EFFECT OF MACERATION TIME ON THE RED WINES PRODUCED FROM ORGANIC GRAPES FROM PLANTATIONS WITH DIFFERENT YIELDS

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At present more and more consumers are choosing their foods based on their nutritional value, safety and even environment impact. For this reason, the segment of population buying organic food products is at an all-time high, including in Romania, where 80% of the tested consumers believe that the organic food is healthier, while also 75% of them understand that organic agriculture contributes to environmental protection (Petrescu *et al*., 2015).

Although the new generations are more interested in organic products for their link to sustainability, they are also looking for products perceived as healthier. Consumers are more easily accepting organic wines when these are also containing more components linked to a better human health.

To meet the demand for wines more beneficial for human health, one of the main preoccupations is to increase the concentration of polyphenolic compounds.

For red wines, the phenolic composition determines to a large extent the overall quality.

Some red varieties of grapes naturally accumulate higher phenol concentrations

but others - such as the Romanian variety Feteasca neagra – are less fortunate in this regard

and could benefit from some technological interventions.

In case of organic wine, however, only few interventions are allowed.

Thus, the present study focuses on easily acceptable strategies that may help improve the polyphenol composition of organic red wines of **Feteasca neagra** (*Vitis vinifera*).

Feteasca neagra, a Romanian autochthonous variety, which has gained more and more recognition for its quality wines.

The plantation has been grown and certified in accordance to the organic production principles and regulations since 2009 on a surface of 8.1 ha at the Research and Development Station Murfatlar

Thus, the present study focuses on easily acceptable strategies that may help improve the polyphenol composition of organic red wines of **Feteasca neagra**.

The goal to optimize phenolic concentration in Feteasca neagra grapes can be achieved by interventions in the vineyard and/or wine technology

Vine

- Yield control, performed by pruning
- Reduced yield – T1 - 20 buds/vine
- Normal yield – C (Control) 28 buds/vine
- Increased yield - T2 - 36 buds/vine.

Wine

- During winemaking, the grapes from the three yield variants were macerated for either
- 8 days – V1
- 16 days – V2

Red wine samples were produced by the traditional method with punching down cap.

in 2 years of harvest:

2016 (favourable)

2017 (less favourable)

for the three bud-load variants

(C, T1 and T2)

for each bud-load variant, for the wines macerated for 8 days (V1) and 16 days (V2)

- Specific polyphenols of wines thus obtained were determined by HPLC (UltiMate 3000 Thermo Finnigan, Quaternary gradient, Chromeleon Workstation, detection at 280 nm with a Diode Array Detector).

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- The main chemical parameters were determined in accordance to the OIV methods.

Chemical composition of wines obtained in experimental variants of Fetească neagră

All the main chemical analyses were performed but we only show here the parameters which were clearly influenced by the vintage, grape yield and maceration time.

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
General composition						
2016 Alcoholic strength (% vol.)	13.0±0.1 c	**13.27±0.1 ab**	**13.36±0.1 a**	**13.41±0.1 a**	12.9±0.2 c	13.1±0.2 bc
2017 Alcoholic strength (% vol.)	11.9±0.1 b	12.1±0.2 b	**12.6±0.1a**	**12.7±0.2 a**	11.2±0.2 c	11.4±0.1 c
2016 Total acidity (g L^{-1} tartaric acid)	5.11±0.22 ab	4.81±0.26 b	5.04±0.33 b	5.19±0.25 ab	5.04±0.31 b	5.56±0.19 a
2017 Total acidity (g L^{-1} tartaric acid)	6.26±0.20 b	6.75±0.24 a	6.43±0.20 ab	6.75±0.18 a	6.25±0.21 b	6.83±0.26 a
2016 Non-reducing dry extract (g L^{-1})	24.7±0.2 c	25.3±0.2 b	25.4±0.1 b	26.1±0.1a	23.8±0.1 c	24.3±0.2 d
2017 Non-reducing dry extract (g L^{-1})	24.2±0.2 c	24.8±0.1 b	25.3±0.1 a	25.5±0.2 a	22.8±0.2 d	23.0±0.2 d

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
General composition						
2016 Alcoholic strength (% vol.)	13.0±0.1 c	**13.27±0.1 ab**	**13.36±0.1 a**	**13.41±0.1 a**	12.9±0.2 c	13.1±0.2 bc
2017 Alcoholic strength (% vol.)	11.9±0.1 b	12.1±0.2 b	**12.6±0.1a**	**12.7±0.2 a**	11.2±0.2 c	11.4±0.1 c

The variants with reduced bud-load (T2=20 bud/vine) recorded significantly higher values for the alcohol in wine compared to the control and to the variant with higher yield, due to a better sugar accumulation in the berries.

In 2016 the conditions were more favourable for the sugar accumulation, thus the variant T2 did not differ significantly from the control (T1>C=T2),

but in 2017, all the variants were different in this respect (T1>C>T2), showing that in less favourable years a high yield has a negative effect on the final quality.

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 Non-reducing dry extract (g L^{-1})	24.7±0.2 c	25.3±0.2 b	25.4±0.1 b	26.1±0.1 a	23.8±0.1 c	24.3±0.2 d
2017 Non-reducing dry extract (g L^{-1})	24.2±0.2 c	24.8±0.1 b	25.3±0.1 a	25.5±0.2 a	22.8±0.2 d	23.0±0.2 d

In the high yield variants, the average extract decreases by approximately 1 g/l as compared to control and 2 g/l as compared to the low-yield variants.

This fact is not negligible, as a difference of 1 g/l dry extract may be perceivable by sensory analysis and, coupled with a lower alcoholic concentration, gives the impression of a lighter-bodied wine.

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16days maceration	V1=8 days maceration	V2=16days maceration	V=8 days maceration	V2=16days maceration
2016 Total acidity ($g\ L^{-1}$ tartaric acid)	5.11±0.22 ab	4.81±0.26 b	5.04±0.33 b	5.19±0.25 ab	5.04±0.31 b	5.56±0.19 a
2017 Total acidity ($g\ L^{-1}$ tartaric acid)	6.26±0.20 b	6.75±0.24 a	6.43±0.20 ab	6.75±0.18 a	6.25±0.21 b	6.83±0.26 a

The total acidity also shows that 2017 was a less favourable year for grape maturation (acidity was not corrected).

The yield, however, did not induce significant differences among variants.

