Journal of Agricultural, Food and Environmental Sciences
UDC 634.8-035.66(439)
Original Scientific Paper

EFFECT OF BUD LOAD AND CLUSTER THINNING ON THE PRIMARY AROMA COMPOUNDS OF FURMINT GRAPE VARIETY IN TOKAJ REGION

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Abstract
The free aroma compounds of the grapevine are localized mostly in the berry skin, but minor amounts can be detected in the pulp as well. The quality of white grapes and the prospective wines made from these is closely related to the concentration and to the composition of the aroma compounds. These characteristics of the grape can complement the information of the classical database based on sugar, acidity etc. In our experiment, the effects of the ripening process and of the grapevine load on the berry aroma composition were investigated in a Furmint vineyard of Tokaj wine region in Hungary in two consecutive years (2013, 2014). From the large amount of the aroma compounds 3 main groups were followed by GCMS measurements: the C6 alcohols/adehydes, the terpene-alcohols and the nor-isoprenoid compounds. Between the basic data (sugar, pH) in only few cases were significant differences found between different values, however the vintage effect was very marked. Regarding the C6 aldehydes and alcohols concentration, a decrease was found during the ripening period and the cluster thinning at the moment of véraison was proven to be beneficial on the composition. This practice had a positive effect on terpene accumulation in the berry, but in 2014 presumably due to the botrytis infection, minor differences were found. Some nor-isoprenoid compounds, like ionone and damascenon showed a higher concentration due to the yield limitation, but the tendencies of the two years remained different.

Key words: Bud load, cluster thinning, Furmint, Tokaj wine region, aroma composition.

Introduction

The free aroma compounds of the grape accumulate mostly in the berry skin and in smaller amount in the pulp. The quality of the white grapes and wines deriving from them is largely determined by the concentration of the aroma compounds. In a given base material, the aroma composition is in interaction with the grape variety, terroir and the ripening stage as well. In our experimentation, we examined the effects of the bud load and of the ripening process on the aroma composition of Furmint (the most traditional grape variety of the Tokaj wine region). The aim of the research was to understand whether the primary aroma composition is stable in a given terroir or how much it could be influenced by the vintage and by technological effects.

During the grapevine ripening several non-volatile compounds (aroma precursors) are transformed to volatile compounds which are detectable by sensorial analyses. The aroma compound of the wines are characterized in details by BAYONOVE ET AL. (1998). They ascertained that the aroma composition of the wines is extraordinarily complex, because these compounds can react with the alcohol, glycerol, organic acid, carbohydrates and polyphenol components of the wine. Among the about 900 volatile compounds detected in the wines, about 10 % plays a role directly in the formation of the aroma character.

In warm territories and warm vintages, the bunch zone shading is a good solution for the prevention of the primary aroma compounds. A big difference can occur (almost 10 °C) between the berry temperature of the shaded and non shaded berries. Temperatures above 35°C can change the berry metabolisms, and the most important ripening processes are stopped (Price et al., 1995; Deloire & Hunter, 2005). The aroma composition and the localisation of the volatile compounds are largely affected by grape varieties (Gunata et al.1985). Bayonove et al. (1984) wrote first about the existence of the glycolised types of aroma compounds in Musat grapes. Strauss et al. (1986**)** and gomez et al. (1994) examined the aroma composition on three Vitis vinifera red grape varieties. They concluded that the main aroma components of these grape varieties belonged to the alcohols and aldehydes, and these compounds are located mostly in the pulp. After enzymatic hydrolysis, they found the highest concentration of the alcohol group. The terpenic alcohols (typical in muscat varieties) have been detected, mostly in bound forms. However they could not extract geraniol by the method of methanol extraction. The biggest concentration was found in linalool & α-terpineol. In the experiment only the linalool appeared in a concentration above the threshold of sensorial detection. The C6 aroma compounds were mostly located in the berry skin and pulp. This phenomenon can be explained by the lypoxigenase enzyme activity located in the solid parts of the berries. The long maceration or fermentation seems to be useful to extract terpenol, but it can negatively affect the quality by the decreasing concentration of the non-desirable flavour compounds, (eg. C6 aldehydes) (Bayonove et al , 1984). The grape berry β-glycosidase activity is low; consequently just few bound aroma compounds extraction is possible. However glycosidase enzymes from other sources, can very effectively used in the winemaking technologies (Ayran et al., 1987).

