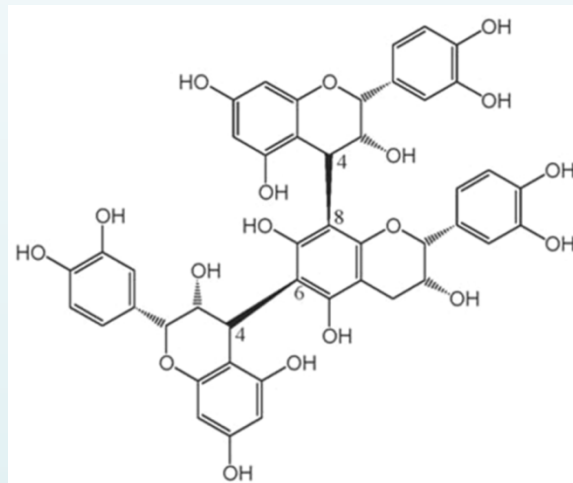




What do Enological Tannins offer to Northern Grape Winemakers?



Murli R. Dharmadhikari

Midwest Grape and Wine Industry Institute

Department of Food Science and Human Nutrition

Iowa State University

Ames, Iowa

Introduction

In today's presentation we will focus on enological tannins and their application in premium red wine production.

- Help improve the quality of both white and red wines.
- A viable option to produce premium red wines.
- High-end red wines, with good color, fuller body, supple tannins and long aging potential.

The Rationale

- We know that phenolic compounds in general, and pigments and tannins in particular, are important to the color, body and mouthfeel of a red wine.
- During winemaking only a portion of grape phenolics are extracted into final wine.
- Winemakers often employ several techniques to maximize the extraction of tannins (and pigments) from grapes into final wine.
- However, when the extraction of these compounds in wine is deemed insufficient, winemakers often add enological tannins to improve wine quality.
- This practice has been used by vinifera wine producers but it can also help the producers of red wine from northern grapes.

Importance to Northern Grapes

- Northern grape cultivars are relative newcomers to the red winemaking scene and very little is known about their phenolic composition.
- We need extensive research in the area of wine phenolics to address the challenges in quality red wine production from northern grapes.
- It is important to note, that many factors such as variety, fruit maturity, terroir, viticulture and winemaking practices, influence the phenolic composition of grapes and quality of the resulting red wine.
- At ISU, we are evaluating the effects of enological tannin additions on the quality of red wines from NG cultivars.

Tannins and Total Anthocyanin Content of Grapes and Wine (mg/l)

	Marquette		Frontenac		Vinifera	
	Grapes	Wine	Grapes	Wine	Grapes	Wine
Tannins	391	207	483	224	--	1-3 g/L
Total Anthocyanins	743	640	960	601	1610	1207

This data represents one year and one Iowa location.

Note that these varieties contain relatively lower amounts of tannin, and therefore to make high-end red wines we need to **maximize the extraction of tannins and pigments from the grape and add enological tannins as needed.**

For harmonious development of wine in bottle, the T/A ratio should be between 1 and 4, i.e. 500mg/l of Anthocyanin and 1-3 g/l of tannin (P.Ribereau-Gayon et al 2000).

Strategy for Premium Red Wine from Northern grapes

Suggested strategy:

- Develop best viticultural practices to maximize the development of tannins and pigments in grapes.
- Employ various techniques to maximize extraction and retention of phenolics during the winemaking process.
- If the tannin to anthocyanin ratio is not optimum (between 1 and 4) then supplement must with enological tannins.

Enological Tannins

background

What are Tannins?

- The word tannin comes to us from the leather industry where production of leather from hide is called tanning.
- It is this key property of tannins to react with proteins that transforms hide into rot proof leather.
- Tannins are a part of a diverse and large group of phenolic compounds found in grapes and wines.
- They are water soluble phenolic compounds with Mwt. of 600-3500.
- They are large molecules (polymers) with a strong propensity to interact with and precipitate proteins.

What are Enological Tannins?