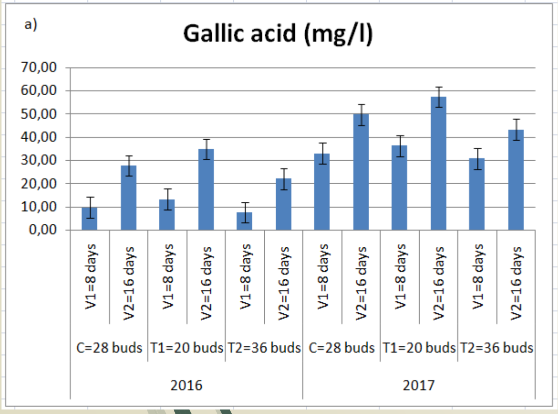
Phenolic compounds

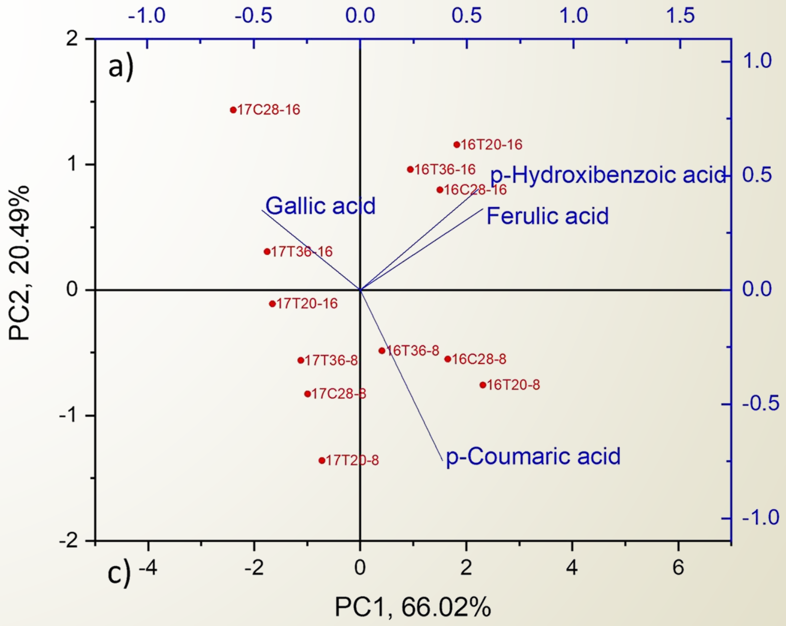
Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
Phenolic acids (mg L^{-1})						
2016 Gallic acid	9.77±1.9 de	27.88±2.1 b	13.42±2.1 d	34.87±2.7a	7.76±1.2 c	22.16±2.1c
2017 Gallic acid	33.08±2.9 d	49.81±4.1 b	36.34±3.2 d	57.44±4.2 a	30.86±2.9 d	43.34±3.2 c
2016 p-Hydroxybenzoic acid	5.5±1.0 b	7.04±1.5 ab	6.29±1.8 ab	8.34±1.6 a	2.05±0.9 c	6.99±1.6 ab
2017 p-Hydroxybenzoic acid	0.4±0.1 bc	0.66±0.2 b	0.62±0.2 b	0.97±0.1 a	0.31±0.1 c	0.45±0.1 bc
2016 p-Coumaric acid	1.44±0.8 a	1.16±0.8 a	1.78±0.9 a	1.23±0.7 a	1.0±0.2 a	0.84±0.2 a
2017 p-Coumaric acid	1.2±0.3 ab	0.15±0.02 c	1.56±0.8 a	1.15±0.4 ab	1.01±0.02 ab	0.69±0.1 bc
2016 Ferulic acid	4.37±1.3 bc	6.31±1.6 ab	6.03±1.3 ab	7.52±1.5 a	2.83±1.1 c	4.13±1.2 bc
2017 Ferulic acid	0.03±0.01 d	0.09±0.01 ab	0.07±0.01 bc	0.10±0.02 a	0.03±0.01 d	0.06±0.02 c
Flavanols (mg L^{-1})						
2016 Catechin	7.01±1.7 bc	13.69±2.0 a	9.07±2.1 b	14.61±2.3 a	5.52±1.8 c	10.04±2.2 b
2017 Catechin	4.83±1.5 cd	7.84±1.7 ab	5.75±1.4 abc	8.07±1.8 a	2.58±0.5 d	5.23±1.2 bc
2016 Epicatechin	1.99±0.8 ab	2.17±0.9 ab	2.71±1.5 ab	3.03±1.0 a	0.87±0.1 b	2.09±1.0 ab
2017 Epicatechin	4.24±1.2 b	6.44±1.1 ab	4.91±1.2 b	7.83±1.5	4.03±1.0 b	5.88±1.5 ab
Flavonols (mg L^{-1})						
2016 Myricetin	4.57±1.6 a	3.94±1.5 a	5.11±1.4 a	4.69±1.2 a	4.16±1.8 a	3.61±1.2 a
2017 Myricetin	2.06±0.9 ab	0.37±0.1 c	3.0±1.0 a	1.23±0.5 bc	1.86±0.6 ab	0.93±0.2 bc
2016 Quercetin	3.52±1.2 b	1.21±0.4 c	5.94±1.7 a	2.9±0.9 bc	3.44±1.1 b	1.8±0.2 bc
2017 Quercetin	0.2±0.05 c	0.15±0.09 c	1.15±0.2 a	0.39±0.1 b	0.10±0.02 c	0.03±0.01 c
Stilbens (mg L^{-1})						
2016 Trans-resveratrol	1.18±0.5 a	1.48±0.8 a	1.37±0.9 a	1.55±0.5 a	1.01±0.2 a	1.32±0.3 a
2017 Trans-resveratrol	3.64±1.1 c	5.48±1.6 bc	6.23±1.3 b	9.29±2.1 a	2.99±0.2 c	4.96±0.8 bc

