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Influence of maturity level on the storability of the Georgian variety “Iveria”

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Abstract:

Grapevine storage is still a major concern in Georgia. Grapes are one of the most unstable crops in terms of storage, which is related to its botanical-morphological structure. Metabolic processes results in a considerable reduction in nutritional properties during storage.

The study aimed to determine the effect of different maturity levels of the Georgian selective grape variety "Iveria" on its storability, based on some biochemical indicators: dry matter, sugars, vitamin C, organic acid, amino acids as well as the impact of their possible changes on the qualitative indicators of grapes hatvested at different dates.

Monitoring of weight loss, dry matter concentration sugars and acidity were conducted in the initial, middle, and final stages of storage at 0 °C/ -1 °C temperatures during 90 days. Sugar were measured by Bertrand’s method, ascorbic acid was evaluated using Tillman’s method. Titratable acidity is measured by titrating a sample of grapevine juice using 0.1M sodium hydroxide to a pH of 8.2. dry mass using refractometer, 0.1 N NaOH was used to titrate acidity (g/100ml) to a phenolphthalein end point or, alternatively, to a pH of 8.The concentration of total amino acid was measured using Ninhydrin, and absorbance was determined at 570 nm on a UV-5100B UV/VIS spectrophotometer.

It was revealed that the second harvested grapevine variety ‘Ivera” maintains the quality properties (taste, aroma, physical appearance) after 90 day of storage without berry loss and browning. Thus, the harvested date is determined when the sugar concentration reached less than 23% and all biochemical compound are presented sufficient for long term storage.

Key words: *Grapevine, storage, biochemical parameters, variety “Iveria”*.

INTRODUCTION

Grape is one of the important and useful cultures due to their composition.[1] Traditionally, table grapes are subjected as a highly perishable fruit characterized by water loss, rachis browning after harvest, and during long-term storage [2]-[4]. Due to the lack of table grapevine during winter, the customers demand high-quality table grape fruit market, becomes more competitive, grape quality has attracted more and more attention from producers, so it is necessary to develop grapevine storage technology. Grape storage is a complex technological process including storage of the product for a long period without a noticeable change in its quality. The biochemical processes are different during long-term storage and depend on the varieties, harvested condition, maturity level, and different geographic location [5], [6].Most researchers agree that pH, total soluble solids (TSS), titratable acidity (TA), the sugar-to-acid ratio (TSS/TA), and aroma are the major maturity indices of table grapes [7].

It is difficult to determine the harvested date of grapevine and estimate the maturity level of grapes. [8], [9]. The same grape variety may not ripen at the same time. The process of grape maturing is accompanied by the accumulation of sugars, in which glucose and fructose are dominant. At the beginning of ripening, glucose is more than fructose, after completed maturity, their ratio is equal, and the total acidity is low [10].

The main component for storage is sugar concentration, less than 12-13 % is considered unuseful for storage, high sugar concentration of more than 28-30% during late harvest (over maturity) also is not suitable for storage. It is known that ripe grapes accumulate large amounts of glucose and fructose but little sucrose [11], [12]. In contrast, in ripening fruits the ratio of sucrose :(glucose + fructose) in the apoplast is higher [13]. Organic acids in grapes determine organoleptic properties such as flavor, color, and aroma and the stability and microbiological control of the products. Tartaric and malic acids are the primary organic acids in grape juices, whereas succinic and citric acids occur in less quantity [14], [15].

The number of organic acids in grapes is large at the initial stage of ripening, but it reduces towards the end of their maturity. During the ripening of grapes, the gradual decrease in acidity is caused by the interaction of organic acids, namely tartaric acid and malic acid [16]. Malic acid is transformed into sugar at the end of the grape ripening process. This chemical mechanism reduces the acidity and raises the amount of sugars [17]. As a result, grape maturity should be monitored to ensure that the ratio of organic acids should be as sufficiently high as is crucial for storage.

Among the chemical compounds of grapes, amino acids are also important, which influence the aroma of grapes. The composition and concentration of amino acids depend on the variety, cultivation technology, and environmental climatic conditions [18].

Therefore, in general, grapes should be harvested only when their qualitative indicators are clearly expressed.

The aim of the study was the influence of different maturity levels of the Georgian selective grape variety "Iveria" on its storability, based on some biochemical indicators. Therefore, the study was conducted to determine the changes in the quantitative indicators of sugars, vitamin C, and amino acids in the initial, middle, and final stages of storage and the impact of their possible changes on the qualitative indicators of grapes.

MATERIALS AND METHODS

The experiment was conducted in the Georgian Technical University- Biotechnology Center during 2022-2023 years. The Georgian selective variety “Iveria” was selected for research. The vegetation period is 184 days. The vines are of medium or vigorous growth, abundant, and high-quality production ability. The grapevine variety “Iveria” was collected from experimental plots of Jighaura in two harvest periods with an interval of 14 days in September. Grapevine variety “Iveria” was refrigerated (0°C, -1°C, 90% RH) under 10g/10 kg potassium metabisulphite (KMS) for 90 days. The level of dry matter, total sugar, sucrose, free organic acid, amino acid, and ascorbic acid were evaluated before storage, in the middle, and at the end.

Dry mass was determined using a refractometer (RL3 Refractometer-_RL 3, Poland, Nr 8508/85). Total sugar was measured by Bertrand's method; Bertrand's method is based on the reduction of sugar in the alkaline solution of tartrate complex with cupric ion; the cuprous oxide formed is dissolved in a warm acid solution of ferric alum. The ferric alum is reduced to $FeSO_4$ which is titrated against standardized $KMnO_4$; Cu equivalence is correlated with the table to get the amount of reducing sugar [19].

