

STUDIES ON THE PHENOTYPIC SIMILARITY OF AUTOCHTHONOUS GRAPEVINE CULTIVARS BY MEANS OF STATISTICAL-MATHEMATICAL METHODS

STUDII PRIVIND GRADUL DE ASEMĂNARE FENOTIPICĂ DINTRE UNELE SOIURI AUTOHTONE DE VIȚĂ DE VIE PRIN UTILIZAREA METODELOR STATISTICO-MATEMATICE

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Abstract. Use of statistical mathematical methods in the characterization of cultivars and determination of their degree of similarity provides important information concerning cultivars appurtenance to different sortogroups, the degree of relatedness between cultivars and their differentiation. The purpose of this study was to determine the degree of phenotypic similarity between 11 autochthonous grapevine cultivars based on the physico-mechanical, biochemical and physiological characteristics of grapes and leaves, using Cluster analysis, which admits the existence of polythetic groups and allows verification of genotype belonging to a varietal faction. Group with the lowest chaining index, indicating a high phenotypic similarity, was Coarnă neagră ~ Coarnă neagră selecționată, followed by Purpuriu ~ Cetățuia and Someșan ~ Milcov groups, fact justified by their common origin within the group. A lower degree of similarity was noted between Purpuriu and Radames cultivars, with Villard blanc as common genitor, and between Transilvania and Splendid cultivars (common genitor Black rose).

Key words: autochthonous cultivars, chaining index, cluster analysis, genetic monitoring, principal component analysis

Rezumat. Utilizarea metodelor statistico-matematice în caracterizarea soiurilor și stabilirea gradului lor de similaritate oferă informații importante referitor la apartenența soiurilor la diferite sortogrupuri, precum și la diferențierea acestora. Scopul acestui studiu a fost determinarea gradului de asemănare fenotipică dintre 11 soiuri autohtone de viță de vie, pe baza caracteristicilor fizico-mecanice, biochimice și fiziologice ale strugurilor și frunzelor, utilizând analiza Cluster, care admite existența grupurilor politetice și permite verificarea apartenenței unui genotip la o grupă de soiuri. Grupul care a prezentat cea mai mică valoare a indicelui de înlănțuire, indicând asemănarea fenotipică foarte mare, a fost Coarnă neagră ~ Coarnă

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neagră selecționată, urmat de grupurile Purpuriu ~ Cetățuia, și Someșan ~ Milcov, fapt confirmat de originea lor comună în cadrul grupului. Un grad redus de similaritate a fost observat între soiurile Purpuriu și Radames, având ca genitor comun soiul rezistent Villard blanc, și între soiurile Transilvania și Splendid (genitor comun Black rose).

Cuvinte cheie: analiză cluster, analiza în componenți principali, indice de înălțuire, monitorizare genetică, soiuri autohtone

INTRODUCTION

Knowing and maintaining biodiversity is essential to ensure the survival of any form of life. At national level, the genetic heritage of vine cultivars is often doubtful, because are missing the relevant data on the identity of cultivars, especially on autochthonous grapevine cultivars. This situation makes the selection work more difficult and makes impossible to establish the scientific criteria for the classification of vine cultivars, their description, recognition and their use in new breeding programs.

In Romania, the lack of current and complete scientific studies on existing genetic background is currently one of the main problems of breeders and producers, leading to insufficient use of valuable genotypes in grapevine breeding experiments or limits their spread within vineyards.

The use of statistical and mathematical methods in the characterization of cultivars and the determination of the degree of similarity between them has returned to the attention in the conditions of developing the multiple possibilities of data processing, obtaining relevant information regarding the belonging of cultivars to different sort groups, the degree of association between cultivars, and their differentiation (Boursiquot and This, 1997; Rotaru and Țardea, 2002). The purpose of this study was to determine the degree of phenotypic similarity between some autochthonous grapevine cultivars, based on the main physico-mechanical, biochemical and physiological characteristics of grapes and leaves, using cluster analysis, which admits the existence of polythetic groups (similar groups of cultivars) and allows verification of the genotype belonging to a varietal group, and the separation of studied cultivars into branches according to the principle of dissimilitude or similarity between them.