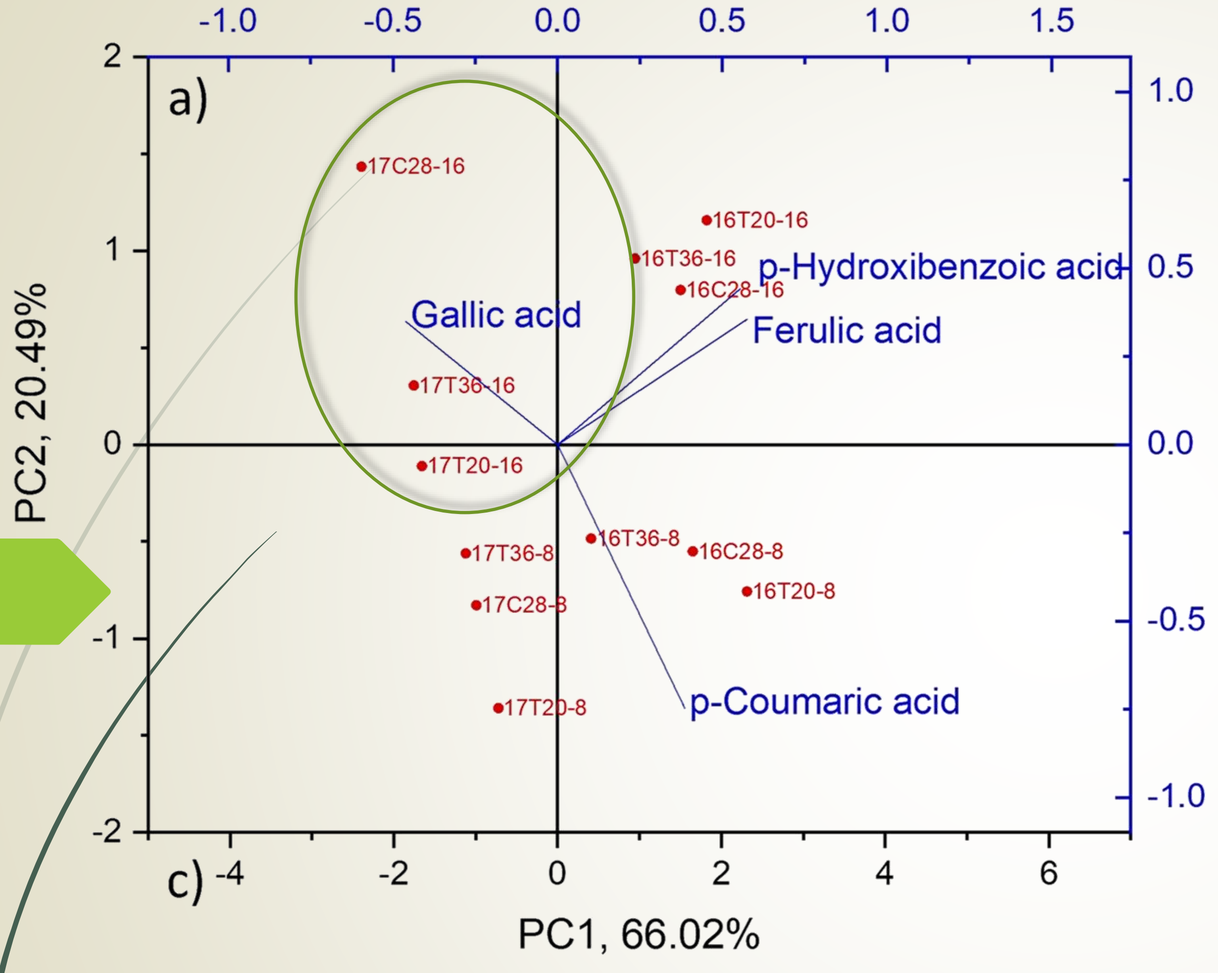
Phenolic acids (mg L^{-1})

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 Gallic acid	9.8±1.9 de	27.9±2.1 b	13.4±2.1 d	34.9±2.7a	7.8±1.2 c	22.2±2.1c
2017 Gallic acid	**33.1±2.9 d**	**49.8±4.1 b**	**36.3±3.2 d**	**57.4±4.2 a**	**30.9±2.9 d**	**43.3±3.2 c**
2016 p-Hydroxybenzoic acid	5.5±1.0 b	7.04±1.5 ab	6.29±1.8 ab	8.34±1.6 a	2.1±0.9 c	7.0±1.6 ab
2017 p-Hydroxybenzoic acid	0.4±0.1 bc	0.66±0.2 b	0.6±0.2 b	1.0±0.1 a	0.3±0.1 c	0.5±0.1 bc
2016 p-Coumaric acid	1.4±0.8 a	1.2±0.8 a	1.8±0.9 a	1.2±0.7 a	1.0±0.2 a	0.8±0.2 a
2017 p-Coumaric acid	1.2±0.3 ab	0.2±0.02 c	1.6±0.8 a	1.15±0.4 ab	1.0±0.0 ab	0.7±0.1 bc
2016 Ferulic acid	4.4±1.3 bc	6.3±1.6 ab	6.0±1.3 ab	7.5±1.5 a	2.8±1.1 c	4.1±1.2 bc
2017 Ferulic acid	0.03±0.01 d	0.09±0.01 ab	0.07±0.01 bc	0.10±0.02 a	0.03±0.0 d	0.06±0.02 c

From the phenolic acids class, as reported by other authors too, both on 'Fetească neagră and other varieties, gallic acid predominates, higher values being present in the less favourable 2017.

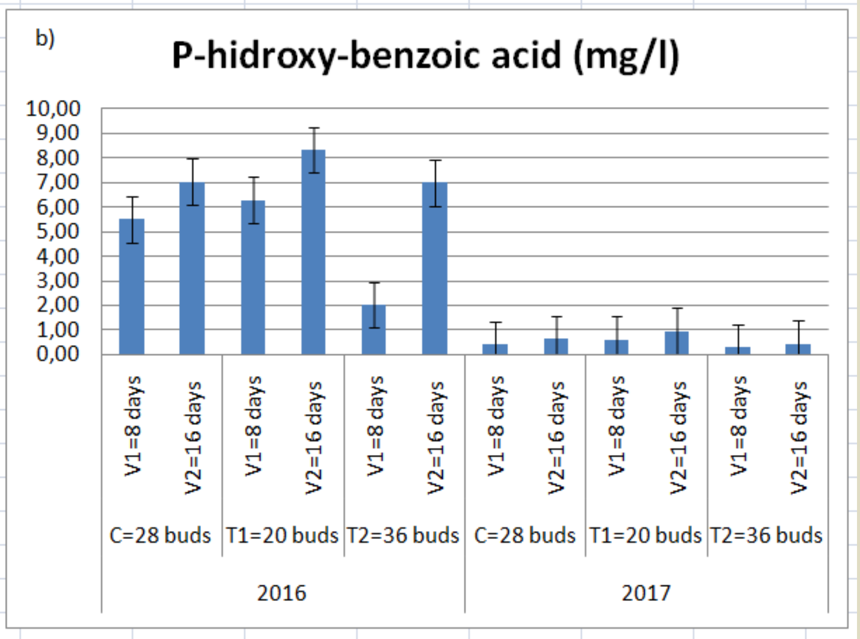






Gallic acid concentration increases with the time of maceration during winemaking (16 days), while the grape yield has less influence on this parameter.

