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AN AHP EXERCISE TO IDENTIFY THE MOST VALUABLE GRAPEVINE VARIETIES OF RED AND ROSÉ WINE FOR HUŞI VINEYARD

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Key words: *analytic hierarchy process, pairwise comparisons, Vitis, Moldavian Hills*

INTRODUCTION

Huşi Vineyard, one of the oldest vineyards of Moldavian Hills Viticultural Region is located in the South-Eastern part of the Central Moldavian Plateau, between Crasnei Valley to the West and the Prut Valley to the East (between 45°51' parallel to North and 46°31' parallel to South) (Fig. 1). From the administrative point of view, Huşi Vineyard is found in the counties Vaslui (Huşi, Avereşti, Vutcani and Murgeni viticultural centers), Iaşi (Bohotin and Vaslui viticultural centers) and Neamț (Bozieni viticultural center). The relief is hilly, with depressing hills, the altitudes being between 22 and 300 m. The Moldavian Hills Viticultural Region is the largest viticultural region in the country, with an impressive cultivated area of 69154 ha.

The climate is of temperate-continental type, with moderate-continental hue in the high hills and excessively-continental at the level of Huşi Depression. The vegetation period is 212 days, the useful thermal balance 3300°C and the sum of the insolation does not exceed 1708 hours. During the vegetation period the precipitations fall in quite small quantities, 300-350 mm only, and in winter frequent minimum temperatures of -29°C occur (Stroe, 2012).

The predominant pedological fund is formed from chernozems, limestone chernozems, cambic chernozems, vertic chernozems, gray chernozems, argic chernozems, luvosols, typical luvosols, alluvisols, geoserodic regosols. Of these, chernozems are most valuable for vineyards (Toti et al., 2017).

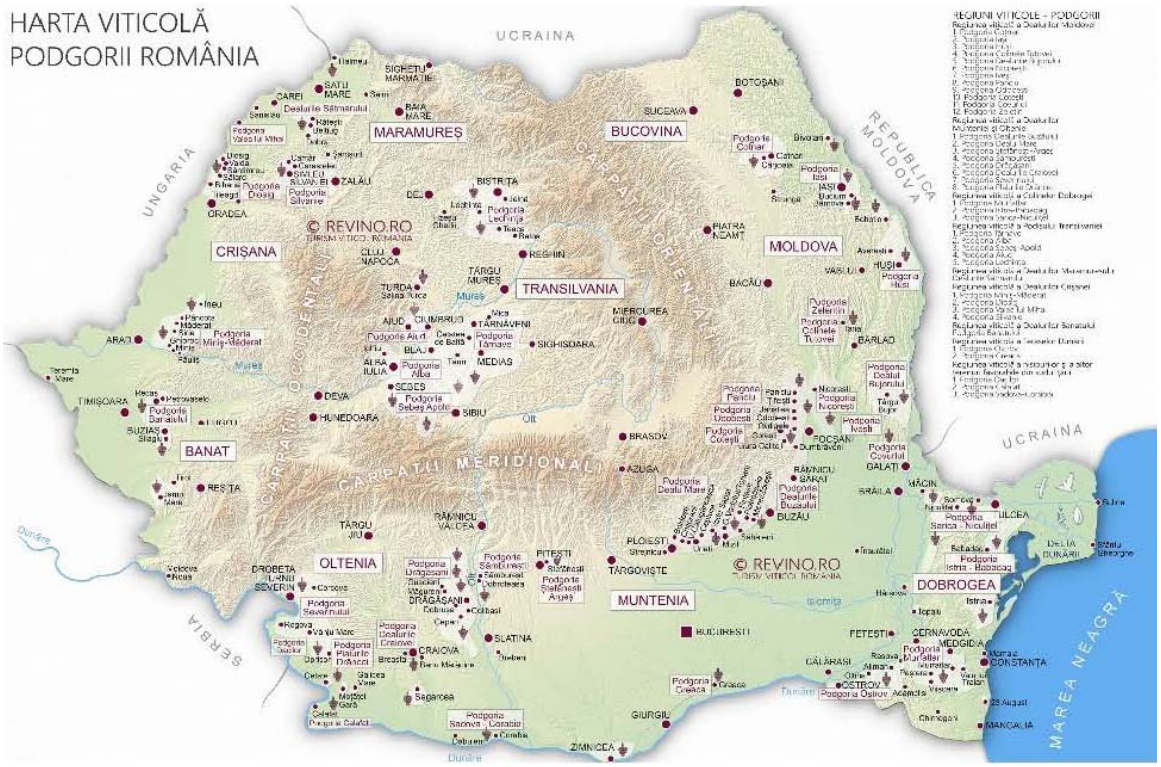

Fig. 1 The viticultural map of Romania
Source: https://revino.ro/viticultura-in-romania

