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IDENTIFICATION OF THE MOST VALUABLE GRAPEVINE VARIETIES OF WHITE WINE FOR HUŞI VINEYARD BY ANALYTICAL HIERARCHICAL PROCESS

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Key words: *Vitis, AHP, pairwise comparisons, ranking, Region II, durable viticulture*

INTRODUCTION

Huşi vineyard is situated in the Moldavian Hills Viticultural Region (Region II),in a hilly area with heights ranging from 22 to 300 m, in the south-eastern part of the Central Moldavian Plateau, betwixt the Crasna and the Prut valleys. The Husi vineyard extends over the territory of 3 counties: Iaşi (Bohotin viticultural centre), Vaslui (Huşi, Vaslui, Avereşti, Vutcani and Murgeni viticultural centres), and Neamț (Bozieni viticultural centre). The Moldavian Hills is the biggest viticultural region from the country with 69154 ha of cultivated area, from which Huşi vineyard has an area of about 3000 ha (Order no. 1205/2018, https://www.agro.basf.ro/ro/concurs-vinuri/podgorii-alese/podgorii/,https://www.agro.basf.ro/ro/stiri/basf-in-camp/ghidul-principalelor-regiuni-viticole-si-podgorii-din-romania.html).The first attestations of vineyards' antiquity date from the 15th century (Fig. 1) (Neniu, 2022).

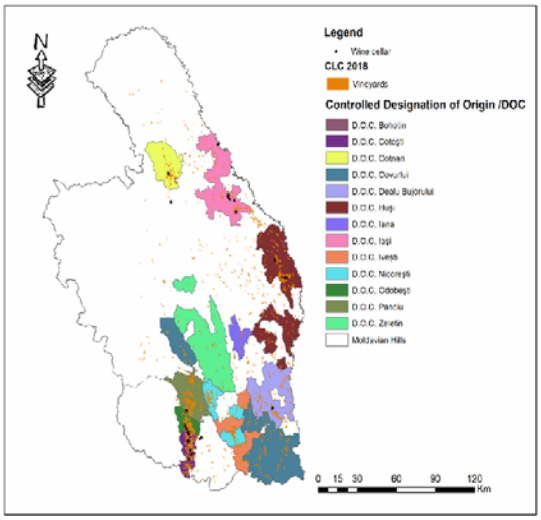

Fig. 1. Vineyards and areas occupied by vines in the Moldavian Region (after Neniu, 2022)

According to the EU zoning, Moldavian Hills Region is in the C I wine-growing zone (Fig. 2) (Bucur, 2011; Antoce et al., 2013).

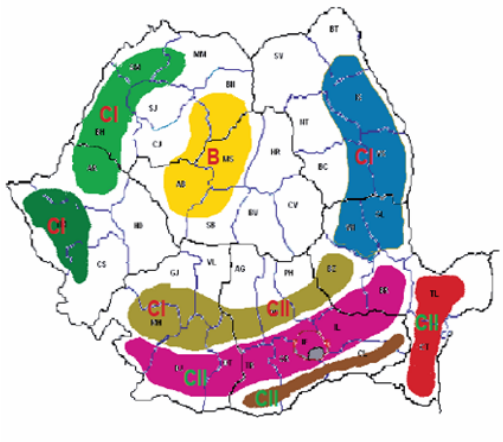

Fig. 2. Romanian viticultural regions according to European Union zoning (after Antoce et al., 2013)

The climate is temperate-continental, with moderately continental characters on the big hills and extremely continental at the Husi Depression level. Annual precipitation varies between 550 and 650 mm.(https://www.agro.basf.ro/ro/stiri/basf-in-camp/ghidul-principalelor-regiuni-viticole-si-podgorii-din-romania.html).

The vegetation period is 212 days, the useful thermal balance is 3300°C and the sum of the insolation hours is up to 1708 hours.

Throughout the durationof the vegetation period the precipitations fall in quite small quantities, 300-350 mm only, and in winter minimum temperatures of -29°C occur frequently (Stroe, 2012).

The average annual temperature for the Huşi area is 9.5°, the value equal to the country's average. The highest temperature for Huşi city was recorded on July 3rd, 1938, being of 40.2°C, and the lowest, on February 1st, 1937, being -29.1°C (https://www.onvpv.ro/sites/default/files/pdfs/caiet_de_sarcini_doc_husi_314ro.pdf). Late grapevine

varieties don't have the necessary conditions for grape ripening in Huşi vineyard (Bucur, 2011).

The hydrography of the area is represented firstly by Bârlad and Prut rivers, with their streams with seasonally variable and even episodic flows(https://www.onvpv.ro/sites/default/files/pdfs/caiet_de_sarcini_doc_husi_314ro.pdf).