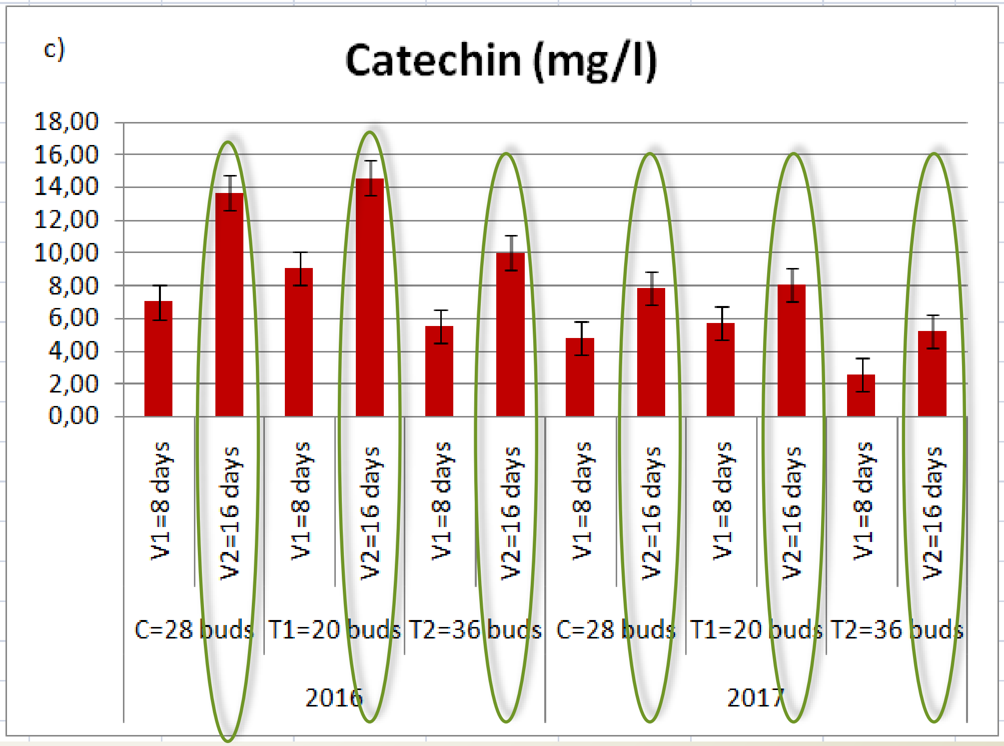
The other phenolic acids, p-hydroxybenzoic, p-coumaric and ferulic, tend to have an inverse accumulation with the gallic acid, their values being higher in 2016, a more favourable year for grape quality.

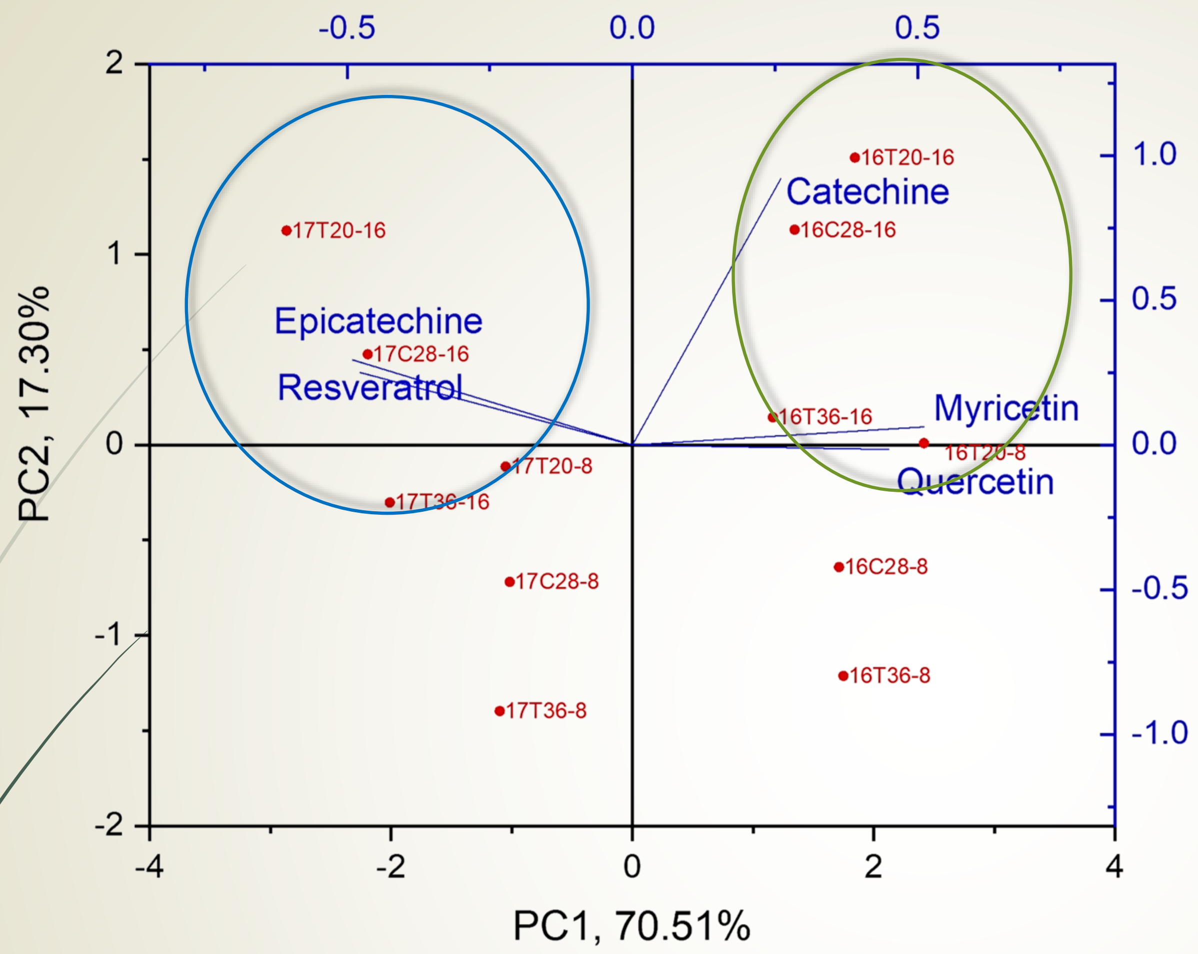


Flavanols (mg L^{-1})

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 Catechin	7.0±1.7 bc	**13.7±2.0 a**	9.1±2.1 b	**14.6±2.3 a**	5.5±1.8 c	**10.0±2.2 b**
2017 Catechin	4.8±1.5 cd	7.8±1.7 ab	5.8±1.4 abc	8.07±1.8 a	2.6±0.5 d	5.2±1.2 bc
2016 Epicatechin	2.0±0.8 ab	2.2±0.9 ab	2.7±1.5 ab	3.0±1.0 a	0.9±0.1 b	2.1±1.0 ab
2017 Epicatechin	4.2±1.2 b	6.4±1.1 ab	4.9±1.2 b	7.8±1.5	4.0±1.0 b	5.9±1.5 ab

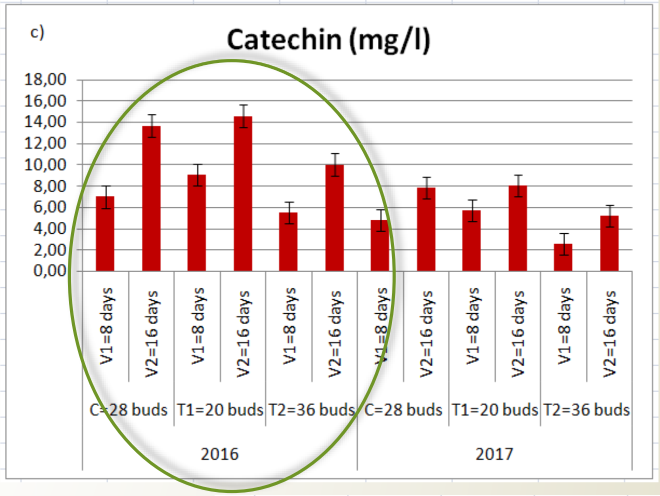
As regards the flavanols, their values also increased with the maceration time, especially in the case of catechin, for which the concentration almost doubled in eight days of additional maceration.