In Husi Vineyard the ecopedoclimatic conditions allow the successful cultivation of a large number of grapevine varieties both for table and wine grapes. Of the varieties for table grapes, a larger area is occupied by the varieties from the Chasselas and Coarnă groups, to which are added the varieties of the fourth epoch, Muscat de Hamburg and Cinsaut (Stroe, 2012).

The vocation of the vineyard, however, is the culture of varieties for white wine, of prime importance being Zghihară de Huşi, Aligoté and Fetească regală varieties destined to obtain white table wines. Of the varieties for high quality wines, in Huşi Vineyards the best known are Fetească albă and Riesling italian, and for the production of aromatic wines, Busuioacă de Bohotin, Muscat Ottonel and Tămâioasă românească varieties are very well known and recognized. On fairly restricted areas, red wine varieties are also cultivated, of which were mentioned: Oporto and Băbească neagră, grown in Avereşti, from which are obtained table wines; Pinot noir, Merlot, Cabernet Sauvignon and Fetească neagră, grown in Vutcani and Murgeni from which are obtained quality wines (Stroe, 2012; Irimia et al., 2014).

Huşi Vineyard is also famous for its Bohotin viticultural center, which presents the natural vocation for producing aromatic wines from Busuioaca de Bohotin, Tămâioasă românească, Muscat Ottonel varieties.

Due to the remarkable quality of wines, Huşi area became known as "the wine country". The vineyard has an area of about 3000 ha, with a grape production around 10000 kg/ha.

This study deals with the application of a hierarchical methodology for evaluating and ranking some grapevine varieties of red and rosé wine valuable for Huşi vineyard, considering their biological features, new climate conditions and tradition of grapevine growing aria.

MATERIAL AND METHOD

By means of AHP, a decision problem is decomposed into a hierarchy sub-problem (*i.e.* the criteria taken into consideration) which will be independently analyzed. Thus, AHP is a theory of measurement through pairwise comparisons and relies on the judgements of experts to derive priority scales (Saaty, 2008).

In this work, the grapevine varieties of red and rosé wines studied by AHP were: Burgund mare, Fetească neagră, Băbească neagră, Merlot, Cabernet Sauvignon, Busuioacă de Bohotin.

In order to determine the most important grapevine varieties for Huşi vineyard, 17 criteria with a scale of 7 levels each were used in the AHP exercise, 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 8: 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 - transport from the harvesting point to the storage centre (from 1: the most easy to 7: the most complicated); criterion 12 - perishability (from 1: lowest to 7: highest); criterion 13 - "celebrity" of the product on the market (from 1: the least known to 7: the most popular); 14: Market demand (1: lowest to 7: highest); criterion 15 - biotic threats (from 1: the fewest threats to 7: the most threats); criterion 16 - abiotic threats (from 1: the fewest threats to 7: the most threats); criterion 17 - development of the harvesting process (from 1: undeveloped to 7: extremely developed).

Having a high degree of generality, these criteria have been also used in other fields of research (for non wood forest products - Bragă and Dincă, 2019; Blaga et al., 2019; forest fruits - Vechiu and Dincă, 2019; Enescu and Dincă, 2020; animals - Ciontu et al., 2018). Taking into account the climatic changes influences reported in the viticulture area (Buciumeanu et al., 2018; Dincă et al., 2018b; Vizitiu et al., 2018) and the need to formulate solutions (Vizitiu, 2019) and recommendations (Dincă et al., 2018a), AHP might a very useful analysis to select and rank the grapevine varieties in different viticultural regions in these new growing conditions. The analyses were obtained by using the Expert Choice Desktop software (v. 11.5.1683).

RESULTS AND DISCUSSION

The AHP alternative ranking, based on expert's opinion, is presented in Table 1.