Material and methods

Experimental plots:

Our experiment was set up in the “Sajgo” parcel which is situated close to Mád village in the centre of the Tokaj wine region. A block of 300 grapevine stocks was chosen in a big parcel, with a randomised distribution of each treatment. This territory is characterized by a small slope incision and by a south orientation of the hill. The vineyard was planted in 1995, with low (50 cm trunk height) Guyot training system and with a spacing of 2 m x 0,8m. The bedrock is rhyolite tuff; the soil type is medium hard ground leptosol. We examined the Furmint (clone T 92.) grape variety grafted on 5C root-stock. As a soil treatment in the parcel a mechanical tillage was used and combined by chemical weeding under the rows. A narrow canopy wall was adapted to the training system. All the treatments were randomly distributed in the parcel, by 5 repetitions of each. All repetitions contained 10 grape stocks.

Treatments.

In this parcel, an experiment of 6 different treatments was set up. The applied treatments are represented in the following list, marked by these abbreviations:

- 4R- vines with 4 buds (simple Guyot with one cane and one spur)
- 6R- vines with 6 buds (simple Guyot with one cane and one spur)
- V-Cluster thinning at the moment of the fruit set (Control +1 (lower) bunch/shoot
- ZS-Cluster thinning at the véraison stage. (Control +1 (lower) bunch/shoot)
- D- „double bud load”: Vines are pruned on 12 buds (double Guyot)
- K- Control vine stocks with 8 buds/vine (spur of 2 buds+ cane with 6 buds)

Samplings

During the representative samplings, a sample of 200 grape berries was collected from the different spots of the parcel, from the 2 sides of the canopy wall, and from different bunch levels as well. These samples were frozen just after transporting them to the laboratory. The samplings were performed once in 2013 and in two times in 2014, as shown in Table 1:

Table 1: Sampling dates in the two vintages

	2013	2014
First harvest	October 10	September 19
Second harvest	-	October 3

Examined parameters and their analysis

Free aroma compound analyses were carried out after the thawing of the samples, the seeds were eliminated and the simples were prepared by direct pressing. 100 ml of each collected grape juice was mixed by 100 g of NaCl and 500 ml of distilled water in an alembic. Alembics were heated till their content reached the boiling point. During the preparation of the analyser device, the system was filled up by water, and 4 ml of hexane was laid on the top of the water. The aroma compounds of each sample were collected in the hexane layer. The hexane from the distillation was sent to the small sampling phial of the Thermo Trace 1300 GC device which was directly combined by an ISQ mass spectrometer. The data processing and graphical evaluations were realised by Microsoft Excel program, and the statistical analyses were preformed by SPSS program. First the homogeneity of the berries in each sample was checked by Kruskal-Wallis test, than we examined by the Friedmann rank analyses test whether the differences between each treatment and harvest date was significant or not.

Results and discussions

The experiment was carried out in two consecutive years. 10 different aroma compounds of three primary aroma groups were analysed: C6 aromes, terpenes alcohols and nor-isoprenoids.

C6 aldehydes and alcohols

Several compounds belonging to this group are easily detectable and in a high concentration they cause an unpleasant, vegetal or herbal character in the wines. The high concentration levels can occur in the case of an inadequate ripening or when the grape processing was not gentle enough. The concentration of these compounds is significantly decreased during the ripening stage (Miklósy-kerényi, 2007). We analyse two compounds of this group.