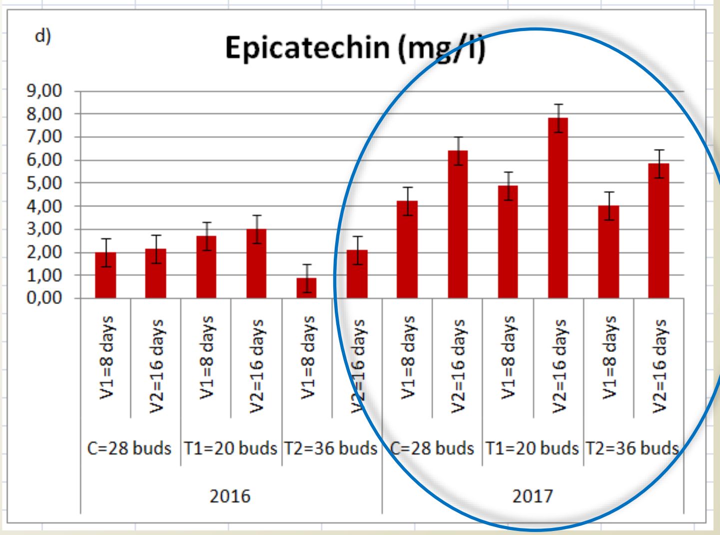




The catechin level was higher in favourable years (2016),

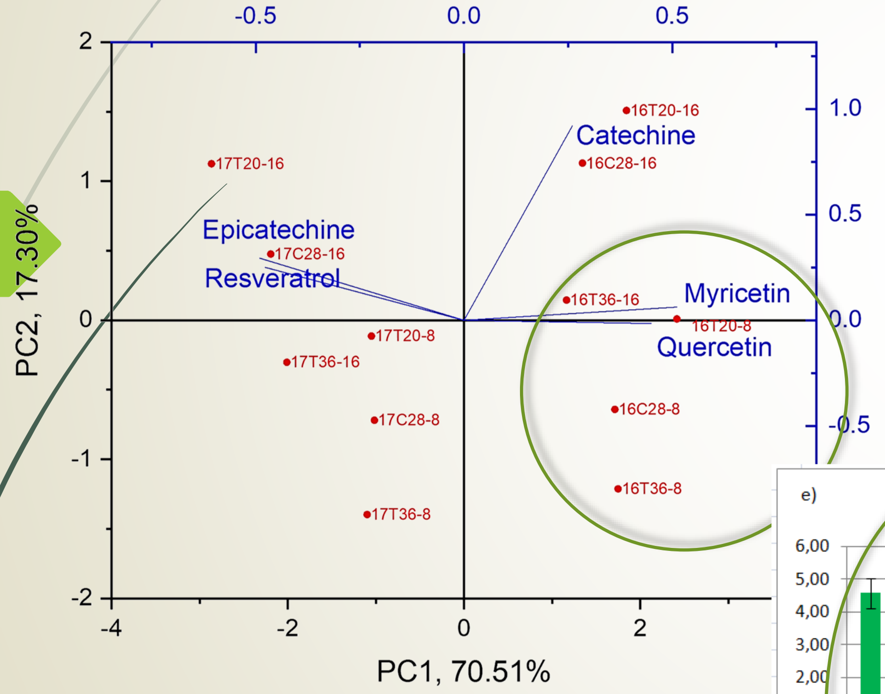
while epicatechin increased in less favourable years (2017).



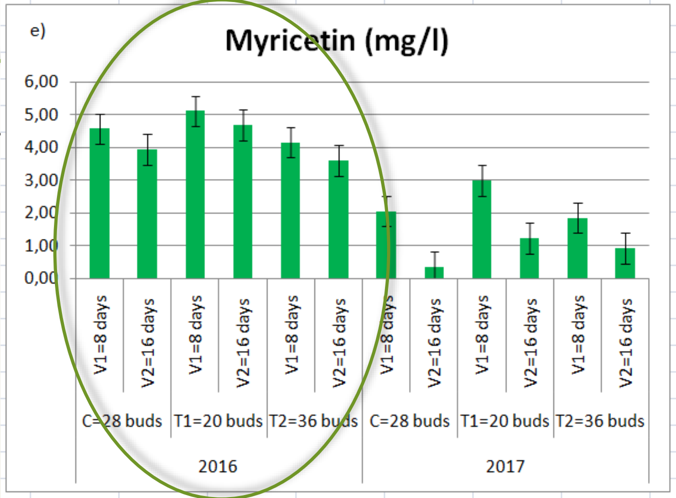


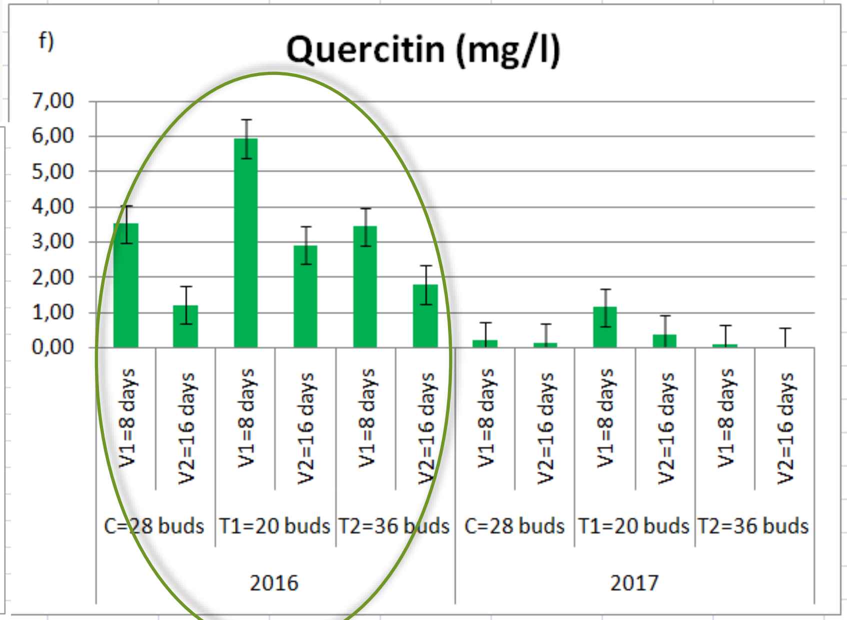
Flavonols (mg L^{-1})

