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# The sensory properties and chromatic characteristics of FeteascăNeagră red wine after the treatment with gum arabic and alternative oak products

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## Abstract

*The red wines production has become a priority in many countries and the demand for this type of wine increases every day. The experiments highlighted the Feteascăneagră red wine characteristics. In order to obtain the Fetească neagră wine, the classical technology for this type of variety was used. After three days following the treatment with micro-granulated gum arabic, the turbidity of the wine was normal, displaying acceptable clogging indices which corresponded to the indices reported in the concentrated wines that are rich in natural colloids. The influence induced by the micro-granulated gum arabic treatment on the color intensity and wine tint was evaluated spectrophotometrically. The treatment at a dose of gum arabic of 20-25 g/hL prevented the sedimentation of the coloring compounds, thus stabilizing the wine. Moreover, at a 25 g/L dose of ArabinolMultinstant gum arabic, the turbidity was reduced by 42.1% and, when the dose was 300 g/L ArabinolMultinstant the turbidity reduction was 53.3%.The addition of oak chips with different degree of toasting such as lightly, medium and strongly toasted, in a quantity of 5g/L, induced profound sensory changes to the red wines, which most of the tasters attested them as being positive, regardless of the type of oak chips used.*

**Keywords:** FeteascăNeagră, red wine, sensorial properties, color stability, gum arabic, oak

## 1. Introduction

Wine represents one of the most consumed beverages from all over the world.Wine is an alcoholic beverage that contains various biologically active compounds such as polyphenols extracted from grapes during the processes of vinification (V.RASTIJA &al. [1]). The polyphenolic compounds, such as anthocyanins, tannins, and flavonoids that have a high antioxidantactivity by protecting the body cells against oxidation. Thesecompounds are present in large quantities in wine, especially inred wines, and moreover,the polyphenols compounds are responsible for the quality of redwines, influencing their astringency, bitterness and colour (A. HOSU& al. [2]).Additionally, the wine industry needs new strategies to ensure the production of wines that are liked by consumers not only due to their health benefits but also due to their taste. The tendency of the wine producers should seek to bring new improved wines and to offer each consumer a specific product with the desired characteristics. Wine products vary widely in their sensory properties, which usually triggers very different consumers' responses. This diverseness could be taken into account for the identification of new market segments. One of the aspects that usually differentiate consumer responses towards wine products consumption, despite of liking, is the emotional response (M. MORA & al. [3]).H. L. MEISELMAN [4]reported in his study that by introducing theemotions caused by food concept in the sensory analysis provides

the wine industry with additional consumer insights. Several studies carried out by R. BARRENA [5] and A.P. SILVA [6] showed that consumers distinguish between products more for their emotional benefits than for their technical or functional properties. Wherefore, the study of consumer's preferences and emotional responses could provide the optimal solutions for making products more competitive to the wine industry (A.P. SILVA [7]) by using the emotional characterization of wines as a new marketing tool to connect with consumers (M. MORA & al. [3], R. BARRENA [5],A.P. SILVA [6]).

In order to achieve high qualitative wines, several compounds are used not only to improve the sensorial properties but also several other characteristics of red wines such as: clarity, wine colour intensity and tint. Regarding the turbidity of wines, it is very important to note that the presence of considerable amounts of protective colloids, which limit the flocculation and reduce the rate of sedimentation,may explain why wines made from grapes containing large quantities of polysaccharides can take years to clarify naturally (P. RIBÉREAU-GAYON & al. [8], J. MORENO & al. [9]). One of the most used compounds in treating the wine is gum arabic. Due to its composition consisting of non-fermentable polysaccharides, gum arabic is characterized by a pleasant taste, which considerably improves the balance of wines and especially those with accented acidic or tannic notes. The complex molecular structure of gum arabic allows it to place itself among the taste buds receptors, by temporarily isolating them so as to delay or reduce the astringent and bitter perceptions. This compound also participates in the taste tactile sensations (roundness, unctuosity, structure) specific to red wines. Although the phenomenon related to their formation is little known, it is already certain that several compounds can prevent the flocculation of mycelium and, consequently, theturbidity ofthe wine.