According to the AHP results, the grapevine varieties of red and rosé wine with highest potential for Huşi vineyard were: Busuioacă de Bohotin, Fetească neagră and Burgund mare (Fig. 2). These varieties are part of the main grape varieties for red wines grown in Romania, along with Merlot, Cabernet Sauvignon, Băbească neagră, Roşioară, Pinot noir, Traminer roz.

Busuioacă de Bohotin variety appears to originate in Greece from where it has spread to the main western countries of Europe. In our country it

was discovered and multiplied in 1926-1928; is considered a native variety from the Bohotin locality.

Table 1. AHP alternative ranking
(BM= Burgund mare, FN = Fetească neagră,
BN = Băbească neagră, M = Merlot,
CS = Cabernet Sauvignon, PN = Pinot noir,
BB= Busuioacă de Bohotin)

Criterion	Grapevine varieties						
	BM	FN	BN	M	CS	PN	BB
1	6	7	3	4	5	1	2
2	1	2	3	4	5	7	6
3	7	2	3	5	6	1	4
4	4	3	5	6	7	1	2
5	7	5	3	6	4	2	1
6	1	2	7	3	4	5	6
7	3	5	2	7	6	1	4
8	2	4	1	5	3	7	6
9	5	7	1	6	4	3	2
10	2	7	3	4	1	5	6
11	5	3	4	1	2	6	7
12	4	3	1	2	5	6	7
13	2	6	1	4	5	3	7
14	1	6	5	2	4	3	7
15	1	3	5	4	2	6	7
16	6	5	4	3	2	1	7
17	7	6	3	2	4	1	5

According to the of Zoning noble grapevine varieties admitted in culture in Romania's viticultural areals/2006, Busuioacă de Bohotin variety was zoned for the Huşi, Tutovei Hills and Dealu Mare Vineyards.

The variety has medium growth vigor, with the grapes ripening in the 4th epoch. The fertility of the variety is in the middle class, it forms around 60% fertile shoots, the values of the two fertility coefficients are between 0.3-0.6 the relative and 1.0-1.23 the absolute one.

Busuioacă de Bohotin variety has high demands on ecopedoclimatic factors, which results in its very low ecological plasticity as compared to Tămâioasă românească and Muscat Ottonel varieties. Also, this genotype has a higher sensitivity to diseases and pests, it is sensitive both to excess water from the soil and drought, has limited resistance to frost and hoar-frost.

Average of the marks obtained with criteria 15 and 16 revealed that this genotype is the most affected by biotic threats and abiotic threats of the seven genotypes studied in this work.

The full ripening of the grapes takes place starting with the second decade of September, the period up to which it accumulates 180-200 g/L sugars, however, having a much lower potential for sugar accumulation than the Tămâioasă variety. The fact that it is very sensitive to the attack of grey mould, can hardly be subjected to overmaturation. The variety realizes small productions, the quantity does not exceed 7-9 t/ha (Stroe, 2012).

The wine obtained is an aromatic wine, of ruby color with different shades and falls both in the category of high quality semi-sweet and sweet wines. According to criterions 13 and 14, Busuioacă de Bohotin variety is the most popular and registered the highest market demand as compared to other 6 cultivars taken into the study.

Due to the fact that the wine is highly appreciated, the wine research has registered several clones of Busuioacă de Bohotin: 26 Pietroasa, 5 Iaşi, 9 Cotnari). The clonal selection Busuioacă de Bohotin 26 Pietroasa, approved in 1999, surpasses the population by a significant increase in production (constant production) and a stronger pregnant aroma. The content of the must in sugars is 230-240 g/L.