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 Myricetin	**4.57±1.6 a**	**3.94±1.5 a**	**5.11±1.4 a**	**4.69±1.2 a**	**4.16±1.8 a**	**3.61±1.2 a**
2017 Myricetin	2.06±0.9 ab	0.37±0.1 c	3.0±1.0 a	1.23±0.5 bc	1.86±0.6 ab	0.93±0.2 bc
2016 Quercetin	**3.52±1.2 b**	**1.21±0.4 c**	**5.94±1.7 a**	**2.9±0.9 bc**	**3.44±1.1 b**	**1.8±0.2 bc**
2017 Quercetin	0.2±0.05 c	0.15±0.09 c	1.15±0.2 a	0.39±0.1 b	0.10±0.02 c	0.03±0.01 c



From the flavonol class myricetin and quercetin higher concentrations are also correlated with the favourable 2016 vintage.

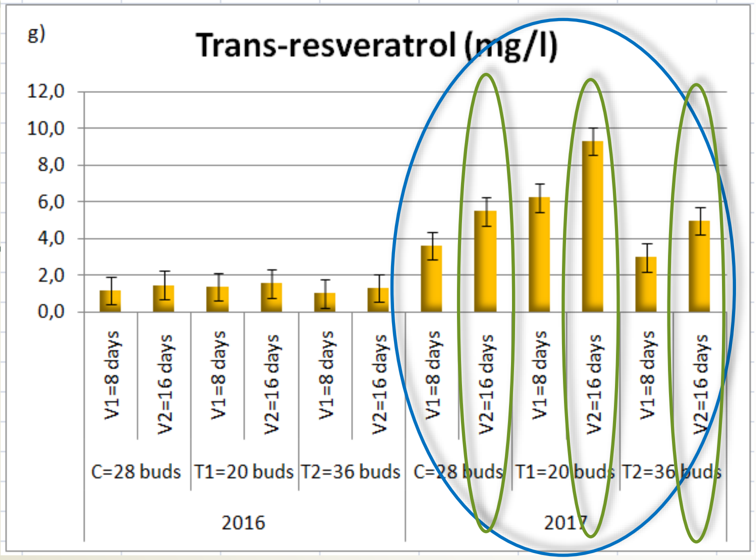




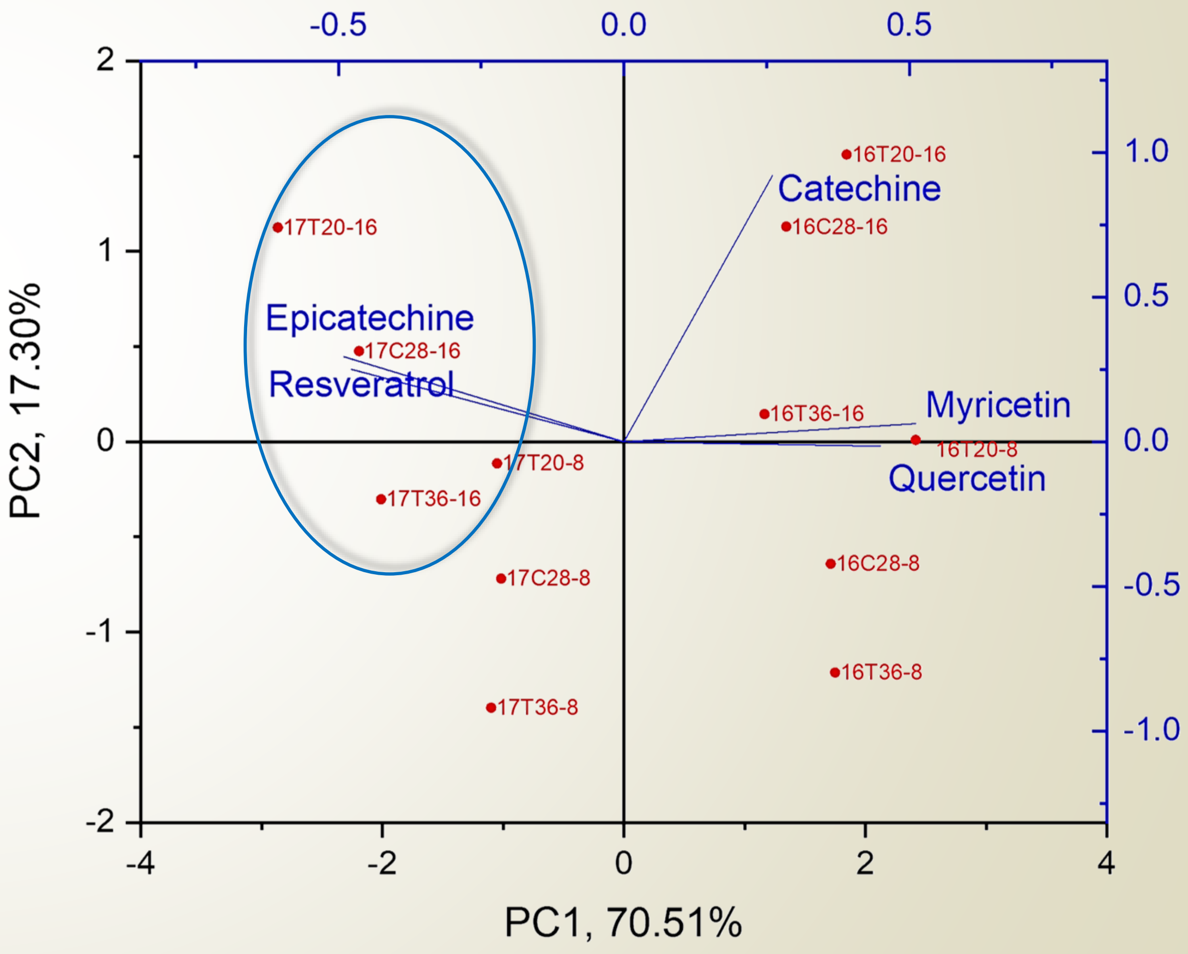
Stilbens (mg L^{-1})

Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 *Trans*-resveratrol	1.18±0.5 a	1.48±0.8 a	1.37±0.9 a	1.55±0.5 a	1.01±0.2 a	1.32±0.3 a
2017 *Trans*-resveratrol	**3.64±1.1 c**	**5.48±1,6 bc**	**6.23±1,3 b**	**9.29±2,1 a**	**2.99±0,2 c**	**4.96±0,8 bc**

Trans-resveratrol tends to accumulate more in the less favourable 2017.