Other techniquesused to improve the composition in biologically active compounds and the sensory properties of wines are wood ageing and the use of alternative wood, mainly oak, products. As the most well-known and well-established technique, wood ageing is a practice used to produce high quality red wines. This technique can promote the migration of various biologically active compounds from the wood into the wine and they may positively influence the complexity and intensity of flavor and aroma (I. JARAUTA & al. [10]). Moreover, due to the porosity of the wood fibers and the presence of the bunghole, the atmospheric oxygen slowly diffuses into the wine, thus enhancing the stabilization of the coloring matter and the phenolic composition evolution (CANO-LÕPEZ & al. [11], F. CHINNICI & al. [12]). The influence of alternative oak products on the sensory profile of wines and distilled beverages proved to be favorable. Each of these products comes from raw wood (untreated) or wood subjected to three different stages of heat treatment. The size is of particular interest because this parameter largely depends on the achievement of the proposed objective, i.e. obtaining the olfactory and gustatory profile required for the wine treated with alternative products. The smaller the size of these products, the greater the contact surface with the wine so that the wood-wine exchanges are accelerating, while the larger the size, the slower the extraction, and the fineness and complexity of the olfactory-gustatory profile become more possible and more similar to those obtained when the wine is matured in oak barrels. In addition, to establish and to differentiate the technological objectives, this complex study addressed the other aspects of the complementarity of barrels - alternative oak products (regarding the choice of the optimal degree of toasting, the appropriate size, the period of contact with the oak wood), and also the sensory impact on the treated wines.

In Romania, in the last few years, one of the most consumed wines is derived from the Feteascăneagră grape variety, being recognized as one of the oldest Romanian varieties, whose origin is incontestable. The wines made from Feteascăneagră grape variety have a fine, discrete,

fragrant bouquet which is unmistakable, being preferred by many consumers. These few considerations highlight the opportunity and importance of the study that focused on the production of high quality red wines in regards to the Feteascăneagră variety.

One of the main aims of this study was to highlight the effect of the treatment with gum arabic on the clarity, turbidity, chromatic characteristics and sensory characteristics of a Feteascăneagră variety dry red wine. Moreover, the sensory characteristics of the obtained red wine after maturation in the presence of raw and toasted oak wood chips were also assessed. Besides the comparative sensory analysis, the undertaken study focused on finding new technological applications, new technical processes that address the requirements demanded by wine production and a more successful symbiosis between the wood and wine.

## 2. Materials and methods

### 2.1. The wine production

The experiments were carried out on the Feteascăneagră grape variety, from the Murfatlar vineyard, under the climatic conditions of 2016-2017. In order to obtain the Feteascăneagră wine, the classical technology for this type of variety was carried out.The grapes were harvested at their maturity. The process of winemaking started with the destemming and crushing of the grapes. The obtained mash was sulphited and transferred to other recipients for maceration and fermentation.

### 2.2. Theeffect of gum arabic addition on the turbidity of wine

The turbidity of the wine was assessed using the Turb 550 IR turbidimeter (Radnor, Pennsylvania, U.S.A).After thealcoholic fermentation completion, the wine was treated with different doses of ArabinolMultinstant gum arabic (25 g/L, 50 g/L, 75 g/L, 100 g/L, 200 g/L and 300 g/L). The turbidity of the wine was evaluated after a period of 24 hours and 72 hours, respectively.

### 2.3. The effect of gum arabic addition on the chromatic characteristics of wine

In this experiment, to analyze the Feteascăneagră chromatic characteristics, after the alcoholic fermentation the obtained wine was treated with a dose of 20 g/L ArabinolMultinstantgum arabic. Afterwards, it was transferred to new oak barrels and held for 6 months. The monitored parameters were the color intensity of the wine, the wine tint and the gelatin index.