In this area, the following types of soils are found: limestone chernozems, chernozems, cambic chernozems, gray chernozems, vertic chernozems, argic chernozems, luvosols, leached chernozems, alluvisols, typical luvosols, geoserodic regosols (Toti et al., 2017, https://www.agro.basf.ro/ro/stiri/basf-in-camp/ghidul-principalelor-regiuni-viticole-si-podgorii-din-romania.html). Leached chernozems and gray soils are the most widespread in the Husi Depression and, also, they are the most valuable for grapevine plantations, their sandy-loamy texture which improves physical properties through their basic bio-chemical characteristics: intense biological activity, high humus content, increased cationic exchange capacity, slightly acidic neutral reaction, high degree of saturation in bases and nutritional elements (https://www.onvpv.ro/sites/default/files/pdfs/caiet_de_sarcini_doc_husi_314ro.pdf).

In Huşi vineyard the ecopedoclimatic conditions allow the successful cultivation of a large number of grapevine varieties both for table and wine grapes (Stoe, 2012). The traditional established wineproduction directions of Huşi are quality white winesand white table wines (Irimia et al., 2013).

The Husi vineyard offers favourable conditions for the cultivation of varieties for white wine, being of primordial importance Aligoté, Zghihară de Huşi and Fetească regală varieties, for the obtaining of table white wines. In this vineyard the famous varieties for quality wines are: Riesling italian, Fetească albă, Tămâioasă românească, Muscat Ottonel and Busuioacă de Bohotin varieties. Varieties of red wines are cultivated in fairly small areas (Cabernet Sauvignon, Fetească neagră, Pinot noir, Oporto, Băbească neagră, Merlot) (Stroe, 2012).

The purpose of this study is the assess and rankthe grapevine varieties of white wine important for Huşi vineyard with the help of the analytical hierarchical process (AHP). The choice of the studied varieties took into account the traditions of the wine-growing area.

MATERIALS AND METHODS

In the present AHP exercise seven grapevine cultivars (*Vitis vinifera* L.), for white wine were used: Aligoté, Băbească gri, Donaris, Ozana, Pinot gris, Riesling italian, Fetească regală.

AHP is one of the most widely used multi-criteria decision-making methods that was first developed by Saaty (1977, 2008). Through AHP, a decision problem is unfolded into a hierarchy subproblem (criteria) that will be analysed independently. Thus, AHP is a measurement theory by compares pairs and relyon objective expert opinion to derive priority scales. AHP allows for a bit inconsistency in judgment because humans are not always consequent.

With the purpose to identify the most valuble grapevine genotypes for Huşi vineyard, 14 criteria (with a generality high degree)with a scale of 7 levels each were used, as follows: criterion 1 - harvesting period (from 1: the shortest harvesting period to 7: the longest harvesting period); criterion 2 - portfolio of derived products (from 1: the smallest number of derived products to 7: the highest number of derived products); criterion 3 - harvested quantity by one worker in 8 hours (from 1: the lowest quantity to 7: the highest quantity); criterion 4 - harvesting cost (from 1: the lowest cost to 7: the highest cost); criterion 5 - knowledge for recognition (from 1: most recognizable product to 7: hardest recognizable product); criterion 6 - knowledge for harvesting (from 1: the less knowledge necessary to 7: most knowledge necessary); criterion 7 - tools needed for harvesting (from 1: the least to 7: the more); criterion 8 - complexity of harvesting process (from 1: lowest to 7: highest); criterion 9 - distribution range (from 1: lowest to 7: highest); criterion 10 - market potential (from 1: low to 7: high); criterion 11 - perishability (from 1: lowest to 7: highest); criterion 12 - "celebrity" of the product on the market (from 1: the least known to 7: the most popular); criterion 13 - biotic threats (from 1: the fewest threats to 7: the most threats); criterion 14 - abiotic threats (from 1: the fewest threats to 7: the most threats); The results were attained using the Expert Choice Desktop software (v. 11.5.1683).

These criteria have been utilized previously in silviculture (Blaga et al., 2019; Bragă and Dincă, 2019; Ciontu et al., 2018; 2019; Pleşca et al., 2019; Tudor and Dincă, 2019; Vechiu and Dincă, 2019; Enescu and Dincă, 2020) and in the viticulture research fields (Buciumeanu et al., 2020a,b; 2021,2022; Vizitiu et al. 2021, 2022). Similarly, an AHP exercise for grapevine genotypes of red and rosé wine for Huşi vineyard has been done before (Vizitiu et al., 2020).

Also, given the climatic changes influences observedin the last years in viticulture and silviculture, and the request to find solutions and recommendations (Dincă et al., 2018a,b; Vizitiu et al., 2018, 2019), AHP could be very useful in selecting and ranking the plant genotypes from diverse areas under these conditions.