Two Classes of Tannins

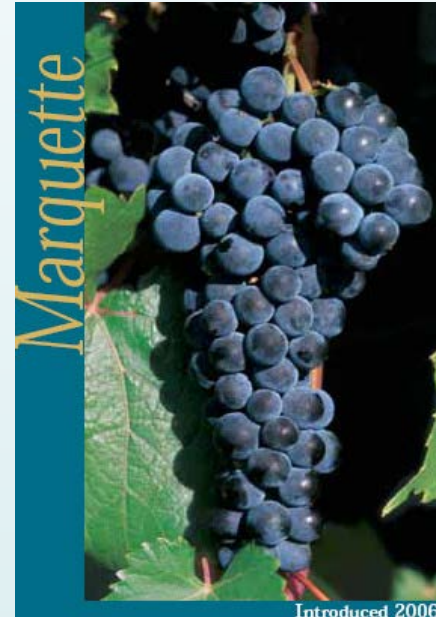
Non-Flavonoid

Hydrolysable



Flavonoids

Condensed



- Enological tannins include both classes of tannins

Hydrolysable (Non-flavonoid) Tannins

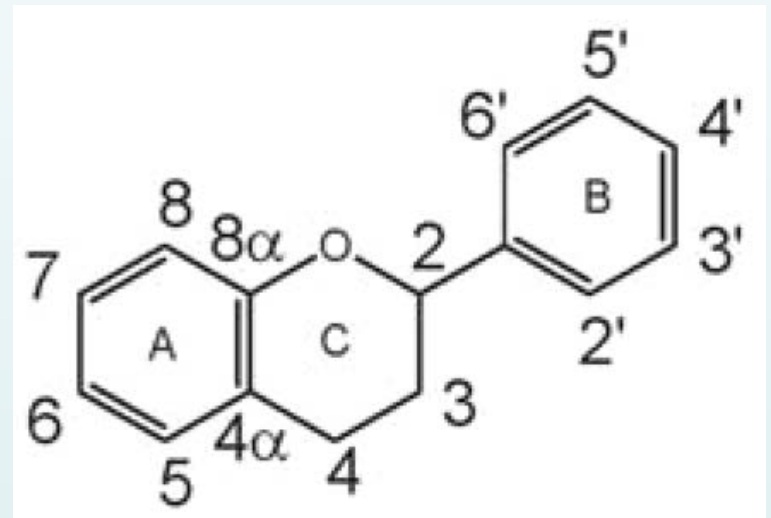
- They can be extracted from oak barrels during oak maturation of wine.
- They can also come from the addition of enological tannins.
- Sources of wood tannins include:
 - Oak barrels, oak alternatives, oak gall nuts
 - Tara, (a South American bean) and Quebracho (a tree from South America)

Condensed Tannins

Flavonoids

- Grape derived tannins are called condensed tannins.
- They belong to the flavonoid class of phenolic compounds.

C6-C3-C6 skeleton



Condensed Tannins: Structure and Variability

Length of chain: The size of the tannin molecules vary from dimers and trimers up to oligomers with more than 30 subunits.

Linkage: Variation in tannin can also be due to the site of linkage between flavanol units. Usual linkage is between C-4 and C-8 of the adjacent units but linkage between C-4 and C-6 has also been found.

Flavan-3-ol Groups: Variability due to different flavanol subunits in the chain. These variations contribute to the complexity of structure and their impact on wine's sensory properties.

Differences in Skin and Seed Tannins

- The average size of skin tannins is much larger than seed tannins.
- Skin tannins combine with polysaccharides and protein and contribute to softness and roundness, but can impart herbaceous notes if fruit is not ripe.
- Skin tannins contain epigallocatechin subunits whereas seed tannins generally lack epigallocatechin.
- Seed tannins give body and structure but can also impart excessive astringency.

How to Maximize Phenolic (Tannin and Pigments) Extraction During Winemaking

Phenolic Extraction

Pre-fermentation Options

- **Partial stem removal:**

Stems can be included in fermenting must to boost tannin levels. However green stems can contribute harsh and green tannins. Stems should be well lignified and trials should be conducted for to determine stem addition.

- **Cold soak:**

Extraction of must constituents (tannins and pigments) in an aqueous medium (without alcohol). However, be aware of the risk of contamination by undesirable yeast and lactic acid bacteria. Only clean fruit with a relatively lower pH should be subjected to cold soak.

Phenolic Extraction

Pre-fermentation Options cont.

- **Water removal:**
R/O membrane.
- **Saignee:**
Draining free run from must to change the skin to juice ratio.

