

## **Determination of chemical transformations and aging potential during aging in dry red wine made from Saperavi grapes harvested in the Kindzmarauli microzone.**

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**Abstract:** There are more than 450 local grape varieties in Georgia. A distinctive high-quality Georgian wine grape variety is Saperavi, which is one of the best representatives of the assortment of red-wine grape varieties in the world. This variety reveals its outstanding properties in certain microzones, including the Kindzmarauli microzone, where the naturally semi-sweet wine with the designation of origin "Kindzmarauli" is produced. We set a goal to make a dry red wine from the Saperavi variety grapes harvested from the Kindzmarauli microzone. We fermented them in different vessels and then compared them to each other, both organoleptically and what physico-chemical and biochemical transformations we would witness during its aging. The research became more interesting for us after it turned out that there was no research on the aging potential of dry wine made from Saperavi harvested from the Kindzmarauli zone in the Georgian It is not found in academic works. We believe that red dry wine made from Saperavi grapes harvested in the Kindzmarauli zone is distinguished by its special organoleptic characteristics and has great aging potential.

Out of the 39 registered wine designations of origin in Georgia, 19 are produced in Kakheti, and among them, red wines with a designation of origin are mainly made from Saperavi. Saperavi is the most common red grape variety in this region. It is the best material for almost all types of wine , although it exhibits its best qualities in the soil and climate conditions of its specific macro and micro regions, one of which is the Kindzmarauli zone.

Saperavi grapes are used to make both qvevri and dry red European wines. Saperavi also produces excellent rosé and sparkling wines. ( [www.wine.gov.ge](http://www.wine.gov.ge) )

"Comparatively softer, Bordeaux-type, full, harmonious, velvety wines are produced by Saperavi on the left side of Alazani - in the foothills of the Main Caucasus, mainly on medium-grained alluvial-carbonate alluvial-non-carbonate soils. These include: Kvareli (Kindzmarauli), Napareuli, Sabui, Artani (Sazlago) and other high-quality red wines of origin." (Sak. AMP)

“Professor K. Modebadze (2) characterizes Saperavi wine as “intensely colored, full-bodied, velvety in its age, which, when prepared in a European manner, is not inferior to the best wines of France.” (Sak.Amp)

The high qualities of Saperavi wine have been noted by many famous winemakers. "Indeed, Saperavi, with its high organoleptic properties, intense color,

Impact factor 9

body, harmonious blend of components, and strong bouquet in antiquity, takes first place among the best red wines in the world." (Sak. AMP)

from the National Wine Agency, Kindzmarauli ranks among the leading wines with protected designation of origin in terms of the number of wines exported.

Kindzmarauli, as a naturally semi-sweet wine, is particularly high in the world wine market, although it is no less interesting for us to see what special properties a dry wine made from Saperavi grapes harvested from the same microzone can have. It is worth noting that no research has been conducted specifically on dry wine made from Saperavi from this microzone to determine its aging potential. In our opinion, this issue is very important and noteworthy.

the physicochemical and biochemical transformations that occurred in dry red wine made from Saperavi grapes harvested in the Kindzmarauli microzone, as well as its aging potential.

The content of tannins and phenolic compounds in wine is very low, about 0.1%, compared to other wine components. However, their importance is particularly important in red wine from the skins of grapes.

Anthocyanins are derived from grape skins. It is well known that they are one of the most important components of red wine because they react with other compounds in the wine to form polymeric pigments. As the wine ages, anthocyanin molecules undergo various reactions, resulting in their concentration in the wine bottle decreasing, but the wine still retains its red color.

Anthocyanins are indeed colored, but their color is pH-dependent and thus have different colors at different acidity levels. It is the transformation of these components that is of interest to us during our research into the aging process of wine.

Another important compound in wine is tannins. Condensed tannins are polymers of flavan-3-ols that give wine its acidity, slight bitterness, and dryness. It is known that changes in the structure of tannins play a crucial role in wine aging.

It should be noted that no experimentally substantiated studies can be found in the Georgian scientific literature. Thus, we set out to conduct various studies, which began with determining the chemical composition of the wines. We took for analysis: Saperavi 2019, our own Saperavi 2023 and Saperavi 2024 wines, which were obviously harvested from the Kindzmarauli microzone.

Initial analyses of the wines studied showed that the wines of three different years and aging periods have similar data. We can highlight some of the analyses and highlight the chemical transformations that accompany the aging process. Total polyphenol content of Saperavi, Kindzmarauli The microzone in 2019 is 2.12 g/l, which is an indicator that, like new wines, it still has great aging potential.

Impact factor 9

| Parameter / Dimension            | Name of wine material / Saperavi, Kindzmarauli Microzone 2019 | Name of wine material / Saperavi, Kindzmarauli Microzone 2023 | Wine material name / Saperavi wine 2023 Trial non-zone |
|----------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|--------------------------------------------------------|
| Alcohol %                        | <b>14.2</b>                                                   | <b>14.26</b>                                                  | <b>13.59</b>                                           |
| Total sugar g/l                  | 1.3                                                           | 1.4                                                           | 1.3                                                    |
| Titrate acidity g/l              | 5.4                                                           | 5.6                                                           | 6.3                                                    |
| Volatile acidity g/l             | 0.46                                                          | 0.47                                                          | 0.43                                                   |
| <b>pH</b>                        | 3.79                                                          | 3.66                                                          | 3.63                                                   |
| Free <b>SO<sub>2</sub></b> mg/l  | 19                                                            | 21                                                            | 10                                                     |
| Total <b>SO<sub>2</sub></b> mg/l | 80                                                            | 55                                                            | 25                                                     |
| Density                          | 0.9952                                                        | 0.9950                                                        | 0.9926                                                 |
| Malic acid g/l                   | 0                                                             | 0                                                             | 0.4                                                    |
| Lactic acid g/l                  | 1.56                                                          | 1.37                                                          | 0.97                                                   |
| Extract g/l                      | 28.6                                                          | 30.3                                                          | 29.8                                                   |
| Total polyphenols in g/l         | 2.12                                                          | 2.2                                                           | 1.63                                                   |

It turned out that our research conducted on a spectrophotometer revealed different data in wine.