The analysis was carried out with the help of the Expert Choice Desktop software (v. 11.5.1683).

RESULTS AND DISCUSSIONS

All studied grapevine genotypes are zoned for Huşi vineyard, according to Order no. 225/2006

regarding the approval of the noble varieties zoning for fruitful grapevines allowed for cultivation in the wine-growing areas in Romania.

The analytical hierarchical process alternative ranking (the average of the qualifiers given for each criterion), resulted from experts'judgment, is presented in Table 1.

Table 1. AHP alternative ranking

Criterion	Grapevine varieties						
	Aligoté	Băbească gri	Donaris	Ozana	Pinot gris	Riesling italian	Fetească regală
1	6	7	1	2	4	5	3
2	3	6	5	7	1	2	4
3	4	6	7	3	1	2	5
4	3	5	7	6	4	1	2
5	7	6	1	2	5	3	4
6	5	4	6	7	1	3	2
7	2	3	5	6	7	1	4
8	5	3	6	7	1	4	2
9	5	4	6	7	1	3	2
10	7	5	1	2	3	4	6
11	6	3	1	5	7	2	4
12	5	3	4	7	1	6	2
13	1	6	2	7	3	4	5
14	2	1	3	4	5	6	7

According to the AHP results, the first three grapevine varieties with the highest potential for Huşi vineyard were Ozana, Băbească gri and Aligoté (Fig. 3).

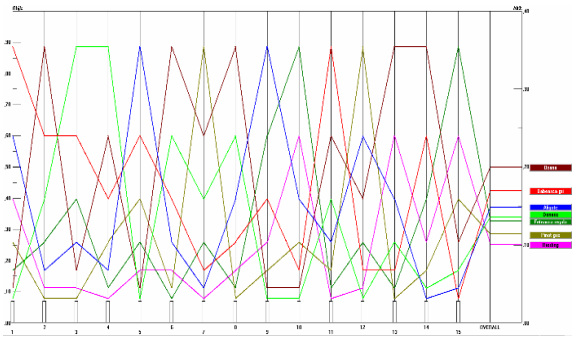

Fig. 3. The ranking of the seven grapevine varieties for white wine cultivated in Huşi vineyard: Ozana, Băbească gri, Aligoté, Donaris, Fetească regală, Pinot gris, Riesling italian

Ozana is a noble grapevine variety both for table and wine use (Fig. 4), obtained at Research Station for Viticulture Iaşi by Dănulescu Dumitru, Sandu – Ville Gorun and Sandu – Ville Gabriela, through the free fertilization of the Coarnă neagră variety, beingregistered in 1982. The grapes are medium-sized (172 g), the skin is yellow-greenish, the pulp is semi-crispy, with a sweet-sour taste, unflavoured, accumulates 190-220 g/L sugars, the total acidity in the must is 4-4.7g/L expressed in H_2SO_4, grape production can reach 12 t/ha. The ripening of the grapes takes place in the IInd-IIIrd epoch (August 0-31). The obtained wine is white, of superior quality, with an average alcoholic strength of 13.2vol%, with balanced acidity. At the end of the vegetation period (170 – 175 days) the wood of the annual canes is very well matured, giving to the variety an increased resistance to frost. (https://www.madr.ro/docs/cercetare/Rezultate_activitate_de_cercetare/SCDVV_Iasi.pdf; https://www.horticultorul.ro/vita-de-vie/soiuri-de-romanesti-de-vita-de-vie-cu-utilizare-mixta-masa-si-vin/).

In other works, it is stated that the variety has medium resistance to frost and diseases (Stroe, 2012) or it is sensitive to low temperatures (Bucur and Dejeu, 2020).

After Glăman et al. (2018) the grapes reach maturity for consumption between the 15th and 20th of August and for winemaking in the IIIrd and IVth epochs. Ozana variety is appreciated for its taste qualities and frost resistance, which recommends it for areas with thermal restrictions. Having an early maturity, it can be also cultivated in more areas of the north of the country, being allowed in the Moldavia vineyards.

Fig. 4. Ozana variety (https://www.madr.ro/docs/cercetare/Rezultate_activitate_de_cercetare/SCDVV_Iasi.pdf)

Băbească gri is a grapevine variety of white wine (Fig. 5) obtained at Research Station for Viticulture Odobeşti, by Popescu Gheorghe, Milu Oşlobeanu, Ion Poenaru, Margareta Bădiţescu and registered in 1975. It is a bud variation of Băbească neagră variety, fixed by vegetative propagation. The grape bunches are of medium size, branchy, and lax. The berry is of medium size (1.8 - 2.5 g), discoidal in shape (similar to the Băbească neagră variety), with a smoky-grey skin, juicy and unflavored pulp with sourly taste. The variety has high growth vigour, it ripens its grapes in the 6th stage and shows good resistance to environmental factors (drought, frost).

