Scientific Papers. Series B, Horticulture. Vol. LXII, 2018
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

VOLATILE PROFILE OF FETEASCĂ NEAGRĂ WINES OBTAINED IN MURFTALAR REGION AND THE INFLUENCE OF THE ORGANIC AND CLUSTER THINNING VITICULTURAL PRACTICES

Victoria ARTEM[1], Arina Oana ANTOCE[2]

[1]Research Station for Viticulture and Oenology Murfatlar, 2 Calea București, 905100, Murfatlar, Constanta
[2]University of Agronomic Sciences and Veterinary Medicine of Bucharest, Faculty of Horticulture, 59 Mărăşti Blvd, District 1, 011464, Bucharest, Romania

Corresponding author email: aantoce@yahoo.com

Abstract

'Feteasca neagră' is a versatile grape variety, with results highly dependent on the cultivation region and viticultural practices. In Murfatlar this variety is cultivated both organically and conventionally, thus providing a good opportunity to study the behaviour of the variety in the two cultivation systems. Furthermore, in both culture systems, in some experimental variants 30% of the grapes from each vine were removed after the cluster formation - a practice often employed with an aim to obtaining a better-quality crop. The grapes harvested in autumn at technological maturity were vinified in 4 variants, in accordance to the viticultural practices applied: organic and conventional cultivation, with or without cluster thinning. In this work the influences of these viticultural practices on the volatile profile of the obtained wines were evaluated by using a flash GC-electronic nose. Although some differences are present when 30% cluster thinning is applied, the main influence in the volatile profile of wines is still induced by the cultivation system, irrespective of the grape reduction practice. The variability among the volatile profiles of the 4 groups of wines is explained in proportion of 85.3% by the cultivation system and only 12.4% by the grape reduction practice. The wines made from conventionally grown grapes display a more complex volatile profile as compared to the wines obtained from organic grapes.

***Key words**: 'Feteascǎ neagrǎ', electronic nose, volatile profile, organic viticulture, cluster thinning.*

INTRODUCTION

'Feteascǎ neagrǎ' is a versatile grape variety, with results highly dependent on the cultivation region and viticultural practices. Considering the increasing consumption of organic wine and the constant demand for quality wines, it is logical that practices such as organic cultivation or the reduction of yield by cluster thinning practice should be taken into account. Due to the particularities of the Murfatlar region, 'Feteascǎ neagrǎ' finds here conditions to be cultivated not only by the conventional technology, but also organically. In previous studies (Ranca et al., 2010), 'Feteascǎ neagrǎ' of Murfatlar showed that it is suitable for organic cultivation, several good results being already reported (Artem et al, 2014a).

Also, to improve the concentration of the anthocyanins accumulated in the grapes, a special practice, used by other authors too (Bubola et al., 2011), was applied in the Murfatlar vineyards, consisting of the reduction of the clusters on each vine by 30%. While some improvement in polyphenolic quality was obtained by this cluster thinning (Artem et al., 2015), the organic cultivation also showed some increase in phenolic compounds important for health (Artem et al., 2014b) and wine ageing.

However, both practices are costly and should be applied only when the wines can be perceived by the consumers as being different. For this reason, comparing the volatile profiles with an electronic nose based on flash chromatography is an easy way of determining if the wines resulted from grapes produced with different viticulture technologies can be clearly discriminated.

Even though the taste of wine is not evaluated in this work, the volatile profiles determined can explain some of the effects induced by the viticulture technologies and could also be a basis for further analysis.

MATERIALS AND METHODS

In Murfatlar, ‘Fetească neagră’ variety is cultivated both organically and conventionally, thus providing a good opportunity to study the behaviour of the variety in the two cultivation systems. The technologies for the cultivation in both systems are those usually applied in the region and they were detailed elsewhere (Artem, 2017).

In order to assess if a better quality of grapes can be obtained by reducing the yield, in both culture systems, variants with 30% of the grape reduction were also produced. The grape thinning was performed on each vine, 30% of the clusters being removed after the cluster formation.