MATERIAL AND METHOD

Research was carried out on 11 grapevine cultivars created in Romania: Someșan, Milcov, Napoca, Cetățuia, Coarnă neagră, Coarnă neagră selecționată, Gelu, Transilvania, Splendid, Purpuriu and Radames, the biological material being sampled from the Ampelographic collection of the University of Agricultural Sciences and Veterinary Medicine, Iasi, Romania (27°53 'E; 47°09' N).

In order to highlight the relationships between the analyzed cultivars, based on the main physical and mechanical (uvological indices, grape weight, 100 berries weight, rachis weight, number of berries on bunches, number and weight of seeds), biochemical (humidity, soluble substance, minerals, ascorbic acid, phenolic

compounds, pH, sugars, acidity, proteins, anthocyanins, peroxidase activity) and physiological (chlorophyll a, chlorophyll b, carotenoids and chlorophyll index) characteristics, were plotted the dendrogram and the histogram of analysed cultivars, on the basis of the generalized Ward criterion, in the XLStat® software, in Microsoft Excel® application. Physico-chemical determinations were performed according to the OIV methodology (OIV, 2012). The results of the experimental determinations were previously published by the authors in the context of the characterization and quality assessment of the studied cultivars (Filimon *et al.*, 2016; Filimon *et al.*, 2017).

RESULTS AND DISCUSSIONS

From the analysis of the obtained dendrogram was noted the existence of ten major polythetic groups (fig.1). In this ensemble, first cultivars that aggregate, and which have the highest phenotypic similarity, are the Coarnă neagră (CN) and Coarnă neagră selecționată (CNS), which showed the lowest chaining index of 119,12, to which the Gelu cultivar (cv.) was further attached.

The second node was formed by Purpuriu and Cetățuia cultivars (658.61), followed by the chaining of Someșan and Milcov (806.93), which form the third minor node of the dendrogram.

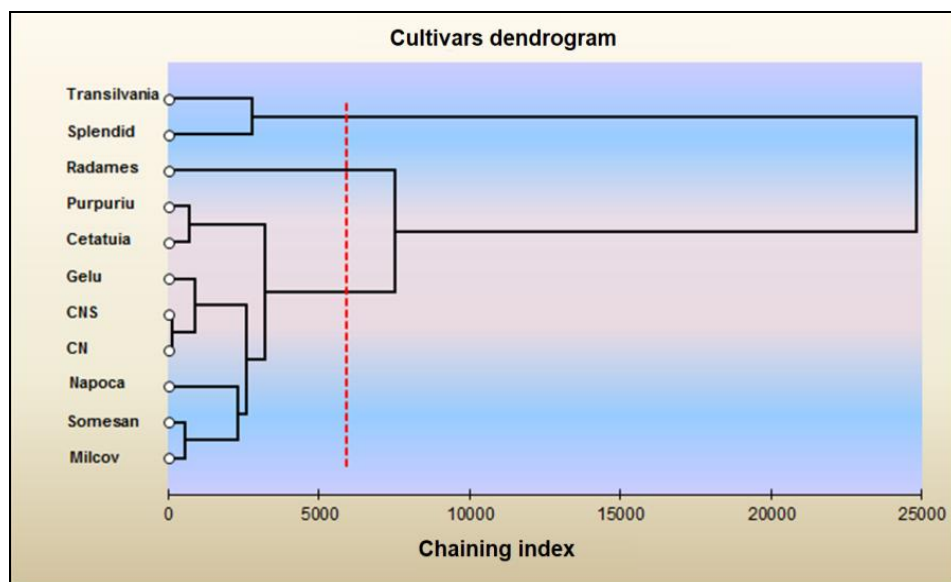


Fig. 1 Dendrogram of the autochthonous grapevine cultivars analyzed based on the physico-biochemical characteristics

Fourth node was formed by addition of Gelu cv. to first node (Coarnă neagră and Coarnă neagră selecționată). This approach is explained by the fact that the Gelu cv. is obtained from Coarnă neagră cv. (by seed irradiation), showing a large number of common characteristics with the genitor.