### 2.4. The effect of gum arabic addition on the sensory characteristics of the Feteascăneagră wine

The unctuous character is traditionally attributed to the presence of glycerol and mannoproteins. These types of compounds alongside other moleculesalso provide the character of unctuosity and the interactions between tannins and other macromolecules have an effect on the acidity, astringency, and bitter sensation. The sensory analysis of wine was carried out by a panel consisting of 8 people, 6 men and 2 women, all of whom were certified as authorized wine

panelists.In regards to the quality ofthe red wine, the chosen descriptors for the analysis were color intensity, olfactory intensity, olfactory quality, taste intensity, taste quality, astringency, bitterness, unctuosity. The maximum score was 5 points for the excellent score, 4 points for the very good score, 3 for the good score, 2 for the less good score, 1 for the not goodscore.

### 2.5. The effect of alternative oak products treatment on the sensory characteristics of the Feteascăneagră wine

The sensory analysis of the Feteascăneagră red wine samples was performed after 3 months of maturation in order to assess the influence of the treatment with oak chips on the sensory quality of the wine. The wine thus obtained was treated with oak chips, that had a different torrefaction or toasting degree, at a dose of 5 g/L. The oak chips that were used were untreated medium size oak chipsas well as softly, medium and strongly treated oak chips. This treatment was performed during the malolactic fermentation.As mentioned before, the sensory analysis of wine was carried out as described at chapter 2.4.

## 3. Results and discussion

### 3.1. The effect of gum arabic addition on the turbidity of wine and on the chromatic characteristics of wine

**Table 1** shows the turbidity evolution of the new wine after 24 and 72 hours, respectively, following the treatment with different doses of ArabinolMultinstantgum arabic. By analyzing the data, it was observed that the turbidity value of the wine increased after a 24-hours period depending on the dose of ArabinolMultinstant that was used. The same situation was observed for the samples of wine after 72 hours after the treatment with ArabinolMultinstant. Moreover, three days after the treatment, a turbidity decrease was observed compared to the turbidity of the wine after one day. So, when using the 25 g/L dose of ArabinolMultinstant, the turbidity was reduced by 42.1% and, when the dose was 300 g/L ArabinolMultinstant the turbidity reduction increased up to 53.3%. It was also noted that after three days following thetreatment, the turbidity value was normal, showing acceptable clogging indices which correspond to the indices reported in the concentrated wines that are rich in natural colloids. The behavior of the micro-granulated gum arabic can change with the type of wine, and it is therefore recommended to perform preliminary laboratory tests on the membrane clogging ability prior to its industrial use. From the experiment, it was emphasized that the addition of gum arabic ensured the clarification and the stabilization of the wine, before bottling.

Table 1.The turbidity (measured asNephelometric Turbidity Units) and clogging index of the red wine treated with variable doses (g/hL) of micro-granulated gum arabic (ArabinolMultinstant - AM)

| Gum arabic dose (AM) g/hL | After 24 hours | | | After 72 hours | | |
|---|---|---|---|---|---|---|
| | Turbidity (NTU) | Clogging index: membranes 0.45 µ | Clogging index: membranes 0.80 µ | Turbidity (NTU) | Clogging index: membranes 0.45 µ | Clogging index: membranes 0.80 µ |
| 25 | 0.95 | 9 | 4 | 0.55 | 7 | 0 |
| 50 | 0.99 | 9 | / | 0.75 | 8 | / |
| 70 | 1.40 | 9 | 5 | 0.90 | 8 | 0 |
| 100 | 1.60 | 18 | / | 1.10 | 11 | / |
| 200 | 1.85 | 27 | 5 | 1.40 | 15 | 0 |
| 300 | 4.50 | 180 | / | 2.10 | 55 | / |