Sequence of Phenolics Extraction During Fermentation

- Pigments are extracted at the beginning of fermentation. They reach a maximum level and their concentration slightly declines.
- Tannin extraction from skins also begins with fermentation but it continues to increase with maceration time.
- The use of enzymes can facilitate extraction of skin constituents.
- Seed tannins however, are extracted when cuticle is dissolved, towards a mid-point in fermentation and the extraction continues with maceration.
- Extraction of polysaccharides also begins with fermentation but some of them precipitate with the formation of ethanol.

Extraction Techniques

- Maceration time, temperature and cap management techniques influence the extraction of phenolic compounds.
- **Longer maceration time** (post fermentation) is desirable to promote extraction. However the grapes should be rich with ripe tannins.
- In the range of 20 to 30 C° **elevated temperature favors** increased extraction of phenolic compounds needed to make full bodied wines with long aging potential.
- Many cap management techniques are used.

Phenolic Extraction

Cap Management Techniques

In red wine fermentation, the skins and seeds float to the top forming a cap. This cap must be broken and mixed with the juice to facilitate the extraction of pigments and tannins.

Various methods used:

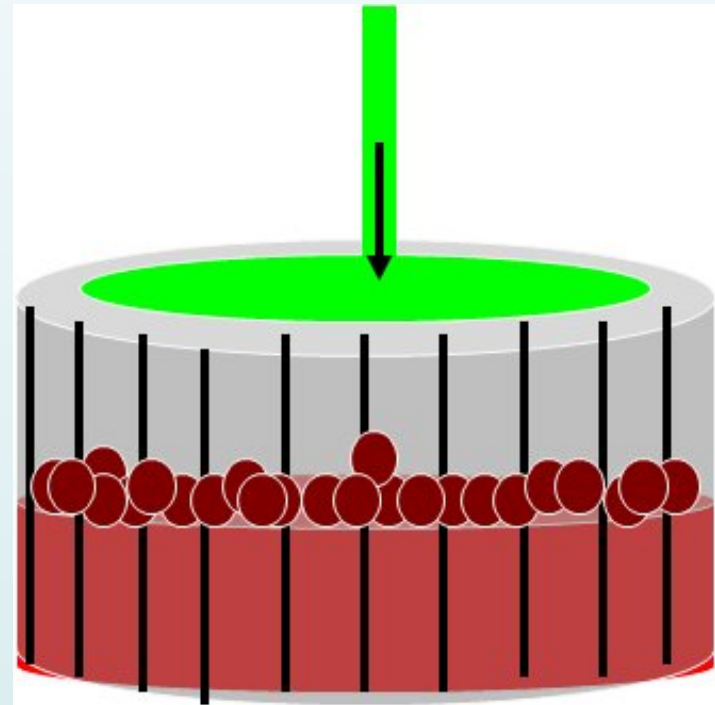
- Manual punching down, or mechanical robotic
- Pump overs/delestage
- Auto fermenters
- Rotary fermenters

Punch down

In this process a piston or piston-like device is used to physically push the cap down into the center of the tank. The cap will reform on the surface of the wine, but the contact with the high temperature mid-tank and the ethanol enhances extraction. Punch downs may be performed once to several times per day.