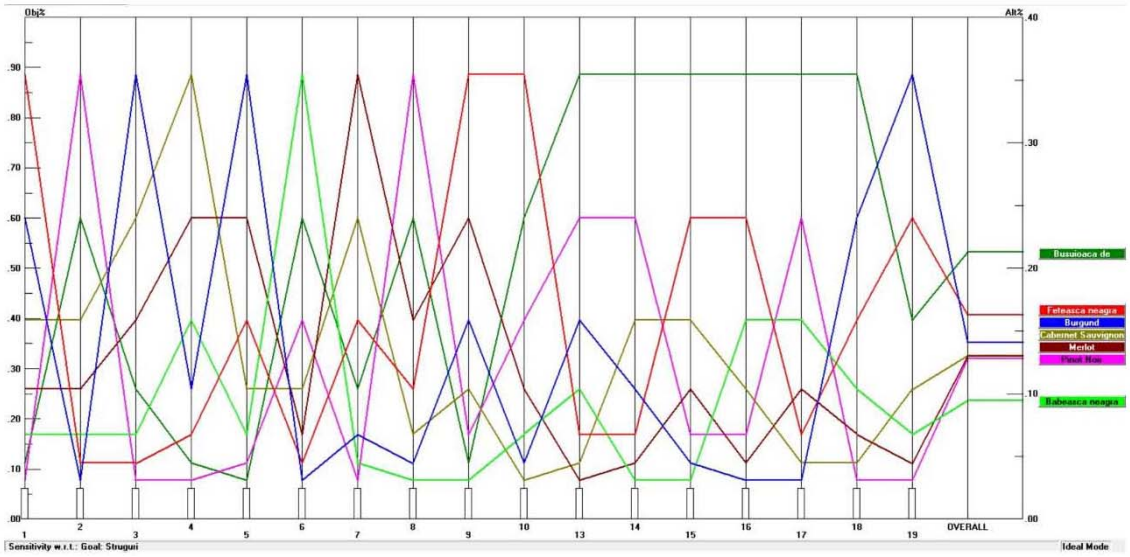

Fig. 2. The ranking of the eight grapevine varieties for red and rosé wine, grown in Husi Vineyard

Busuioacă de Bohotin 5 Iaşi, approved in 2004, is characterized by high yields and increased accumulations of sugars. Busuioaca de Bohotin 9 Cotnari, approved in 2009, is characterized by 8.3 - 11 t/ha grapes production and sugar accumulation of 200 g/L.

Fetească neagră is an ancient grapevine variety, considered a Dacian variety, which appears to be a selection of *Vitis silvestris*. It is known and cultivated from very distant times in the old vineyards of Moldavia, where it produced alongside the local black varieties, the famous wine of Uricani. It is part of *Proles orientalis - Caspica subproles.*

This variety is distinguished by a high growth vigor, with a short period of vegetation, of only 150-160 days.

The rather excessive, lush growth sometimes restrains the normal differentiation of the fruit buds, thus leading to the formation of a low percentage of fertile shoots. It is a variety with good resistance to frost and has a medium drought tolerance. In terms of resistance to cryptogamic diseases, it exhibits fairly high and medium resistance to powdery mildew, and in the centers with high hygroscopicity in the ripening phase of grapes it suffers from the attack of grey mould.

Fetească neagră variety ripens the grapes early (in the second decade of September), but which differs with the area in which they are grown.

The fertility of the variety is quite low, the fertile shoots being 24-38% only, and the values of the fertility coefficients are within the limits: 0.4-0.5 relative and 1.1-1.3 absolute.

Fetească neagră variety is cultivated in many wine centers, the largest share being in the Moldavian Hills Viticultural Region and in the of the Muntenia and Oltenia Hills Viticultural Region (Prahova, Argeş, Olt).

This variety obtained the maximum grade on 1, 9 and 10 criteria (harvesting period, distribution range and market potential).

Fetească neagră variety is considered the hope of the Romanian wines.

Within the population of the Fetească neagră variety cultivated in Dealul Mare vineyard, several biotypes were detected, most of them differing in size and compactness of the grapes, explaining the variability of production in this variety.

The most valuable biotype noted has a more weighted vegetative growth, and the grapes are large, compact, which leads to a higher production capacity.

Fetească neagră variety registered several clones approved in Romania: 7 Odobeşti (2005), 4 Valea (2006), 10 Pietroasa (2008), 6 tefăneşti (2008), 44 Tohani (2008), 21 Cotnari (2009), 9 Murfatlar (2009).

By sexuat hybridization between Băbească neagră and Fetească neagră has been obtained Codană variety (approved in 1975), whose production is noted by consistency and quantity (12-20 t/ha) (Stroe, 2012). Codana variety is also grown in Huşi aria.

Burgund mare is a variety originating in central Europe. It is part of *Proles occidentalis***.** It is considered to be a mugural variation of Pinot noir variety.

The variety is characterized by a high growth vigor, with a fairly long vegetation period of over 185 days. The wood maturation is done in a 75% proportion and shows a medium tolerance to the action of the low temperatures up to -22ºC, and a good drought tolerance (the excess humidity can harm it).