Other researchers such as P. RIBÉREAU-GAYON & al. [8] explained that the turbidity of a red wine is due to the colloidal particles flocculation caused by several chemical reactions. It is certain that the presence of natural polysaccharides, with their protective colloid properties, prevent the formation of turbidity and deposits. In some cases, to enhance this protective effect the additionof a colloid such as gum arabic is needed. The doses of gum arabic generally used are between 5–20 g/hL, in aqueous solutions, at concentrations ranging from 15–30%. It not only stabilizes the clarity, but also the turbidity, and has a very high capacity for fouling the filter surfaces **(**P. RIBÉREAU-GAYON & al. [8])

The preservation of the red wines color is an important necessity, especially when the winemust kept over the winter. In the young wines, the fraction of colloidal colorants can be eliminated by the bentonite treatment. In this case, there was an anthocyanins absorptionthat produced a loss of the wine color intensity. In order to stabilize the natural colorants in the young red wines, the addition ofArabinolMultinstant micro-granulated gum arabic at an optimum rate of 25 g/hL was used in order to slow downthe polymerization and precipitation of the coloring compounds during the wine storage.**Figure 1** shows the effect produced bythe micro-granulated gum arabic treatment on the color intensity and wine tint evaluated by spectrophotometric measurements. As it was expected, the treatment with gum arabic at a dose of 20-25 g/hL prevented the sedimentation of the coloring compounds.

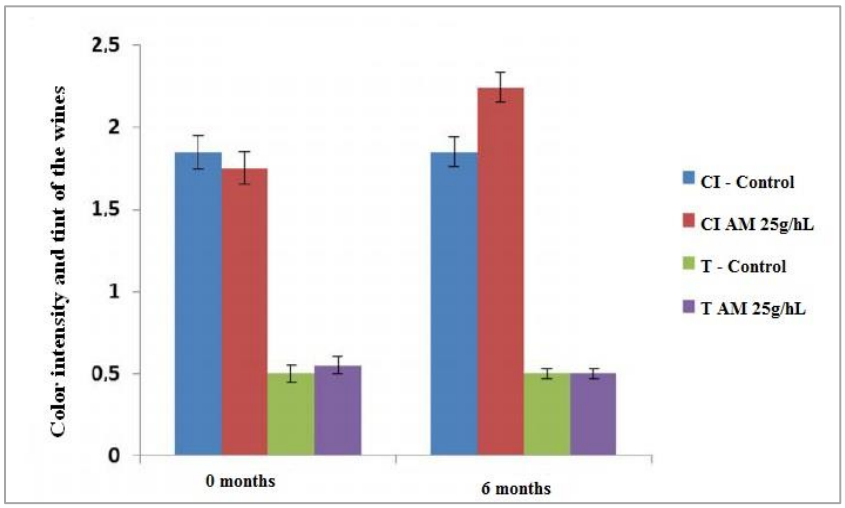


Figure 1. The effect of the treatment with micro-granulated gum arabic on the color intensity and tint for the studied samples

Analyzing the data from **Figure 2**, it can be noticed that for the gum arabic treatment at 25 g/L the gelatin index dropped from 74 to 62 compared to the control variant at which the gelatin index increased from 74 to 75. The transfer of the wine into oak barrels attenuated the taste variations of the control variant very little. On the contrary, the addition of gum arabic reduced the astringency by lowering the gelatin index, due to the fact that many combinations can be formed between the arabino-galactan macromolecules of the gum arabic and the polyphenols of the wine (and also undoubtedly of the oak barrel). If the dose of gum arabic is too small, it cannot oppose the precipitation of the dyes. However, if the dose is too high, of over 100 g/hL or more, the reversal of the desired protection can be obtained. Gum arabic is, in this case, a precipitating factor. These large amounts are used to alleviate the astringency and bitterness of the wines that may still have aggressive tannins at the time of bottling.