The hexanal concentration has shown a considerably higher level in 2014 than in 2013, due to the unfavourable vintage effect. The hexanal concentration decreased for most treatments, with a significant difference in the case of the cluster thinning/véraison at the second harvest time. The results of the double bud load and cluster thinning/fruit set remained stable, but in the control juices a non significant increase was shown (Figure 1.)

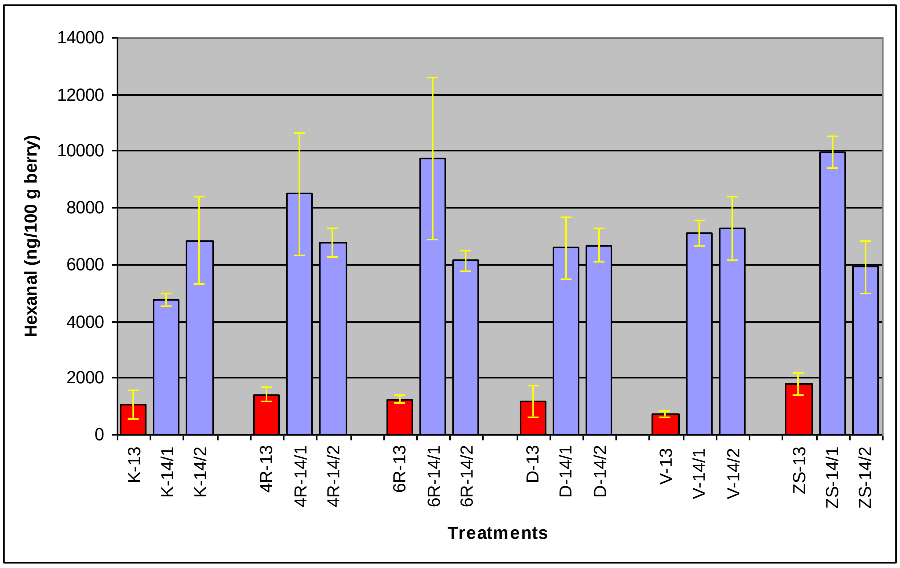

Figure 1: The hexanal concentration of the musts in different treatments. (ng/100 g), (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

In 2014, the trans-hexen-al concentration was significantly higher than in 2013. The differences between treatments remained small; however the positive effect of the cluster thinning was proved in both sampling dates. Based on our results, we concluded, that in the vintages relatively cool and rainy, like 2014, the cluster thinning (mostly at véraison) provokes a positive effect on the aroma composition & quality in the case of the fertile grape varieties, like Furmint is. The too vegetal and brut character of the wines seems to be decreased in these samples, with the postponing of the harvest time after the cluster thinning interventions (Figure 2.).

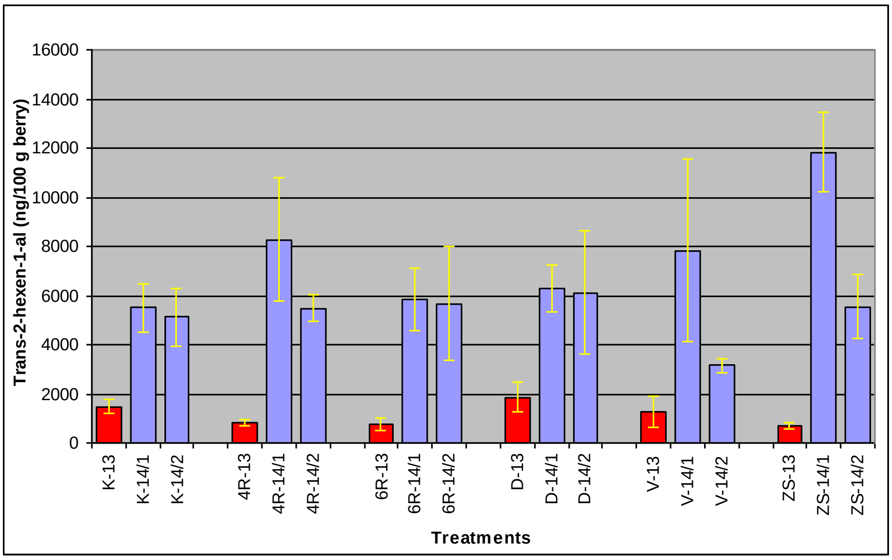

Figure 2.: The level of trans-2-hexan 1-al concentration in different treatments grape juice (ng/100 g), (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