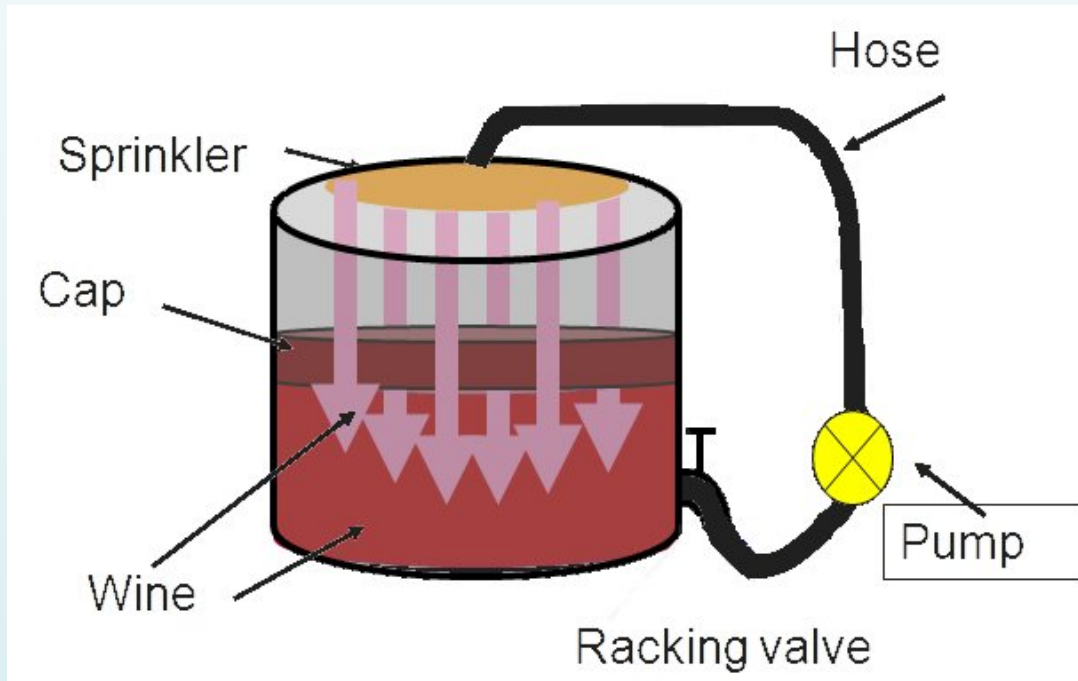
Source. Christian Butzke, Purdue university



Source: Dr. Linda F. Bisson, Dept. of Viticulture and Enology, UC Davis

Pump Over

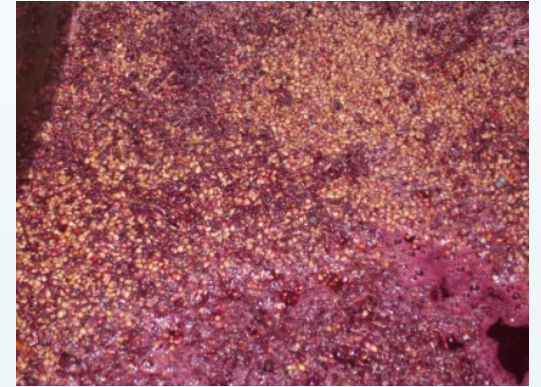
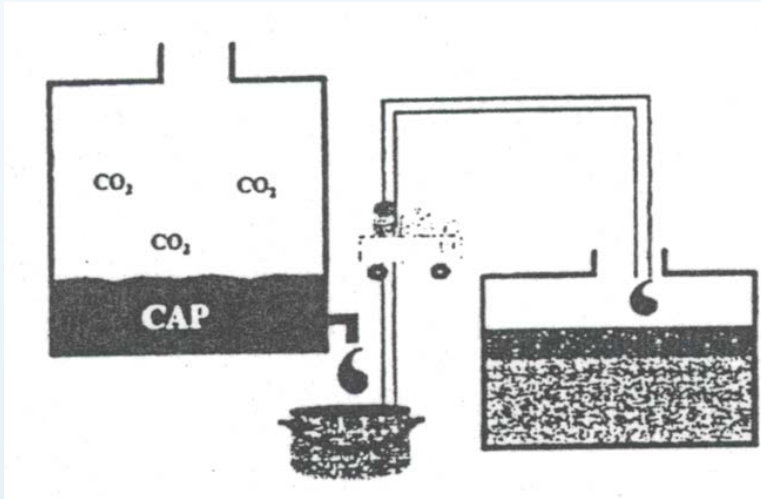
Pumping Over: The process of using fermenting juice from the bottom of the tank to bathe the cap of skins and seeds that forms on the tank exposing the cap to the ethanol of fermentation.