Someșan, Milcov and Napoca cv., which have as common genitor Muscat Hamburg cv., formed the fifth node of the chain (2203.68). Transilvania and Splendid cv. (node 8; 4015, 47) are the last that aggregate to the rest of the dendrogram, having as a common genitor the Black rose cv. The final node (tenth node), linking all the analyzed cultivars, showed a high value of the chaining index (24809.97), indicating their high variability and belonging to various sortogroups.

The lower the linking value, the more the cultivars that formed the groups are more phenotypically similar. The values of the chaining index for all nodes are shown in the obtained histogram (fig. 2).

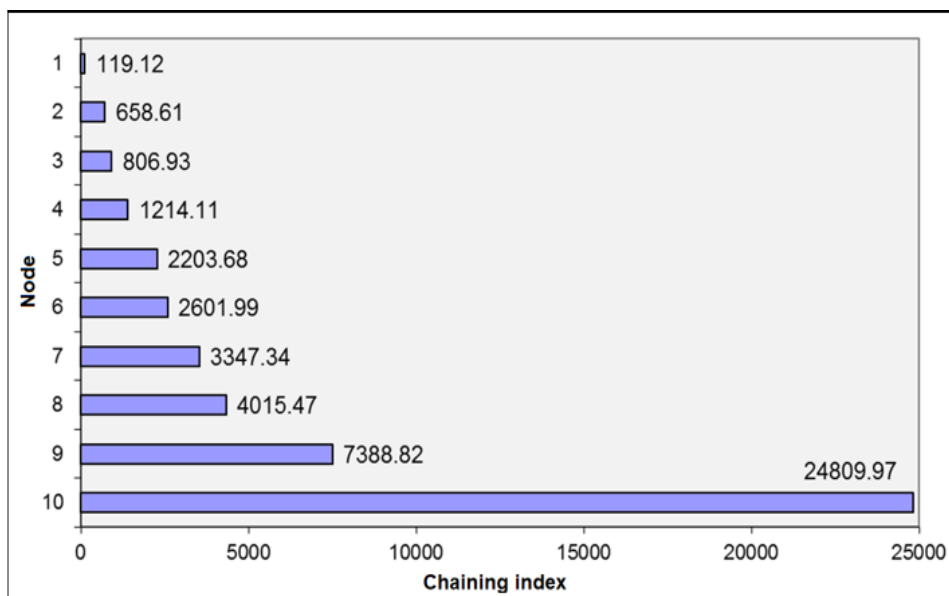


Fig. 2 Hierarchical histogram of autochthonous grapevine cultivars analyzed

In table 1, is presented the level of clustering of the autochthonous cultivars within the dendrogram and the genotypes that formed each node. For the formation of groups, on the basis of individual characteristics, principal component analysis (PCA) was initiated, based on the study of covariance or the correlations between variables, which allows the differentiation and grouping of the cultivars based on leaf and grapes peculiarities (Rotaru and Petrea, 2006). Thus, the main node comprises all 11 cultivars studied, in the order of their phenotypical similarity: Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu ~ Someșan ~ Milcov ~ Napoca ~ Purpuriu ~ Cetățuia ~ Radames ~ Transilvania ~ Splendid.

Principal component analysis (PCA) indicated the presence of four main groups of cultivars.