Monohydroxi-terpenalcohols

This group of flavours is present in the musts of Muscat grape variety in highest concentration. Although the Furmint does not belong to this group, in the Furmint wines, these compounds can be detected and they are considered as an important factor of the aroma-complexity.

The β-terpineol concentration was the highest in this group. It is stated, that the concentration of terpenes in 2014 was significantly higher than in 2013, which can be explained by the negative effect of the hot and dry autumn vintages on the degradation of these compounds. In the β-terpineol concentration significant differences were found neither between the treatments, nor between the harvest dates. However, in both vintages the intervention of the cluster thinning at the véraison influenced positively the β-terpineol accumulation of the grape berries (Figure 3.)

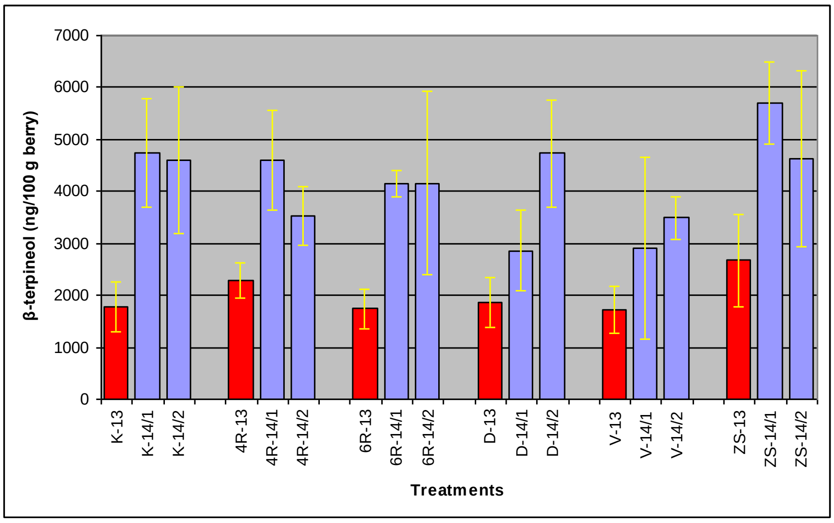

Figure 3. The β-terpineol concentrations in the different treatment grape juices (ng/100 g) (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

We could detect a considerably smaller concentration of the α-terpineol in the grape berries. The concentration of this compound did not show a significant difference among the treatments, but the decrease during ripening was proved in all of treatments.

Among the terpene compounds, the linalool has the most intensive smell (orange flower, coriander), which is typical for the Muscat grapes & wines. In our experiment, we could detect this compound, however its concentration in 2014 remained significantly lower than in 2013. Probably it is due to the high level of botrytis infection in the second experimental vintage. Some reference mentioned that in the metabolism of this fungus the linalool is transformed to superior alcohols, oxides and esters (Bock et al., 1986). Among the treatments, the cluster thinning had a positive and significantly bigger effect on the linalool concentration in 2014, than in 2013. This fact is true for timing at the véraison, because after intervention at the fruit set, the berry size became bigger, so that the compact bunch construction caused a faster botrytis infection and a lower linalool concentration. No significant differences were found between any of the treatments, in the concentration of this aroma compound (Figure 4).