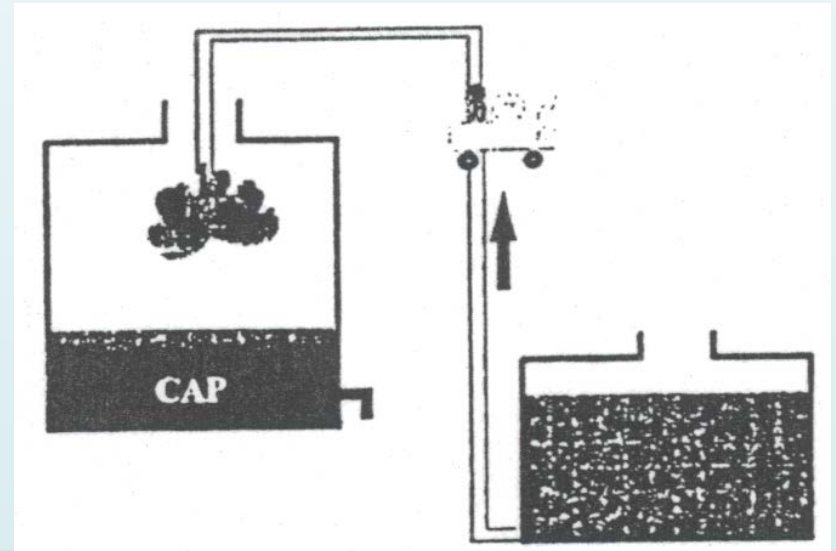
Source: Dr. Linda F. Bisson, Dept. of Viticulture and Enology, UC Davis