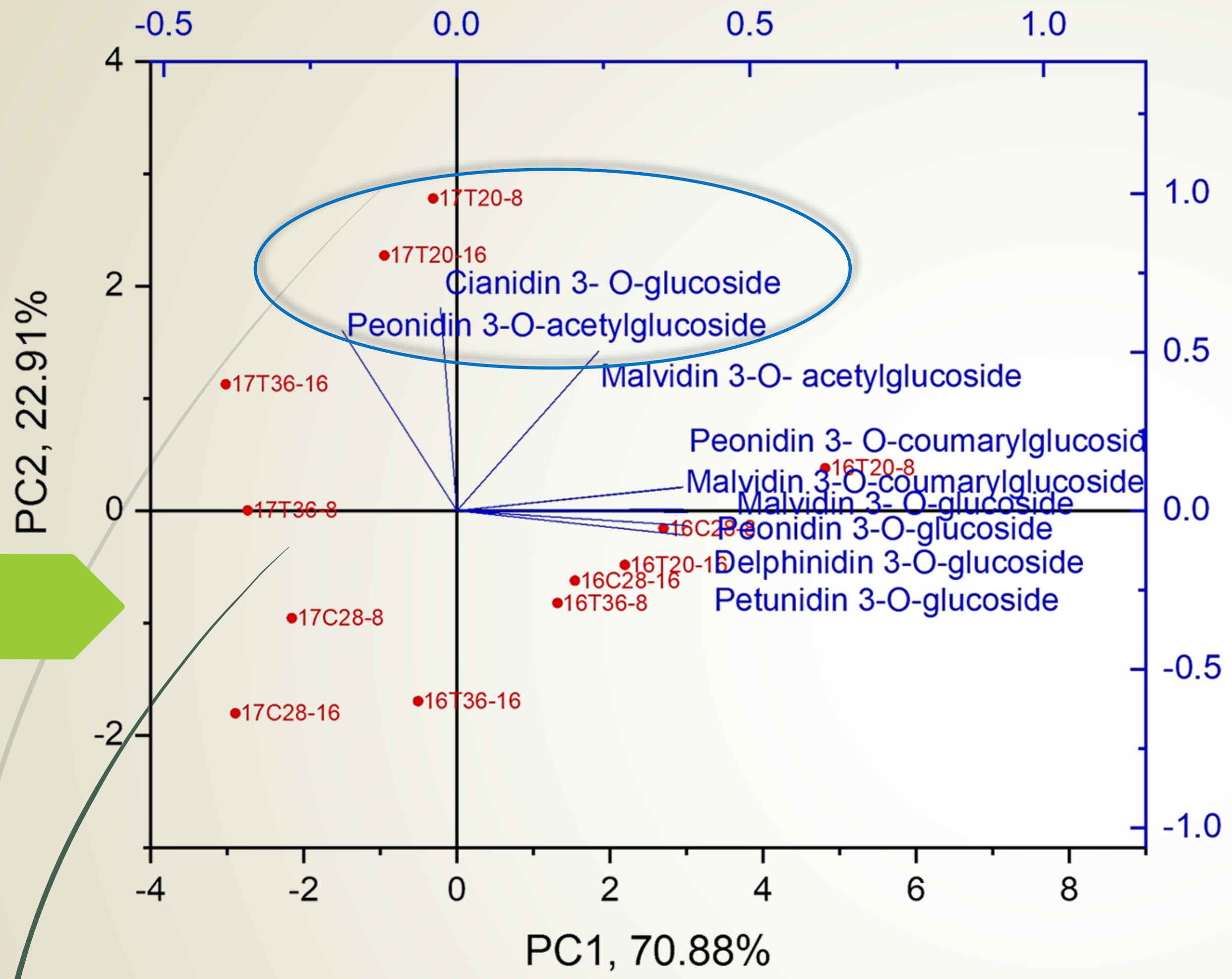
Its extraction was significantly increased by the longer maceration on skins whenever the specific phenol was present in sufficient quantities on the skins.



Anthocyans (mg L^{-1} malvidin)