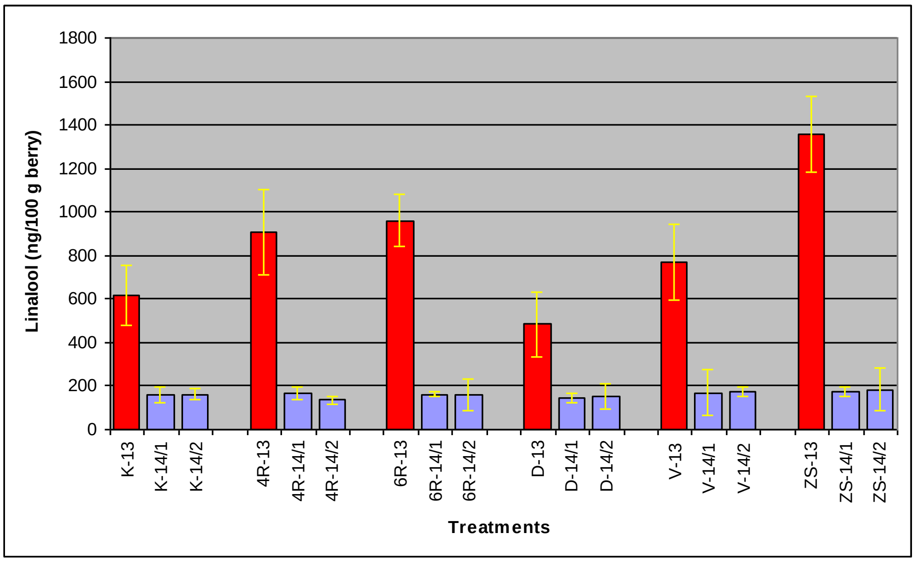

Figure 4.: Linalool concentration in different grape berries (ng/100 g), (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

Furthermore β-citronellol was detected in a small concentration (below 100 ng/100 g berry) and with a decreasing level during ripening. Significant differences were found between the control and the cluster thinning at the fruit set. By the decreasing bud load and yield the concentration remained smaller, mostly in the double bud load treatment. In a very small quantity nerol was detectable in the Furmint berries as well. No significant differences were found among the treatments, however the concentration of this aroma compound in general decreased by postponing of the harvest date. The geraniol was detectable in some of the Furmint berry samples, however the concentration was very low, between the values of 0 and 50 ng/100 g, so in some samples no geraniol was detectable. This aroma compound consequently is not determinate for the Furmint aroma character, and in our study its concentration did not reach the level of sensorial detection

Nor-isoprenoids

Among the remarkable molecules of this group the ionon (α and β form) and the β damascenon are the most important in the grape berries. The smell of the previous is similar to the violet and can be found in different red grape varieties (e.g. Syrah) as well, while the latter is known as a dominant fruity or exotic flower aroma (Baumes, Razungles, 1992). We detected both molecules in the samples by GC-MS method. The ionone concentration varied from 200 to 500 ng/100 g, no significant difference was found between the applied treatments. During the ripening the ionone concentration decreased in more treatments. This phenomenon was typical tendency for the cluster thinning (both times, fruit set/véraison) (Figure 5).