The grape production is around 11-20 t/ha and much higher sugar accumulations (163 g/L) as compared to the parent variety Băbească neagră, grape size of 184-199g and acidity 7.8 g/L expressed in H_2SO4. White table wines are obtained, with excess acidity, being good as raw material in the sparkling wines or distillates production. The grapes production is high but with a large variation in the accumulation potential of sugars (Stroe, 2012; Glăman et al., 2018;https://www.madr.ro/docs/cercetare/Rezultate_activitate_de_cercetare/SC-DVV_Odobesti_-_Portofoliul_de_soiuri_si_clone.pdf).

Stroe (2012) mentioned that Băbească gri variety has good resistance to high temperatures, and it has medium tolerance to gray mould. According to Glăman et al. (2018), the variety shows good resistance to downy mildew and gray mould, and medium resistance to powdery mildew.

Băbească gri variety was zoned in the Odobeşti vineyard and in other areas with similar conditions of Vrancea county, being intended for white wines of current consumption and aged wine distillates production (https://www.madr.ro/docs/cercetare/Rezultate_activitate_de_cercetare/SC-DVV_Odobesti_-_Portofoliul_de_soiuri_si_clone.pdf).

Fig. 5. Băbească gri variety (https://www.madr.ro/docs/cercetare/Rezultate_activitate_de_cercetare/SC-DVV_Odobesti_-_Portofoliul_de_soiuri_si_clone.pdf)

Aligotéis a grapevine variety of white wine (Fig. 6) of Franch origin, being cited in literature since 1780 (Constantinescu et al., 1959). It is a variety of medium vigor, which shows a good resistance to drought, and can also be cultivated on sands.

The wood of the canes matures well in the fall, which shows a good tolerance to frost, so it can stand up to -22ºC. It is distinguished for its ability to restore its fruit wood affected by frost, starting in vegetation from the secondary buds that are most often fertile. However, it is a variety sensitive to downy mildew and gray mould. Aligoté variety matures in the Vth epoch (Stroe, 2012).

Fig. 6. Aligoté variety (https://www.vitadeviedemasa.ro/produs/vita-de-vie-aligote/#&gid=null&pid=1)

Other authors have mentioned that Aligoté variety has no practical resistance to frost and has medium resistance to cryptogamic diseases. It is exposed to attack by *Cochylis* and *Eudemis* moths, is not attacked by wasps and has good resistance to the *Tetranychus* attack. The Aliogoté variety fully responds to the conditions of cultivation both on sloping and flat land, showing the character of a cosmopolitan variety. The range of distribution of the variety is wider in the northern area of Eastern European countries than in its country of origin and in the countries of the west of our continent (Constantinescu et al., 1959).

The average weight of a grape bunch is 60 g, and 100 berries 140 g. Accumulations of sugars are quite low, being within the limits of 170 and 200 g/L sugars, and the average acidity is 4.7 ‰. Production varies depending on the vineyard, the average being between 10 and 14 t/ha.

The wine obtained from this variety is pleasant, harmoniously constituted, especially when the variety is grown on slightly calcareous sands and skeletal soils. Cultivated on too fertile lands, the variety gives a wine with a special taste, specific to the land. It is cultivated in fairly large areas in the wine region of Moldavian Hills, in the north of Dobrogea and on the sandy lands of Tulcea, Brăila and Buzău counties (Stroe, 2012).

CONCLUSIONS

Huşi Vineyard benefits of favorable eco-climatic conditions for grapevine growing and the

application of the results can help to the development of sustainable viticulture. Thus, in this area can be cultivated grapevine genotypes for white wine. According tothe analytical hierarchical process results, based on pairwise comparisons of subjective criteria (including a portfolio of derived products, harvesting period, biotic and abiotic threats) Ozana, Băbească gri and Aligoté grapevine varieties for white wine were selected as the most valuble for Huşi vineyard.

ABSTRACT

The work purpose was to apply the analytical hierarchical process (AHP) method for ranking and selecting grapevine varieties, to assess the market demands for developing a program of setting up new plantations in a near future in Huşi Vineyard, one of the oldest vineyards of the Moldavian Hills Viticultural Region. Seven grapevine varieties of white wine (Aligoté, Băbească gri, Donaris, Ozana, Pinot gris, Riesling italian, Fetească regală) and fourteen criteria (quantitative and qualitative)were used in the AHP exercise. The analyses were carried out using the Expert Choice Desktop software. Ozana, Băbească gris and Aligoté genotypeswere selected as having the greatest potential for Huşi vineyardfrom the group of white wine genotypes taken into the study. The work can contribute to the maintaining of a durable viticulture, to quality white wines production and a more reliable future of the viticultural area.

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