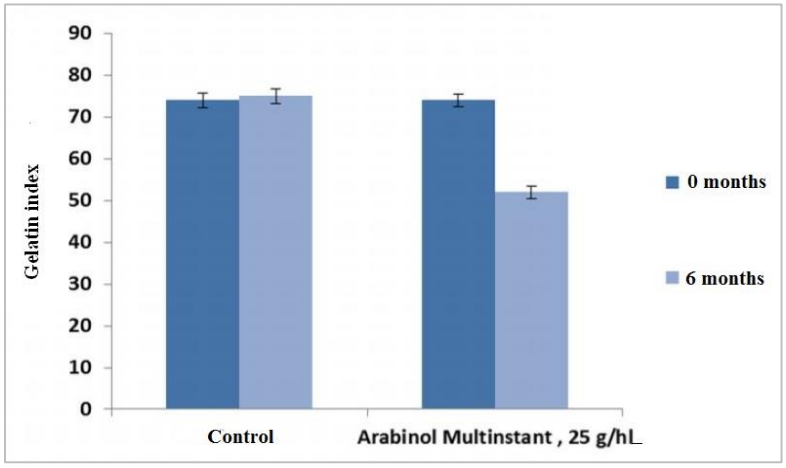


Figure 2. The gelatin index value after the treatment with micro-granulated gum arabic

Normally, the aim is to produce a wine with a good color, balance, softness and distinctivegrape aromas, but without any aggressiveness. Thus, it is very important to promote

the extraction of tannins fromthe grape skins although the excessive extraction should be avoided, as it gives a herbaceous character to the wine. The emphasis should be on the maceration prior to fermentation, with a minimum level of pumping-over, concentrated mainly at the beginning of maceration process, while vatting should be very short and the temperature should be kept below 30°C**(**P. RIBÉREAU-GAYON & al. [8], J. MORENO & al. [9]). P. RIBÉREAU-GAYON & al. [8] stipulated that red wines do not necessarily stabilize in the first year and also that the warm temperatures promote the tannins and polysaccharides combination, the medium still having a high colloidal molecules concentration of the same type so that more colloidal coloring matter may be formed. To avoid this process, it is possible to use 'protective colloids compounds' and eliminate all other colloids by fining techniques. Protective colloids, such as gum arabic, prevent the unstable colloids flocculation by maintaining the particles in suspension rather than eliminating them. Their findings were in agreement with the stabilizing color effect of high molecular weight mannoproteins (420 kDa) and gum arabic from different types of wine such as Muscat, Chardonnay and Carignan. Regarding the gum arabic treatment, it is a natural product with a perfectly neutral flavor that does not affect the organoleptic quality of wine, even at doses much higher than those normally used. The only possible reservation concerns its use in wines intended for long aging (P. RIBÉREAU-GAYON & al. [8]).

### 3.3. The influence of the gum arabic addition on the sensory properties of red wines

The transfer of red wines to new barrels may lead to unexpected results. The tannins present in wine with a tendency to dry the oral mucosa is accentuated so hard that it becomes disagreeable, to such a degree that the wines develop an astringent taste impression often similar to a dusty taste. The experimentsattested that it is possible to eliminate this inconvenience by treating the wines, which may determine a dryness mouthfeel sensation, with micro-granulated gum arabic before transferring the wines into barrels. In this case, the recommended dose of 20-30 g/hL can be adjusted according to the tannin character of the wine, but also according to its hardness expressed by the synergy between harshness, astringency and bitterness. The results obtained from the experiment on theFeteascăneagră wine (Figure 3) indicated the improvement of the unctuosity as a result of the micro-granulated gum arabic addition. The undesirable sensation of harshness and bitterness faded almost instantly after the addition of micro-granulated gum arabic when the wine became more balanced and with a more pronounced mouthfeel persistence. The comparative sensory analysis showed that thegum arabicgenerated a fading effect on the bitterness and a highlighting one on the unctuosity of the wine obtained from the Feteascăneagră variety. This process could be explained by the ability of the micro-granulated gum arabic to combine with tannins in order to reduce their astringency, thus leading to an acceleration of the maturation of the wine.