The grapes harvested in autumn at technological maturity were vinified in 4 variants, in accordance to the viticultural practices applied: organic and conventional cultivation, with or without cluster thinning.

The grapes obtained from conventional and organic growth system, both from vines in which grape thinning was practiced or not, were prepared in triplicate.

The resulted wines are coded as described in Table 1:

Table 1. ‘Fetească neagră’ wine samples

Wine code	Organic cultivation	Conventional cultivation	Grape thinning	Group Colour
FN_Eco_B1_M FN_Eco_B2_M FN_Eco_B3_M	x			light blue
FN_Eco_B1_R FN_Eco_B2_R FN_Eco_B3_R	x		x	dark blue
FN_Con_B1_M FN_Con_B2_M FN_Con_B3_M		x		light brown
FN_Con_B1_R FN_Con_B2_R FN_Con_B3_R		x	x	dark brown

The influences of these viticultural practices on the volatile profile of the obtained wines were evaluated by using a flash GC-electronic nose (Heracles I, Alpha-MOS, France) equipped with two short chromatographic columns of different polarities (1A: DB5 and 2A: DB1701). The equipment, software and the method applied are described in detail in previous papers (Antoce and Namolosanu, 2011; Antoce 2012a, b; Antoce, 2013; Antoce et al., 2015; Antoce and Cojocaru, 2017).

For the electronic nose analysis, 4 ml samples from each wine bottle were taken in 3 vials of 10 ml volume. Thus, each group of wines consisted in 9 analyzed samples.

RESULTS AND DISCUSSIONS

In order to separate the groups of wines based on some of the chromatographic peaks recorded by the electronic nose, from among all the peaks observed only some were selected, namely those with a discrimination power above 0.5 (more exactly from 0.835 down to 0.497). Also used were those peaks with lower overall discrimination power but automatically selected by the software of the apparatus as being of importance.

As a result, the four groups of wines were separated by the electronic nose based on the multivariate statistical analysis of the discriminant factors (Figure 1).

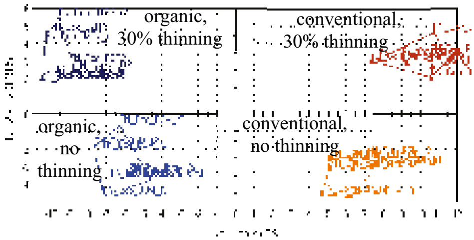

Figure 1. Discriminant Factor Analysis (DFA) diagram of the ‘Fetească neagră’ wine groups obtained from grapes with different cultivation technologies (light blue = organic cultivation; dark blue = organic cultivation and grape thinning, light brown = conventional cultivation; dark brown = conventional cultivation and grape thinning)

In Figure 1 it can be seen that the groups of wines were separated mostly on the basis of DF1 axis (responsible for 85.26% of the variability observed), which represents the cultivation system (organic towards the left side of the diagram and conventional - towards the right side of the diagram). The grape thinning accounted only for 12.38% of the total variability, but still, it can be said that this viticultural practice did have a specific influence on the resulted wines.

More specifically, the separation of the groups of wines from organic and conventional grapes, respectively, was determined by certain volatile compounds. In Figure 2, the vectors corresponding to the selected discriminant chromatographic peaks are also included in the diagram and, as it can be seen, the loadings of most of these vectors on the horizontal axis tend to be higher for the wines from conventional grapes. This also suggests an increased aromatic complexity of those wine samples

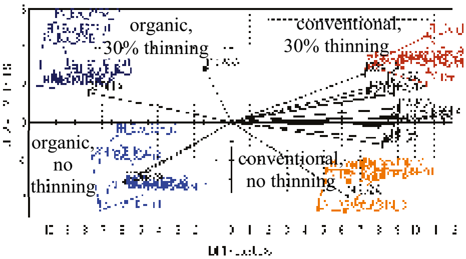

Figure 2. Discriminant Factor Analysis Diagram of the 'Fetească neagră' wine groups with the discriminant peaks (light blue = organic cultivation; dark blue = organic cultivation and grape thinning, light brown = conventional cultivation; dark brown = conventional cultivation and grape thinning)

With the use of the Arochembase software of the electronic-nose, some of the compounds corresponding to important discriminant peaks were identified.

