VITICULTURE & ENOLOGY
UNIVERSITY OF CALIFORNIA DAVIS

Partitioning of potassium during commercial-scale red wine fermentations and model wine extractions

By: James Harbertson and Eric Harwood

In: American Journal of Enology and Viticulture. 60(1):43-49. 2009

• Potassium (K) is the most abundant inorganic element found in grapes. Among the various berry parts – skin, pulp and seeds – the skin has the highest *concentration* of K, followed by the seeds, but the total *amount* of K is greatest in the pulp because the pulp accounts for most (90%) of the berry.

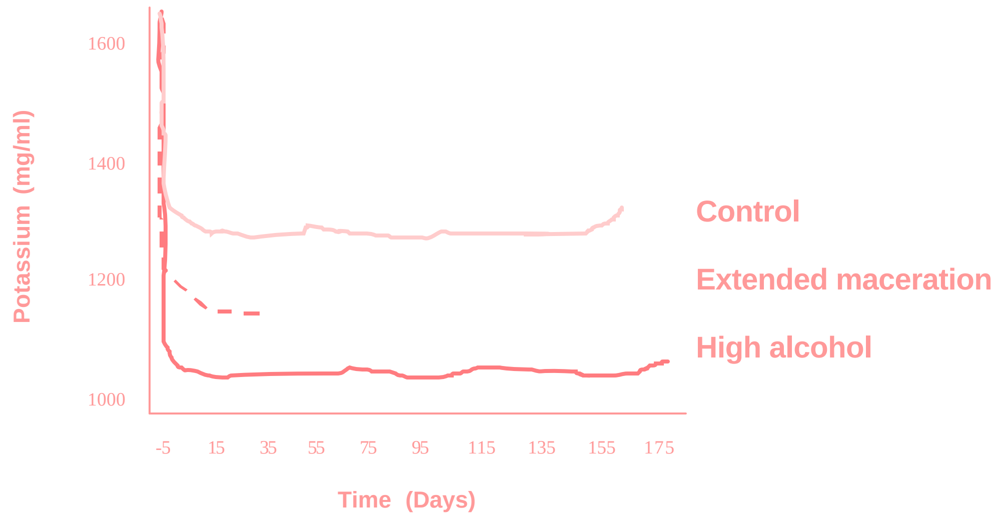
· Potassium plays an important role in winemaking, and excessive K from skins is thought to cause high pH in red wines. Two parameters known to impact final K concentration in wine are **pomace contact time** and **ethanol concentration**. The goal of this study was to evaluate the effect of these two parameters on the extraction of K during commercial fermentations. The authors also tried to elucidate the type of tissue (skin, pulp, seed) that contributes the most K.

• The Merlot fruit used for the experiment had an initial Brix of 28.0 (harvested Oct 12-13, 2007). The fruit was distributed into 5,000-gallon fermentors (2 fermentors per treatment) which were pumped-over ~1 minute per ton, 3X per day, until the must was drained and the pomace pressed. There were 3 treatments:

Control = must diluted to 23.8 Brix, 7-day pomace contact
"High alcohol" = must diluted to 26.8 Brix, 7-day pomace contact
"Extended maceration"= must diluted to 23.8 Brix, 20-day pomace contact

• To account for which tissue contributed the most K to the wine, researchers did a comparison between a "before" and "after" by dissecting intact berries before fermentation, on the one hand, and separating skins and seeds from the spent pomace on the other. These individual pre- and post-fermentation tissues were then digested (nitric acid/hydrogen peroxide) and analyzed for K (flame emission photometry).

• **Results**.
1) K concentration was at a maximum shortly after crushing, and then slowly declined for about 7 days, becoming constant after that. This decline disagrees with previous researchers, who reported an increase in K with skin contact time, rather than a decline.
2) **The "high ethanol" and the "extended maceration" treatments had significantly lower K concentrations than the control**, particularly the "high ethanol" treatment.



3) When the authors compared the K content in *skins at harvest* and in *skins in the pomace* (reconstituted to represent the same amount of original berries), they found **20% lower K in the skins at harvest than in the pomace**, and this was true for all 3 treatments. [*This is surprising, as one would intuitively think that skins after fermentation are depleted of their potassium*].

• Why was there more K in the pomace skins than in the fresh skins?! To investigate this issue, the authors conducted three additional small experiments. In ***Experiment I (pH experiment)***, they tried to extract K from the skins with less harsh methods that would better mimic fermentation conditions. To do that, they incubated berry skins in tartaric acid solution at different pHs (pH 1.0, 2.0, 3.0, and 4.0). They found that, as the pH increased, there was a linear decline in K extracted.

• In ***Experiment II (potassium bitartrate experiment)***, they incubated skins in the presence of various amounts of potassium bitartrate (4, 5, and 6 mg/mL), as well as a solution of potassium bitartrate + pectinase (to explore the influence of this enzyme on K release). They found that, in the presence of high potassium bitartrate, the K left in the skins (the non-extracted portion) increased considerably (22-23%). That is, the extraction of K from the skins depended on the concentration of K already present. When the authors also included pectinase, most of the K was extracted and the K remaining in the skins was very low.

• In ***Experiment III (ethanol experiment)***, the authors incubated skins in a potassium bitartrate solution (4 mg/mL) like above, but varying the concentration of ethanol (12, 14, 16, 18% v:v). They found that the percentage of skin K extracted decreased as ethanol increased (with K extraction practically negligible at 18% ethanol). That is, as the ethanol in the surrounding liquid increased, the K retained in the skin increased.

In conclusion, skins after fermentation (168 to 480 hours contact time) showed higher potassium levels than the skins before fermentation, meaning a net loss of potassium in the journey from fruit to wine. The authors believe that skins behave like an ion-exchange resin, absorbing potassium, but releasing it in exchange for protons when the pH is lowered. Using model solutions, the authors also showed that high concentration of ethanol and potassium further limit K extraction from the skins. One important implication for winemakers is that juices treated with pectinase can lead to an increase in pH, due to an increase in potassium extraction.

Author: Bibiana Guerra, Editors: Kay Bogart, Linda Bisson. This summary series funded by J. Lohr Vineyards & Wines.