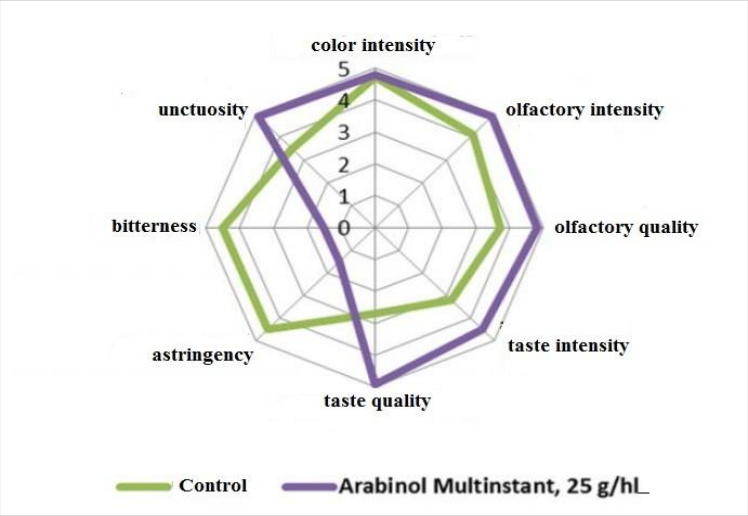


Figure 3. Sensory characteristics of the non-treated and treated wine with gum arabic (ArabinolMultinstant 25 g/hL)

Other preliminary experiments have shown that in Cabernet Sauvignon wine, the dose of gum arabic could be increased up to 30 g/hL, while in the Pinot Noir variety, a dose of only 15-20 g/hL was acceptable (CROITORU [13]).

Other researchers such as A. BARBOSA & al. [14] studied the aroma profile and the volatile phenols (4-ethylphenol and 4-ethylguaiacol) that affected the wine quality through aroma defects. Their study aimed to evaluate the effect of some common oenological techniques such as gum arabic treatment on the concentration of volatile phenols and the sensory impact of these odour-active compounds in wines. The influence of various treatments was evaluated by sensory analysis through multiple comparison tests. The tasting tests were performed in a specialized white sensory evaluation laboratory at room temperature (19 ± 2°C) whereas the wines were stored in a dark cabinet. The wines treated with gum arabic (Filtrostabil), egg albumin (Ovocol) and oak chips did not undergo significant changes in the concentration of volatile phenols, hence suggesting the incapability to establish molecular interactions with these compounds. The application of gum arabic treatment did not generate any significant effecton the sensory analysis of the tested wine (A. BARBOSA & al. [14])

### 3.4. Sensory characteristics of the Feteascăneagră wine treated with alternative oak products

After the treatment of the wine with raw, untreated oak chips there was no noticeable improvement in the sensory quality of matured dry red wines for 3 months (**Figure 4a**). By administering high doses of fresh oak chips (5 g/L) during the malolactic fermentation, the results demonstrated an increase of the desirable sensation of dryness that was quite obvious. For red wines treated with raw chips, the volume and the chromatic characteristics also improved.