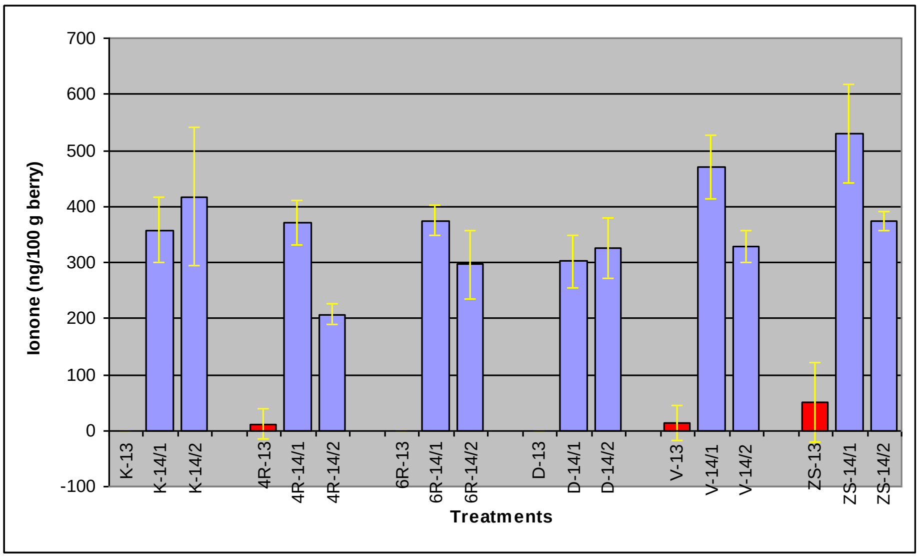

Figure 5: The ionone concentration of the grape berries in the different treatments (ng/100 g), (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

In 2014, the β-damascenon concentration remained similar to the values of 2013, but presumably due to the important botrytis infection the concentration decreased during the ripening stage (Figure 6.).

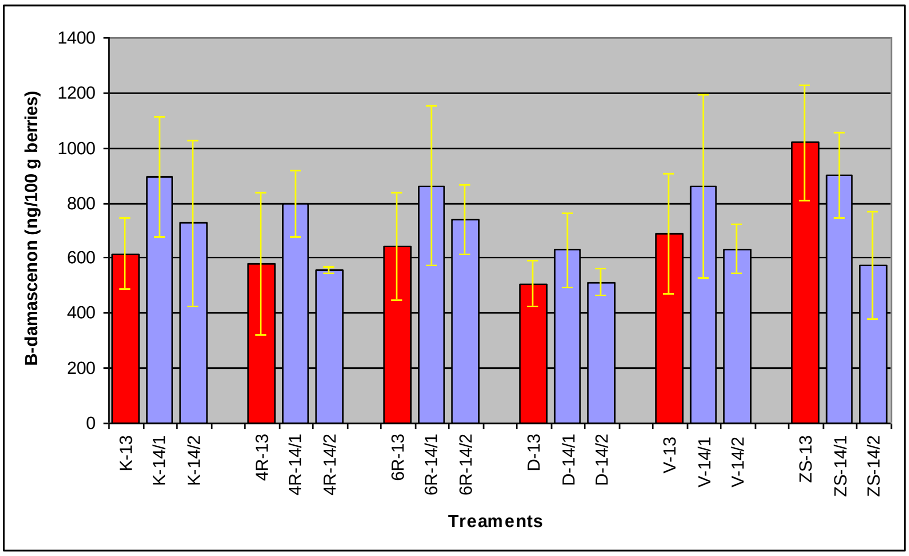

Figure 6: The β-damascenon concentration of the grape berries in the different treatments (ng/100 g), (13- harvest of 2013, 14/1 and 14/2 means the first and second harvest times in 2014)

Schoch et al. (1991) found a similar tendency in their study accordingly, due to the decreasing α damascenon level in the ripening stage caused by the botrytis infection.

Conclusion

In our study, the ripening process and the load effects were monitored by the evolution of flavour compounds. Significant differences were found between the two vintage results in the concentration of C6 aldehydes and alcohols, since in 2013 the values remained lower. The concentration of most of the aroma compounds belonging to C6 group decreased during the ripening stage. Among the yield limitation methods, the cluster thinning at the véraison had positive effect on this character. In the terpenol group, β-terpineol and linalool have shown the highest concentration, and different level in the samples of applied treatments. In 2013 the cluster thinning at the véraison had a good effect on the terpenol accumulation, however the differences between each treatment remained lower in 2014, presumably due to the botrytis effect. In the nor-isoprenoid group, the ionone and damascenon level decreased in 2014 during ripening in all treatments, but no significant differences were found. However, in 2013, we could justify the positive effects of the cluster thinning in this point of view. Based on the results of our experiment, we concluded that in the case of a particular type of grape variety and parcel, the primary aroma composition can be changed first due to the vintage effect and second due to the harvest time and level of yield as well.

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