Table 2 contains the volatile compounds identified for the peaks found to be discriminating for the wines obtained with grapes from the conventional culture with or without grape thinning.

As it can be seen, the specific discriminant volatile profile of the wines obtained from conventional grapes is quite complex, with several compounds conferring fruity aroma, with some green and floral notes too.

Although very close to the 'Fetească neagră' conventional group with 30% grape thinning, the group of wines from conventional grapes without yield reduction had fewer discriminant volatile compounds. With a 0.772 discrimination power the peak 14.32-2A (on DC1701 column) is the only one strongly correlated to conventional 'Fetească neagră' without grape reduction. The peak is close to 4-methoxy-2-methyl-2-butanethiol, which is a compound with aroma of black currant, one of the most specific flavours for this grape variety.

Table 2. Volatile compounds found to be discriminant for the wines obtained with 'Fetească neagră' grapes conventionally cultivated

Column	Peak (retention time)	Discri-mination Power	Compound identified	Type of aroma*
1A (DB5)	8.49	0.557	acetic acid	acid, fruit, pungent, sour, vinegar
1A (DB5)	8.99	0.556	not identified	
1A (DB5)	10.71	0.497	ethyl butyrate	apple, butter, cheese, pineapple, strawberry
1A (DB5)	11.90	0.612	2-methyl ethyl butyrate	apple, fruit, pineapple
1A (DB5)	15.94	0.633	3-hexen-1-ol	green
1A (DB5)	16.50	0.529	amino-benzaldehyde	-
1A (DB5)	18.69	0.835	3-hexenyl acetate	banana, candy, floral, green
1A (DB5)	19.49	0.667	ethyl hexanoate	apple peel, brandy, overripe fruit, pineapple
1A (DB5)	21.67	0.578	not identified	
1A (DB5)	23.91	0.518	2-isopropyl-3-methoxypyrazine	green pepper; bell pepper
2A (DB1701)	12.14	0.663	close to trans-3-hexen-1-ol	
2A (DB1701)	20.22	0.562	3-hexenyl acetate	banana, candy, floral, green
2A (DB1701)	22.44	0.758	2-phenyl-ethanol	fruit, honey, lilac, rose, wine

*The flavour profiles of the identified substances, included in the table to generally describe the possible expected aroma, are taken from Pubchem Open Chemistry database (https://pubchem.ncbi.nlm.nih.gov).

The volatile compounds mostly correlated to wines from organic culture are included in Table 3.

Table 3. Volatile compounds found to be discriminant for the wines obtained with 'Fetească neagră' grapes organically cultivated

Column	Peak (retention time)	Discrimi-nation Power	Compound identified	Type of aroma*
1A (DB5)	10.37	butyl acetate	0.559	apple, banana, glue, pungent
1A (DB5)	32.74	ethyl decanoate	0.086	brandy, grape, pear
2A (DB1701)	11.32	trans-3-hexen-1-ol	0.271	green
2A (DB1701)	13.87	ethyl-2-methyl-butyrate	0.559	apple, ester, green apple, kiwi, strawberry

Basically, the influence of the grape thinning on the wines form organic grapes are not very much discriminated. However, with a 0.521 discrimination power the peak 32.74-1A (on column BD5) is strongly correlated to FN organic without grape thinning. The peak is close to ethyl-decanoate, which mostly confer general, non-specific wine/grape aroma.