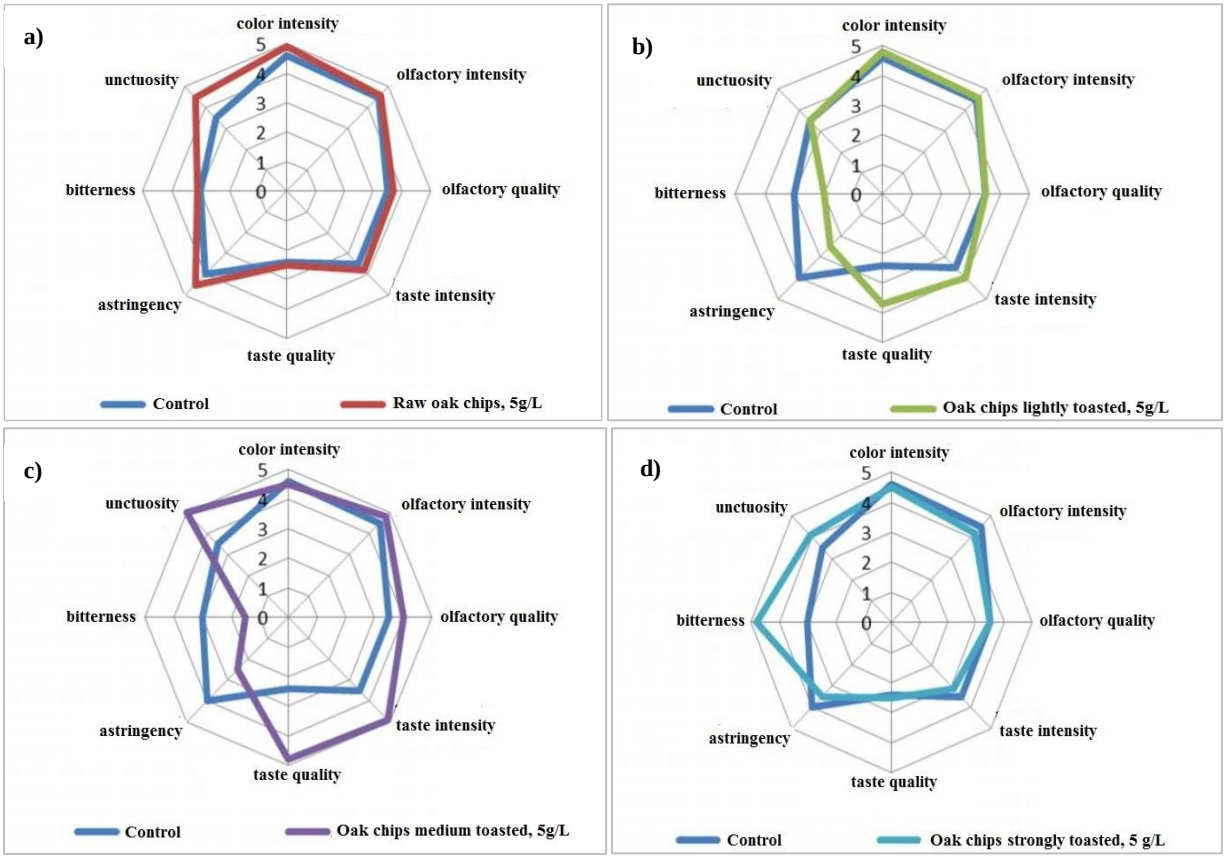


Figure 4. Sensory characteristics of the treated wine with a) raw oak chips, 5g/L; b) oak chips lightly toasted,5g/L; c) oak chips medium toasted, 5g/L; d) oak chips strongly toasted, 5g/L

Instead, the use of raw chips did not improve the olfactory character of the treated wine, and the tannic character was dominant and provided a despicable feeling of dryness in the soft palate. As a result of the treatment of the wine with lightly and medium toasted oak chips, a significant improvement in the sensory quality of the matured red wines was observed (Figure 4 b). The wines treated with lightly toasted chips highlighted vanilla and caramel notes, accompanied by a gustatory character dominated by a caramel and a woody taste and further complemented by an amplitude increase in the soft palate (**Figure 4c**). The same notes of vanilla, caramel and toasted aromas, associated with typical appetizing gustatory sensations (toasted, caramel, vanilla) but also less appetizing (astringency and sawdust), were also noticeable in the wines treated with medium toasted oak chips. The treatment with medium toasted chips emphasized the increased aromatic complexity sensations and the notes of caramel (**Figure 4c**). For the wine samples treated with strongly toasted oak chips, an increase of the aromatic complexity and in the taste notes of coffee and toasted was observed. Also, the feeling of bitterness was very perceptible (**Figure 4d**). M. CANO-LÓPEZ & al. [15] studied the influence of oak chips with different sizes to a wine stored either in a stainless steel tank or in used barrels. The influence of these treatments was assessed by sensory analysis, using the descriptive analysis as well as triangular tests to determine whether the differences between the samples could be clearly perceived. In regards to the aroma descriptors, the following descriptors were used: vanilla, fruity, woody, spicy, horsy, herbaceous and smoky. The vanilla and