The level of cultivar clustering in the dendrogram

Nodes composition	Node no.	Number of cultivars in the node	Index value
Coarnă neagră ~ Coarnă neagră selecționată	1	2	119.12
Purpuriu ~ Cetățuia	2	2	658.61
Someșan ~ Milcov	3	2	806.93
Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu	4	3	1214.11
Someșan ~ Milcov ~ Napoca	5	3	2203.68
Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu ~ Someșan ~ Milcov ~ Napoca	6	6	2601.99
Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu ~ Someșan ~ Milcov ~ Napoca ~ Purpuriu ~ Cetățuia	7	8	3347.34
Transilvania ~ Splendid	8	2	4015.47
Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu ~ Someșan ~ Milcov ~ Napoca ~ Purpuriu ~ Cetățuia ~ Radames	9	9	7388.82
Coarnă neagră ~ Coarnă neagră selecționată ~ Gelu ~ Someșan ~ Milcov ~ Napoca ~ Purpuriu ~ Cetățuia ~ Radames ~ Transilvania ~ Splendid	10	11	24809.97

Thus, was highlighted the intersection of the group of cultivars that have as main genitor Coarnă neagră cv. and that of cultivars that have as genitor Muscat de Hamburg cv., as is the case of Milcov cv. (fig.3).

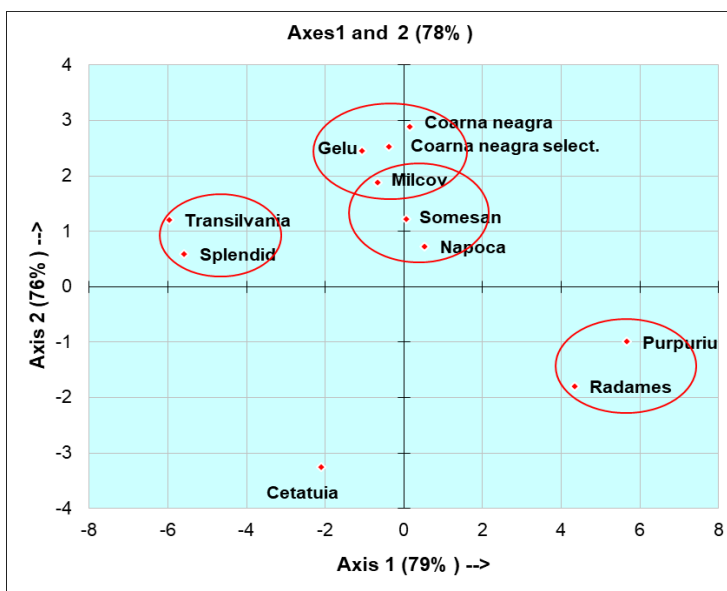


Fig. 3 Polythetic groups formed by principal component analysis

Purpuriu and Radames resistant cultivars, with Villard blanc cv. as common genitor, formed an individual group, as is the case of Transilvania and

Splendid cv. group (common genitor Black Rose). The correlation factors of the two axes were 0.79 (Axis 1) and 0.76 (Axis 2), while the data on the two axes correlated positively with a value of the correlation coefficient of 0.78 (Fig. 3).

CONCLUSIONS

1. Based on the physico-biochemical characteristics of leaves and grapes, cluster analysis led to the grouping of autochthonous grapevine cultivars studied in four major polythetic groups (similar groups of cultivars), which corresponded to their genealogy.

2. Cultivars that showed the lowest value of the chaining index were Coarnă neagră and Coarnă neagră selecționată, followed by Purpuriu and Cetățuia, and Someșan and Milcov, respectively, which indicates the very high phenotypic similarity between these cultivars within the group, given by their common origin.

3. Milcov cv. was included in the group consisting of the Coarnă neagră~Coarnă neagră selecționată ~ Gelu, also joining to the polythetic group of Someșan ~ Napoca cultivars, position justified by the origin of this cultivar, which has as genitors Coarnă neagră and Muscat de Hamburg cultivars.

4. The study of the physico-biochemical characteristics of grapes, together with the physiological and biometric features of the leaves, may provide relevant information on the degree of similarity between cultivars and on their origin, by means of statistical and mathematical analysis of data.

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