It is sensitive to downy mildew, but has been shown to be resistant to grey mould, powdery mildew, *Eudemis, Cochilis*. The fertility of the variety is good, it forms 75% fertile shoots, and the coefficients of fertility have values of 1.1 relative and 1.6 absolute one.

The grapes of Burgund mare variety reach their full maturity at the end of September. The obtained production varies between 16.5 t/ha in Valea Călugărească and 21.9 t/ha in Miniş with accumulations of sugars within the limits of 174-191 g/L, rarely rising up to 225 g/L and having a total acidity of the must, ranging from 5.5 to 6.0 ‰.

The main quality of the Burgund variety is the large quantity of grapes obtained.

However, through authenticity, finesse and an aptitude for aging, Burgund mare wine can stay alongside the wines of Syrah, Pinot noir, Merlot and Cabernet Sauvignon, all being able to occupy the highest stage of recognition (Hodor, 2011).

Thus, this variety obtained the maximum grade on criterion 5 - knowledge for recognition, being the most recognizable variety of the 7 taken into this study.

Burgund mare variety behaves modest in some years, as a variety of current consumption, with productions around 19-20 t/ha and sugars accumulations of 165 g/L. It gives high quality and high yields when is grown on hills with Southern or South-Eastern exhibitions, which receive a lot of heat and light.

Burgund mare is grown on fairly large areas (4 viticultural centers) as a recommended variety (Recaş, Silagiu, Miniş and Măderat) and in 42 centers as an authorized variety (Tulcea, Teleorman, Călăraşi, Dolj, Mehedinți, Buzău, Prahova, Arges and Constanta counties).

By the sexuat hybridization between Burgund and Saint Laurent varieties, in Austria was obtained Blauerzweigelt variety, from which are produced quality red and rosé wines.

In 2009, were approved the clones of Burgund mare 63 Miniş and 86 tefănesti, characterized by high yields (13-15 t/ ha) and sugar accumulation in must of 210 g/L and 220-230 g /L respectively.

CONCLUSIONS

According to AHP results, based on pairwise comparisons of subjective criteria (including knowledge for recognition "celebrity" of the product on the market, biotic and abiotic threats), Busuioacă de Bohotin, Fetească neagră and Burgund mare varieties were selected as the most important grapevine varieties for red and rosé wine for Huşi vineyard.

Bohotin, Fetească neagră, and Burgund mare have different biological characteristics and, therefore, different potential for adaptation to climate changes. Despite its high demands on ecopediclimatic factors (high sensitivity to diseases, pests and drought), Busuioacă de Bohotin, was the first variety with a great potential for Huşi Vineyard. Fetească neagră ranked the second (it having good resistance to frost, medium tolerance to drought, high and medium resistance to powdery mildew). Burgund mare variety, with medium tolerance to cold, good tolerance to drought an resistant to some fungus diseases ranked the third of seven grapevine varieties taken into the study (Burgund mare, Fetească neagră, Băbească neagră, Merlot, Cabernet Sauvignon, Busuioacă de Bohotin).

Busuioacă de Bohotin and Fetească neagră varieties are considered autochthonous varieties. The large quantity of grapes obtained is the main quality of the Burgund mare variety.

The vocation of Huşi Vineyard, one of the oldest vineyard of Moldavian Hills Viticultural Region, is the cultivation of grapevine varieties for white wine, but the extension of red and rosé varieties should be analyzed and taken into consideration, for a sustainable viticulture, under the conditions of climate changes.

ABSTRACT

In order to identify and rank the most important grapevine varieties for red and rosé wine of Huşi vineyard, the Analytic Hierarchy Process (AHP) method has been used. Knowing that the vocation of Huşi vineyard is the culture of the grapevine varieties for white wine, the result of the AHP application was expected to give a scientific contribution to the viticultural market, in order to extend the growing area of some varieties, based on subjective criteria. Seven grapevine varieties (Burgund mare, Fetească neagră, Băbească neagră, Merlot, Cabernet Sauvignon, Busuioacă de Bohotin) and seventeen quantitative and qualitative criteria have been used in the AHP exercise.

The analyses were carried out using the Expert Choice Desktop software package. According to the results, Busuioacă de Bohotin and Fetească neagră (considered autochthonous varieties), and Burgund mare (with high quantities of produced grapes), were selected as the most important grapevine varieties for red and rosé wine in this aria.

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