Overall, the discriminant peaks can differentiate the groups of wine by statistical analysis, but the fingerprint of the wines, consisting of the peaks with their height or area, are not very different. Figure 3 shows that the fingerprints of the wines are quite similar, and especially the wines from grapes where cluster thinning was performed are not easily differentiated from those produced without thinning. However, the samples from organic grapes (blue colour on the diagram) have clear different fingerprints from those from conventionally cultivated grapes (brown colour on the diagram), irrespective of the application of cluster thinning. To verify if the cluster thinning practice caused a significant influence on the volatile profile of the final wines, the distances between the groups of wines were calculated in odor units. Figure 4 shows that the groups from grapes organically cultivated (blue) are relatively separated from those from grapes conventionally cultivated (brown), but inside each type of technology, the odor distances between samples from grapes with and without cluster thinning is not significant (groups of light and dark wine samples of the same colour overlap).

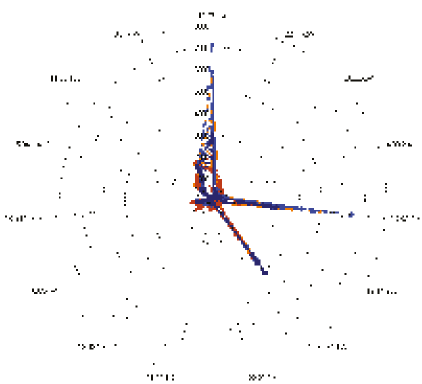

Figure 3. 'Fetească neagră' wines fingerprints based on the height of the discriminant chromatographic peaks (blue = samples from grapes organically cultivated, brown = samples grapes conventionally cultivated)

Thus, it may be safely said that the cluster thinning techniques applied in the vineyards for 'Fetească neagră' do not sufficiently affect the volatile profile of the final wines, so that the consumer will most likely not be able to perceive a clear difference in the aroma.

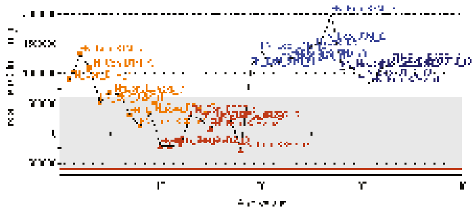

Figure 4. Odor distances of 'Fetească neagră' wines groups produced with grapes from different viticultural technologies (blue = wines from grapes organically cultivated, brown = wines grapes conventionally cultivated)

Aside of the chemical composition of the grapes, the winemaking and the post-fermentative evolution are also influencing the final wine profile. For example, the discrimination of the wine groups was initially performed based on all the peaks with a discrimination power over 0.500. However, by sensory and chemical analysis some samples, but not all, were found to have slightly higher volatile acidity. To eliminate this bias from the discrimination analysis, the statistical DFA analysis was repeated without the peaks related to acetic acid (volatile acidity found at retention times 8.49 and 8.99).

Figure 5 (a and b), obtained based on all peaks with a discrimination power over 0.500, except those for volatile acidity, shows that the groups of wines are separated even better than earlier, still most of the variability being explained by the culture system (DF1 = 82.22%), while the grape thinning accounted for 15.9% (DF2) of the total variability. This slight increase in DF2 (from 12.38% to 15.9%) means that without the volatile acidity which developed only in some of the samples after winemaking, the differences between samples with or without cluster thinning should be a bit more evident. However, the discriminant peaks (Figure 5. b) are not modified, the compounds and their importance in discrimination remaining the same as described in the tables above.

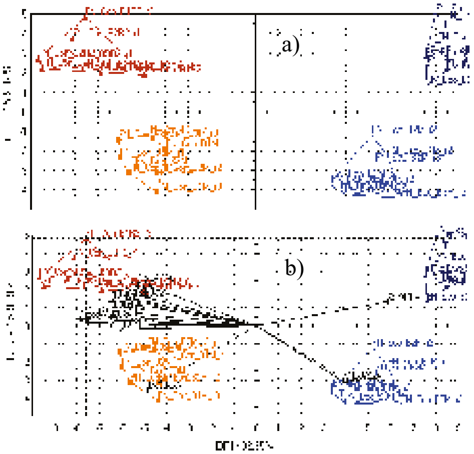

Figure 5. Discriminant Factor Analysis Diagram of the 'Fetească neagră' wine groups after the elimination of bias induced by volatile acidity