For the study, we made dry wine from 2023 non -zone Saperavi, which we prepared in neutral vessels. In order to analyze and compare last year's harvest, we added to the experiment dry wines from the same 2023 Kindzmarauli microzone Saperavi and the 2019 harvest from the same microzone.

Table 1 .

| <b>Wine - 4.16.2025</b>                         | Total phenols<br>mg/ml<br>(calculated as<br>chlorogenic<br>acid) | Phenolic acids<br>mg/ml (calculated<br>as caffeic acid) | Total flavonoids<br>mg/ml<br>(calculated as<br>quercetin) |
|-------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------|-----------------------------------------------------------|
| Saperavi Wine<br>Kindzmarauli<br>Microzone 2019 | 5.24                                                             | 0.418                                                   | 4.480                                                     |
| Saperavi Wine 2023<br>Trial Area                | 3.94                                                             | 0.455                                                   | 3.184                                                     |
| Saperavi Wine<br>Kindzmarauli<br>Microzone 2023 | 5.41                                                             | 0.472                                                   | 4.881                                                     |

Spectrophotometric studies showed that total phenols in mg/ml (calculated as chlorogenic acid) were highest in the 2023 Kindzmarauli microzone Saperavi wine - 5.41. Phenolic acids in mg/ml (calculated as caffeic acid) were highest in the 2023 Kindzmarauli microzone Saperavi wine - 0.472, and the lowest in the 2019 Kindzmarauli microzone Saperavi wine - 0.418. Total flavonoids in mg/ml (calculated as quercetin) were highest in the 2023 Kindzmarauli zone wine - 4.881, and the lowest in the 2023 non-zone Saperavi wine produced by us - 3.184.

Table 2.

| <b>Wine - 4.16.2025</b>                         | Catechins<br>mg/ml<br>(converted to<br>D-catechin) | Total<br>anthocyanins<br>mg/ml | Monomeric<br>Anthocyanins<br>mg / ml (by<br>cyanidin 3-O<br>glucoside) (by<br>recalculation ) |
|-------------------------------------------------|----------------------------------------------------|--------------------------------|-----------------------------------------------------------------------------------------------|
| Saperavi Wine<br>Kindzmarauli<br>Microzone 2019 | 1.146                                              | 0.046                          | 0.037                                                                                         |
| Saperavi Wine<br>2023 Trial Area                | 0.823                                              | 0.137                          | 0.103                                                                                         |
| Saperavi Wine<br>Kindzmarauli<br>Microzone 2023 | 1.388                                              | 0.130                          | 0.104                                                                                         |

Impact factor 9

Catechins mg/ml (calculated to D-catechin) The highest indicator is in Saperavi wine Kindzmarauli microzone 2023 - 1.388, and the lowest is in our 2023 non-zone Saperavi - 0.823. Total anthocyanins mg/ml The highest was found in our non-zone Saperavi wine, 0.137. Monomeric anthocyanins mg/ml (calculated as cyanidin 3-O glucoside chloride) was highest in the 2023 wine from the Saperavi Kindzmarauli microzone, and the lowest was in the 2019 Saperavi Kindzmarauli microzone wine, 0.037.

Table 3.

| <b>Wine - 4.16.2025</b>                   | Leucoanthocyanins mg/ml (calculated as leucoanthocyanidin) | Antioxidant activity - 50% inhibition of DPPH radical by mg sample | Antioxidant activity - 50% inhibition of DPPH radical - relative activity (as a ratio of 1) |
|-------------------------------------------|------------------------------------------------------------|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Saperavi Wine Kindzmarauli Microzone 2019 | 0.318                                                      | 4.919                                                              | 0.203                                                                                       |
| Saperavi Wine 2023 Trial Area             | 0.379                                                      | 6.796                                                              | 0.147                                                                                       |
| Saperavi Wine Kindzmarauli Microzone 2023 | 0.353                                                      | 4.983                                                              | 0.201                                                                                       |

Leucoanthocyanins mg/ml ( as leucoanthocyanidin) (recalculated) was the highest in our 2023 non-zone Saperavi wine, 0.379, and the lowest in our 2019 Kindzmarauli microzone Saperavi, 0.318. Antioxidant activity - 50% inhibition of DPPH radical by mg sample The highest among the test samples was found in Saperavi Kindzmarauli microzone 2019, 4.919, and the lowest in our 2023 non-zone Saperavi, 6.796. Antioxidant activity - 50% inhibition of DPPH radical - relative activity (as a ratio of 1) The lowest indicator in this analysis is in Saperavi 2023, 0.147, which I made as a trial. The highest was Saperavi wine from the Kindzmarauli microzone in 2019, 0.203.

Summarizing the results of our spectrophotometric study, we conclude that the harvest year is of great importance in determining the aging potential of wine, in particular, meteorological factors play a significant role. Although the 2023 wines showed relatively high phenolic compounds and antioxidant indicators, the data from

[Impact factor 9](#)

2019 are not radically different. As a 6-year-old wine, its indicators reflect that wines from this origin have great aging potential.

Also, studies have clearly shown the difference between wines from the same harvest year when grapes are harvested from different locations. The 2023 Kindzmarauli Microzone Saperavi is rich Compared to the 2023 non-zone Saperavi, this in itself indicates that dry wines made from the Kindzmarauli microzone have much greater aging potential.

### **References:**

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