Rack and Return

- Rack

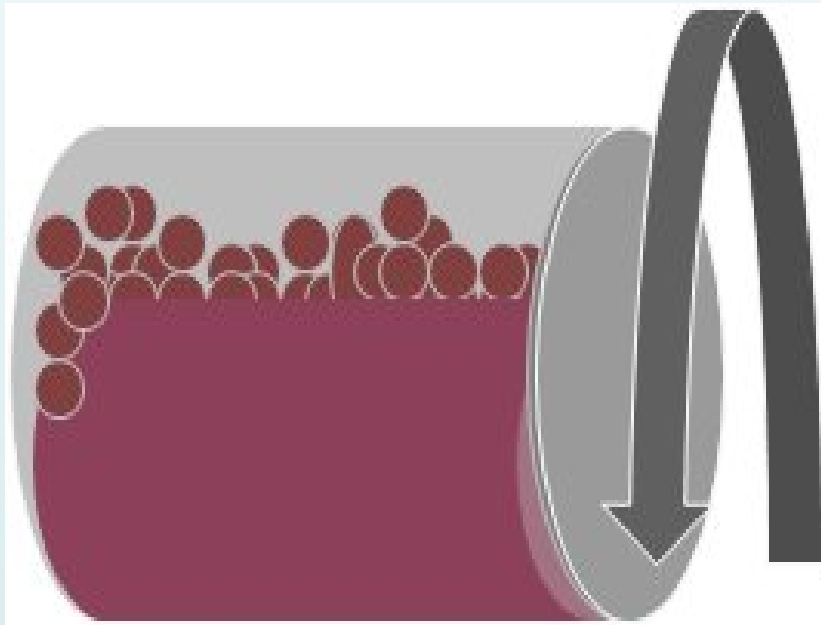


- Return



Rotary Fermenter

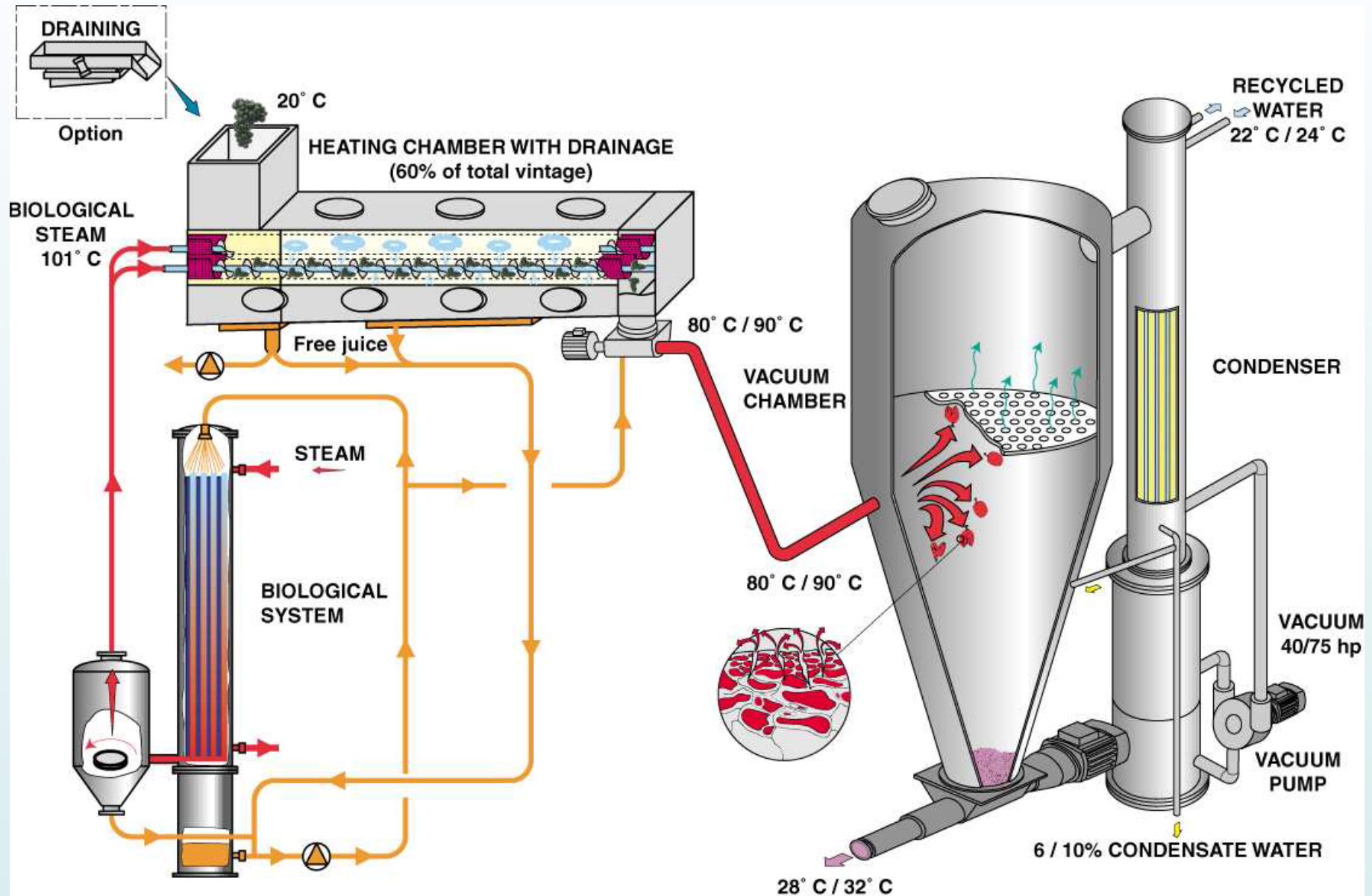
These tanks can be rotated along their axis, leading to mixing of the skins and seeds with the fermenting juice. This serves to assure regular contact of the skin "cap" and the ethanol produced by the yeast and to create a more uniform temperature throughout the tank.



Auto Fermenter



Flash Detent



Post Fermentation Maceration

- Extended maceration for 3-4 weeks post fermentation is a powerful extraction tool.
- The tank must be sealable.
- It should be used only with good quality and fully ripe fruit.
- In general, the wines becomes tannic in the beginning but later softens.
- The reactions are not well understood but polymerization and condensation of tannins with polysaccharides, proteins, peptides from yeast degradation is a possibility.

Phenolic Reactions During Maturation and Aging

- Enhancement and stabilization of color due to the formation of polymeric pigments.
- Tannin polymerization creating diverse structures due to chain length, type of subunits and type of linkage between the molecules.
- Tannin condensation reactions with anthocyanins, polysaccharides and proteins.
- Combinations with polysaccharides and proteins produce a softening of flavor (less astringent).

Palate Balance and Complexity

- Palate balance involves harmonious integration of wine constituents. In dry red wine the main factors are:
Alcohol, quantity and quality of tannin and concentration and types of acidity.
- **Palate balance = alcohol + (tannins + acidity)**
- This formula indicates that perception of sweetness from alcohol, and residual sugar must be balanced with the sum of perceptions from acidity, astringency and bitterness.

Conclusions

- Northern grapes are low in tannins and can benefit from enological tannins.
- Extraction of tannins can be maximized through various processing techniques.
- The balance of alcohol, acidity, and tannins must be maintained.



Viticulture, enology and marketing for cold-hardy grapes



Thanks

Murli R. Dharmadhikari

Midwest Grape and Wine Industry Institute
Iowa State University



The Northern Grapes Project is funded by the USDA's Specialty Crops Research Initiative Program of the National Institute for Food and Agriculture, Project #2011-51181-30850