CONCLUSIONS

This work shows that the flash GC-electronic nose can distinguish wines produced from grapes obtained by different viticultural practices, simply on the basis of their volatile profile. Although some differences are present when 30% cluster thinning is applied, the main influence in the volatile profile of wines is still induced by the cultivation system, irrespective of the grape reduction practice. The variability among the volatile profiles of the 4 groups of wines is explained in proportion of 85.3% by the cultivation system and only 12.4% by the grape reduction practice (these figures change, but only slightly, when the peaks corresponding to volatile acidity are excluded from analysis). For the particular case of 'Fetească neagră' produced in Murfatlar region, the wines made from conventionally grown grapes display a more complex volatile profile as compared to the wines obtained from organic grapes.

REFERENCES

Antoce O.A., Cojocaru G.A., 2017. Detection with flash gas chromatography electronic nose of the general influences of glutathione, ascorbic acid, tannin and carbon dioxide treatments on the volatile profiles of white wines of Fetească regală, BIO Web of Conferences 9, 02003 (2017), 40th World Congress of Vine and Wine, DOI: 10.1051/bioconf/20170902003, 1-6.

Antoce O.A., Stroe M.V, Cojocaru G.A., 2015. Tentative application of an electronic nose to the study of the parentage of Romanian grape varieties Sarba and Alb Aromat, Agriculture and Agricultural Science Procedia, Elsevier 6, 110-117.

Antoce O.A., 2013. Application of an electronic nose based on gas-chromatography to the differentiation of groups of wines, 36th World Congress of vine and wine, Vine and Wine between Tradition and Modernity, Bucharest - Romania, 2-7 June 2013, Proceedings of the 36th World Congress of vine and wine, ISBN: 979-10-91799-16-4, Section 2 Enology, 12 pag, 2013-082_Arina-E-nose OIV 2013-final.pdf.

Antoce O.A., 2012a. Results obtained by applying modern winemaking technologies on the Cramposie variety cultivated in a new terroir, AgroLife Sci. J., Vol. I, 89-92.

Antoce O.A., 2012b. Study of the possibility of discrimination by the electronic nose of Fetească regală wines produced with neutral and aromatic yeasts, Scientific papers, Series B. Horticulture, Volume LVI, Section Miscellaneous, 419-426.

Antoce O.A., Namolosanu C.I., 2011. Rapid and precise discrimination of wines by means of an electronic nose based on gas-chromatography, Revista de Chimie 62 (6), 593-595.

Artem V., 2017. The influence of cultivation techniques of red wine grapes and of their processing on wine quality and on their phenolic potential, Ph.D. thesis, USAMV Bucharest, Chapter 4.1.3.

Artem V., Antoce O.A., Namolosanu I., Ranca A., Petrescu A., 2015. The effect of green harvest on the quality of organic grapes cultivated in Murfatlar viticultural centre, Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture,Vol. 72, No. 2, 299-304.

Artem V., Antoce O.A., Nămoloşanu I., Ranca A., Petrescu A., 2014a. Evaluation of quality of organically grown grapes in the viticultural center of Murfatlar. Scientific Papers. Series B, Horticulture, Bucharest, Vol. LVIII, 113-118.

Artem V., Geană I., Antoce O.A., 2014b. Study of phenolic compounds in red grapes and wines from Murfatlar wine center, Ovidius University Annals of Chemistry, Vol. 25, Nr. 1, 47-52.

Bubola M., Persuric D., Ganic K.K., 2011. Impact of cluster thinning on productive characteristics and wine phenolic composition of cv. Merlot, Journal of Food, Agriculture & Environment, 9 (1), 36-39.

Ranca A., Negraru A., Artem V., Bolos P., 2010. 'Fetească neagră' 9Mf, a new grapevine clone of quality and productivity, Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca. Horticulture Vol. 67, No. 1, 497.

EX·TERRA·AVRVM