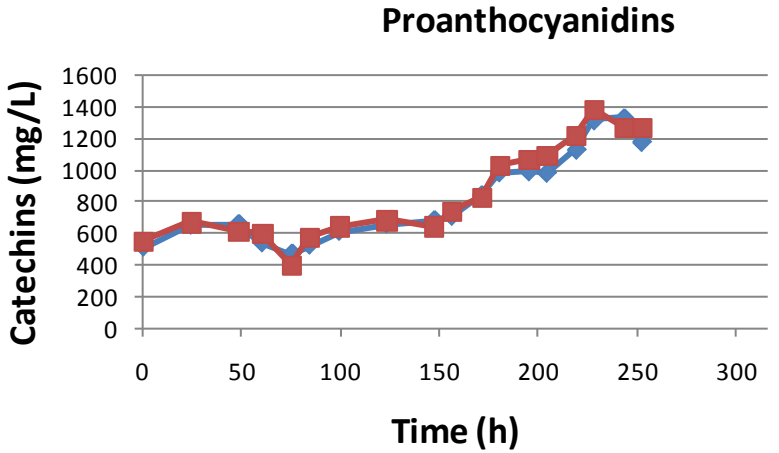


Development of phenol composition (Proanthocyanidins)

- Merlot

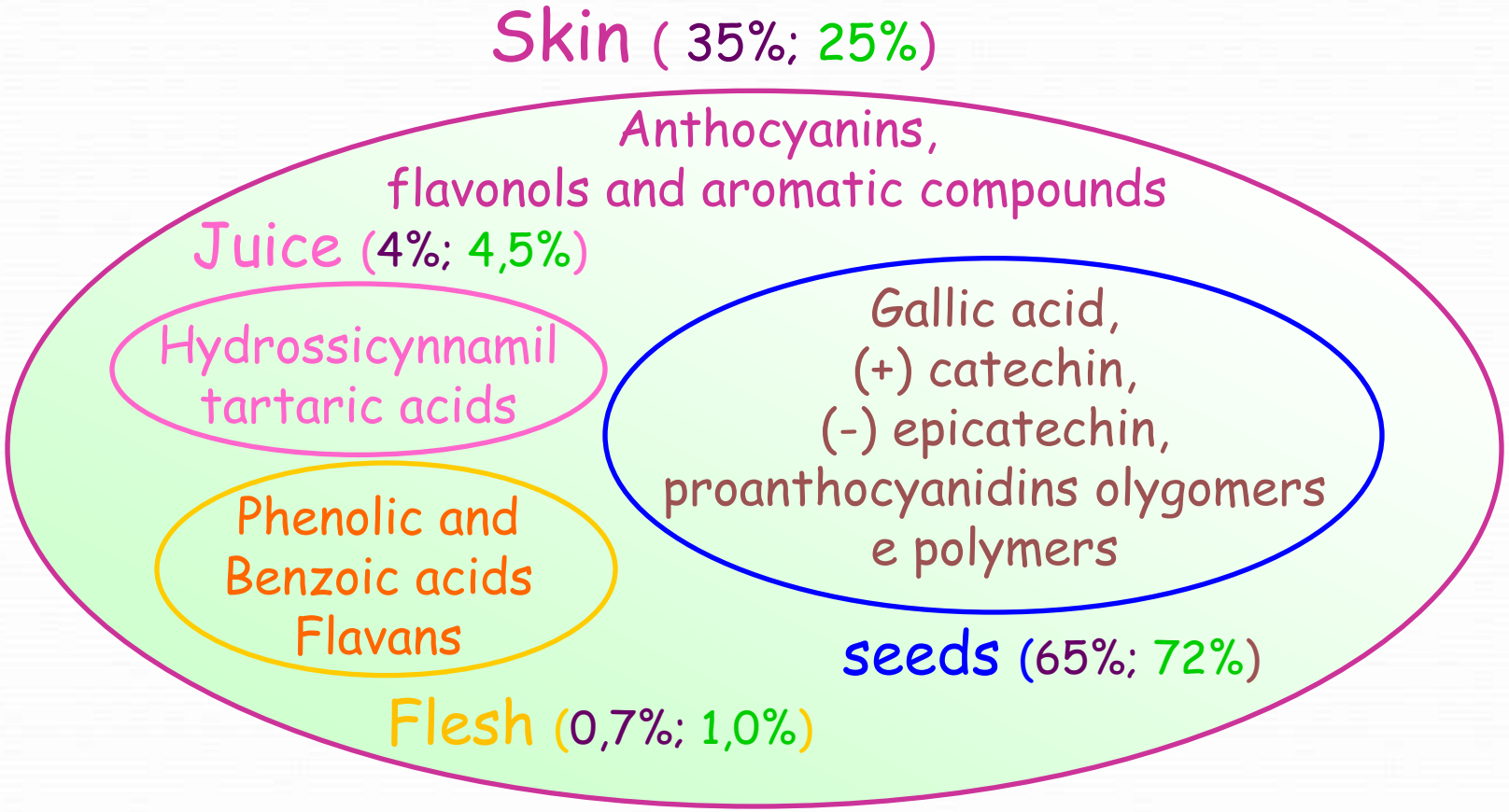


- Cabernet Sauvignon

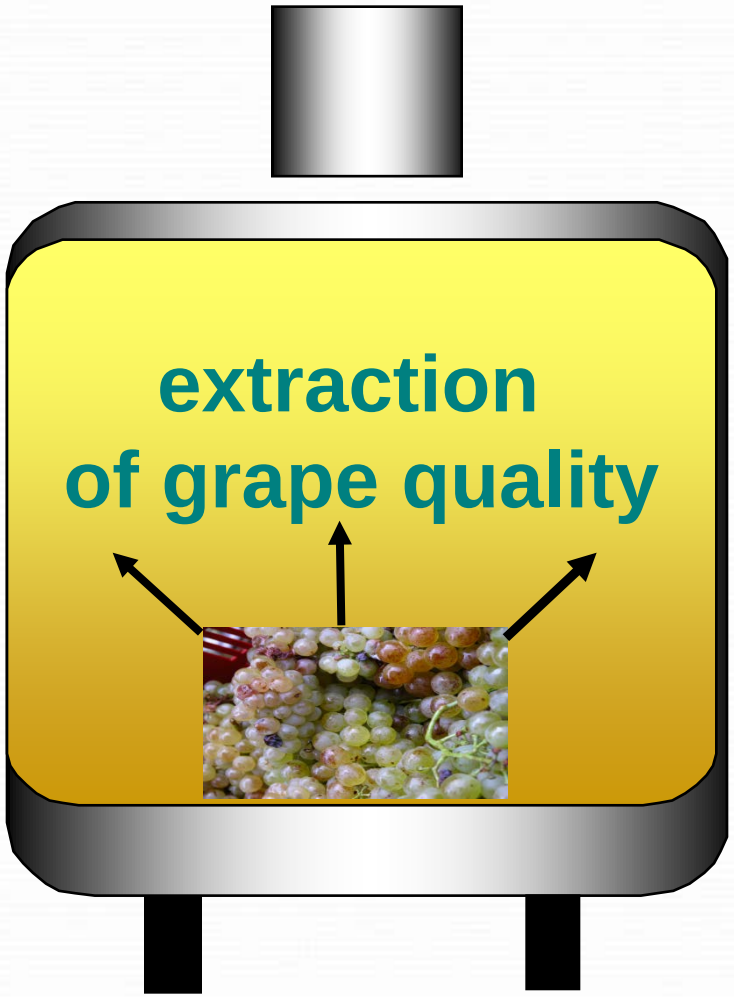


Distribution of phenols inside the grape

(R. Di Stefano, 2003)



Maceration



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mass transfer of valuable compounds from solid parts of grapes