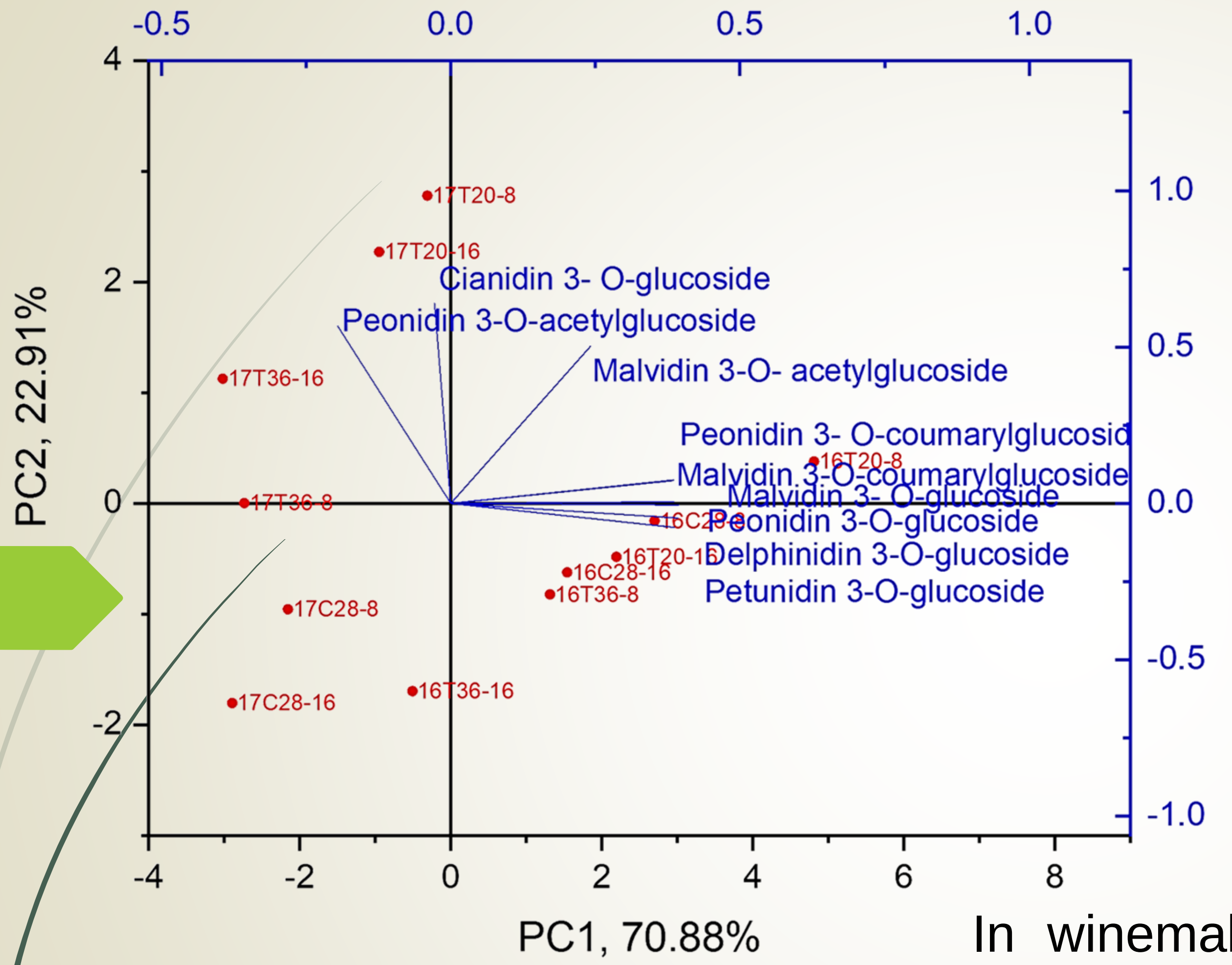
Compound	C=28 buds		T1=20 buds		T2=36 buds	
	V1=8 days maceration	V2=16 days maceration	V1=8 days maceration	V2=16 days maceration	V=8 days maceration	V2=16 days maceration
2016 Delphinidin 3-O-glc	**4.89±1.3 ab**	**3.57±1.0 b**	**7.1±1.9 a**	**4.55±1.3 b**	**4.09±1.1 b**	**2.53±0.9 b**
2017 Delphinidin 3-O-glc	0.85±0.1 b	0.35±0.02 b	2.43±0.8 a	1.93±0.3 a	0.38±0.1b	0.22±0.09 b
2016 Cyanidin 3-O-glc	0.4±0.1 ab	0.37±0.1 ab	0.52±0.1 a	0.42±0.1 ab	0.44±0.1 ab	0.32±0.1 b
2017 Cyanidin 3-O-glc	0.31±0.09 b	0.28±0.1 b	1.06±0.2 a	1.08±0.3 a	0.24±0.1 b	0.86±0.1 a
2016 Peonidin 3-O-glc	5.75±1.2 ab	4.85±1.2 b	7.89±1.8 a	5.71±1.3 ab	4.52±1.5 b	3.46±0.9 b
2017 Peonidin 3-O-glc	0.61±0.1 b	0.37±0.09 b	2.27±0.3 a	2.38±0.8 a	0.25±0.1 b	0.12±0.02 b
2016 Petunidin 3-O-glc	**8.82±1.7 b**	**6.85±1.7 bc**	**12.44±2.4 a**	**8.26±2.0 b**	**6.41±1.9 bc**	**4.57±1.1 c**
2017 Petunidin 3-O-glc	2.28±1.0 ab	0.74±0.1 c	3.17±1.1 a	2.09±0.3 ab	1.9±0.2 bc	1.43±0.1 bc
2016 Malvidin 3-O-gluc	***70.83±4.1 b***	***62.92±3.5 c***	***80.88±3.2 a***	***64.97±4.2 bc***	***70.37±3.9 b***	***40.89±3.5 d***
2017 Malvidin 3-O-glc	32.12±3.2 c	20.72±2.3 d	49.03±2.5 a	41.79±2.9 b	23.4±1.1 d	16.36±1.1 e
2016 Peonidin 3-O-acetylglucoside	0.29±0.1 a	0.26±0.1 a	0.28±0.1 a	0.26±0.1 a	0.27±0.1 a	0.27±0.1 a
2017 Peonidin 3-O-acetylglucoside	0.31±0.1 a	0.26±0.1 a	0.43±0.1 a	0.42±0.1 a	0.42±0.1 a	0.4±0.1 a
2016 Malvidin 3-O-acetylglucoside	**2.12±1.3 ab**	**1.92±0.4 ab**	**2.64±1.0 a**	**2.0±0.9 ab**	**1. 31±0.2 bc**	**0.44±0.1 c**
2017 Malvidin 3-O-acetylglucoside	1.11±0.3 bc	0.55±0.1c	2.7±1.1 a	2.02±0.9 ab	1.46±0.2 bc	1.4±0.3 bc
2016 Peonidin 3- O-coumaroylglucoside	**1.23±0.8 ab**	**0.99±0.1 ab**	**1.6±0.2 a**	**1.07±0.2 ab**	**1.2±0.1 ab**	**0.72±0.09 b**
2017 Peonidin 3- O-coumaroylglucoside	0.25±0.08 b	0.2±0.07 b	0.88±0.2 a	0.76±0.1 a	0.19±0.08 b	0.16±0.02 b
2016 Malvidin 3-O-coumaroylglucoside	**5.29±1.6 ab**	**3.99±1.1 bc**	**6.97±1.5 a**	**4.35±1.0 bc**	**2.55±0.9 c**	**2.55±0.7 c**
2017 Malvidin 3-O-coumaroylglucoside	1.29±0.4 b	0.49±0.09 b	2.68±0.8 a	2.56±0.9 a	1.19±0.1 b	1.11±0.1 b

Obviously, in the more favourable year, 2016, the anthocyanin accumulation was much higher, especially as regards the malvidin 3-O-glucoside, which is the most representative anthocyanin found in ‘Fetească neagră’. Malvidin 3-O-glucoside content is approximately double in 2016, as



This happened with all the other determined anthocyanins, with the exception of cyanidin-3-O-glucoside and peonidin 3-O-acetylglucoside, which had a slight increase in 2017 as compared to 2016, but their values are too small to influence the overall colour.

The other anthocyanins accumulated better in warmer years, so that the initial values of delphinidin, peonidin, petunidin were several times higher in the favourable vintage of 2016 than in 2017.



Anthocyanins is the class of polyphenols which is the most influenced by the grape yield, the variant with the reduced yield (20 bud/vine) having the highest anthocyanin concentration.

In winemaking, the longer maceration period, 16 days, decreased the content of malvidin derivatives by an average of 25.5%. The other free anthocyanins decreased as well during maceration, due to polymerisation or condensation with other polyphenols.

CONCLUSION

The phenolic quality of the organic wines of this variety depended highly on the vintage, but it was observed that in the less favourable years, yield reduction and/or the extension of skin maceration duration was beneficial.

Simultaneous application of yield reduction and longer maceration on skins led to the best results, irrespective of the vintage.

Especially in the less favourable years, interventions in the vineyard and in winemaking process are necessary to optimize the content of quality-related compounds.

REFERENCES

Victoria Artem, Arina Oana Antoce, Elisabeta Irina Geana, Aurora Ranca, 2021, Effect of grape yield and maceration time on phenolic composition of “Feteasca neagra” organic wine, Notulae Botanicae Horti Agrobotanici Cluj Napoca, Volume 49, Issue 2, DOI: 10.15835/nbha49212345

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Effect of grape yield and maceration time on phenolic composition of ‘Fetească neagră’ organic wine

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