Summary 34

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Title: **"Effects of temperature on anthocyanin biosynthesis in grape berry skins"**

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Because red table grape coloration is inhibited by high temperatures, with the resulting lower market prices, these Japanese authors try to find the ideal temperature to grow their red table grapes in greenhouses. They also find which growth stage is the most temperature-sensitive.

• The trial took place in 2003 in Hiroshima, Japan, using 2-year-old *Aki Queen* (*V. labrusca* x *V. vinifera*) potted vines grafted to 5BB. The vines received fertilization and automatic irrigation (whenever soil water potential < -10 kPa). They were also subjected to a strict "manicure-pruning": 3 shoots per vine, 12 nodes per shoot, 3 clusters per vine, and… 30 berries per cluster! To impose the treatments, 3 vines were transferred to either a glass growth chamber kept at 20°C, or to a glass growth chamber kept at 30°C. Vines were also transferred to a "control chamber", which fluctuated from 16-21°C as the season progressed. To be able to learn which was the sensitive period, the transfers took place at one of four possible stages throughout the growing season (I, II, III, IV), which the authors define by date.

		June 2 = bloom
Transfer I:	24 June – 7 July	
Transfer II:	8 July – 22 July	*July 14 = veraison*
Transfer III:	23 July – 4 Aug	
Transfer IV:	5 Aug – 18 Aug	*Aug 18 = harvest*

• **Anthocyanin accumulation.** At harvest, skin disks were punched on the grapes and, after acetic acid extraction, anthocyanins were measured by absorbance at 520nm. Low temperature (20°C) resulted in significantly higher anthocyanins than higher temperature (30°C). Stage III (1-2 weeks after veraison), followed by stage II, were the most temperature-sensitive stages, and **low temperatures at stage III resulted in the highest anthocyanins at harvest**. When the low temperature was applied early on (Stage I), it had the interesting effect of delaying veraison by 3 days. But when it was applied in stage II, it not only increased anthocyanins at harvest, but brought veraison forward by 5 days. Berry weight and Brix were not affected by temperature in this study.

• **ABA accumulation**. Endogenous abcisic acid (ABA) has previously been correlated with anthocyanin accumulation. ABA sprays to clusters are also used to enhance color in high temperature conditions. So the authors measured ABA levels in skins using a combination of techniques (gas chromatography-mass spectrometry). What they found was that **ABA levels after treatment in stage III were about 50% higher at 20°C than at 30°C**.

•**Gene expression**. The authors studied the expression of key genes encoding enzymes known to participate in the biosynthesis of anthocyanins. To do that, they measured the accumulation of the intermediate molecules between the genes and the enzymes, called mRNA (for *messenger RNA*). Higher levels of a specific mRNA mean higher expression of that particular gene. We know which mRNA correspond to which enzyme because their respective sequences are well-known. What the authors found was that the **mRNA levels of the main gene involved in anthocyanins biosynthesis**, as well as other related genes tested, **were higher at 20°C than at 30°C**.

• Connecting their three main findings, the authors concluded that low temperatures caused high levels of ABA that acted as a signal to influence the expression of the main genes involved in the anthocyanins biosynthetic pathway. This, in turn, caused an increase in anthocvyanin levels. As the authors point out, this does not exclude that other parallel mechanisms might also be present.

In summary, the lower temperature (20°C) during the two weeks around veraison was able to increase anchoyanin accumulation in the red table grape *Aki Queen*. This will help optimize the growth conditions of this and related table grape varieties. The finding that higher temperatures (30°C) -particularly those around veraison- should be avoided if we want to enhance color is worth keeping in mind, as it is likely applicable to other table red grapes.

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