woodynoteswere positively correlated to the cis-lactone content (P. CHATONNET [16], P. CHATONNET [17]),a trans-isomer, which is usually present in low concentrations and itenhances the herbaceous and woody aromas (M. CANO-LÓPEZ & al. [15]). The vanilla aroma was attributed to the presence of vanillin. This compound is mainly formed during the thermal degradation of lignin correlated to the oak toasting, although it is also found naturally in green wood. Its sensory characteristics may be diminished during storage because it is easily transformed into non-aromatic compounds such as vanillic alcohol and its derivatives during wine maturation (P.J. SPILLMAN & al. [18]). Regarding the oak chips size, no significant differences were assessed in the scores for fruity, spicy, herbaceous and horsy character when it comes to the intensity that was obtained with the cubes, whereas the highest aroma quality score was achieved with the shavings. It has also been stated that smaller sized chips can absorb the wine quicker. The wine penetrates and soaks the chipsfully, thus facilitating the process of aroma compound diffusion from the wood to the wine (M.L. MORALES& al. [19]). Other studies have also demonstrated that smaller oak chips are more combustible so that more toasting-related compounds are formed and transferred (J. CAMPBELL & al. [20] ), although the same authors demonstrated that if the size is smaller than 5 mm, the aroma compounds are lost due to evaporation. This process might be explained by the lower scores obtained for the aroma quality and intensity by the wine matured with oak powder. As expected, the control wine sample showed the lowest scores for all the aroma descriptors, except for the herbaceous character, which reached its highest value in the studied wine (M. CANO-LÓPEZ & al. [15]).

## 5. Conclusions

The treatment of the new red wine obtained from Feteascăneagră grape variety with highly purified micro-granulated gum arabic allowed the production of wines with a high clarity with a great impact both on the final quality of the wine and on the costs of the filter materials. The stability of the red wine treated with micro-granulated gum arabic specific chromatic indexes increased compared to the stability of the chromatic indexes of the control variant. Treating the red wines with a highly purified micro-granulated gum arabic led to expressive red wines that emphasized their chromatic, olfactory, gustatory, fruity and unctuous characteristics.The use of untreated oak chips may be risky because there is the possibility of transferring into the wine undesirable compounds extracted from the oak wood that may affect the olfactory-gustatory profile of the wines such as bitter compounds, earth-flavored compounds or moldy compounds formed as a result of the poor preservation in the presence of an oak wood with a high humidity. The addition of oak chips induced profound sensory changes to the red wines when judiciously used, which most of the tasters considered them positive, regardless of the type of chips used, with the impossibility of significantly differentiating the fermented and matured wines without oak chips from those fermented and ripened in the presence of oak chips. After the maturation of the red wine in the presence of oak chips, the pleasant tasting sensations of "sweetening" and the diminishing of the astringency and bitterness sensation were reported in the tasting, the increased sensation of sweetening being determined by the passage into the red wine of some natural polysaccharides extracted from oak wood. The favorable changeof the wine’s sensory profile was all the more intense as the doses of chips administered were judiciously chosen, without a linear correlation between the dose size and the intensity of the olfactory-gustatory qualities of the treated wine.

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