Ascorbic acid was evaluated using Tillman's method. Tillman's' method is based on the reduction properties of ascorbic acid on the blue dye 2, 6-dichlorophenolindophenol (DCIP). Ascorbic acid is measured by titration of the sample with DCIP solution in an acidic medium [20].

Titratable acidity is measured by titrating a sample of grapevine juice using 0.1M sodium hydroxide to a pH of 8.2.[21].

Titratable acidity (g/L tartaric acid) was determined using the following formula:

Titratable acidity = 75 × molarity (NaOH) × titer (mL) / Volume of the sample (mL)

The concentration of total amino acid was measured using Ninhydrin, and absorbance was determined at 570 nm on a UV-5100B UV/VIS spectrophotometer (M&A INSTRUMENTS INC, China) [22].

As rancidity is usually accompanied by the formation of free fatty acid, the determination of acid value is often used as a general indication of the condition and edibility of oils.

The acid value is the number of milligrams of potassium hydroxide required to neutralize the free fatty acids in 1.0 g of fat or oil. [23].

Acid value (mg/g) = 56.11 x 0.02 x (Vs — Vb) x F/W

Where; Vs = titration volume of sample (ml); Vb = titration volume of blank (ml); W = weight of fat in the volume of extract used (g); F = factor of 0.02 KOH solution.

Where- F = 5/ Vf: Vf is the volume of 0.02N KOH required to neutralize 5 ml of the 0.02N H_2SO_4 solution.

RESULTS AND DISCUSSIONS

It was revealed that the harvested grapevine in the second period (in the middle of September) contained more sugar, organic acid, and other compounds than samples collected in the first period (at the beginning of September).

The total sugar including fructose, glucose and sucrose, dry matter, titratable acidity, and ascorbic acid content in the first harvested grapevine variety on the different stages of storage are shown in Table 1. The results obtained for the grape variety "Iveria" were expressed in percentage (%).

As shown in the Table 1 the dry matter in the first harvested grapevine variety "Iveria" decreased by 3.3% after 90 days of storage. Due to the increase of fructose, the loss of sucrose and glucose did not have a significant effect on the decline in the total amount of sugars at the end of the storage. Ascorbic acid and titratable acidity showed expected results at all the stages of storage of the grapevine variety "Iveria".

Table 1. The Biochemical parameters in the first harvested grapevine variety" Iveria" during 90 days of storage.

Biochemical parameters of the grapevine variety "Iveria"	Beginning of the storage (%)	After 45 days (Middle of storage) (%)	After 90 days(end of the storage) (%)
Dry matter	21,2	19.4	17,9
Total sugar	18,9	17.5	16,7
Titratable acidity	0.49	0.39	0,28
Glucose	8,9	6.7	5.4
Fructose	8,9	10.5	11,3
Sucrose	1,1	0.8	0,5
Ascorbic acid	3,8	2.4	1.1

According to Table 2 despite decreasing some parameters most of the biochemical compounds are higher in the second harvested grapevine variety than in the first one. Only Glucose and

Ascorbic acid are the same accordingly 5.3% and 1.1%. The amount of total sugar, dry matter, and fructose concentrations at all stages of storage are significantly different between the first and second harvested date. The amount of sugar ranging from 21.9 to 23 % is the second harvested grapevine. The important loss was not revealed in Dry matter (1.9 %) and sucrose concentration (0.7%), but the amount of fructose was enhanced by 3.7%.

Table 2. The Biochemical parameters in the second harvested grapevine variety" Iveria" during 90 days of storage

Biochemical parameters of the grapevine variety "Iveria"	Beginning of the storage (%)	After 45 days (Middle of storage) (%)	After 90 days(end of the storage) (%)
Dry matter	25,2	24.6	23.3
Total sugar	23.1	20.8	21.9
Titratable acidity	0.57	0.52	0,49
Glucose	11.8	8.9	5,3
Fructose	11.8	12.6	15.5
Sucrose	1,6	0.8	0,9
Ascorbic acid	3,8	2.7	1.1

At the next stage of the study, the content of total amino acids was investigated during storage. (see table 3). The amino acid was more stable during the second harvest stage compared to the first. The loss of amino acid reached 0.99 mg/µl in the first harvested grapevine variety while only 0.42 mg/µl reduction was shown in the second harvested grapes.

Table 3. The concentration of total amino acid (mg/µl) in grapevine variety "Iveria" during 90day of storage

Harvested stages	Beginning of the storage mg/µl	After 45 days (middle of the storage) mg/µl	After 90 days (end of the storage) mg/µl
First harvest	0,307	0.214	0,208
Second harvest	0,331	0.302	0,290

Determining the optimal harvesting of table grapes requires monitoring the maturity level after the ripening of berries [24].

Considering the analysis of the obtained results, we can conclude that the "Iveria" variety harvested in the second period showed a slight decrease in total sugars, titratable acidity, vitamin C, and total amino acids, at the end of storage compared to the first period. As we mentioned above the concentration of fructose was increased (3.7%) and titratable acidity slightly decreased in the second harvested grapevine.

The sugars (mainly glucose and fructose) in grapes are crucial for providing the basic function of the fruit, and contributing to its taste [25]. Tartaric acid occurs in extremely small concentrations in berries during these early stages and then accumulates in the pulp of grape berries organic acids are responsible for the taste of juice also and have a significant effect on wine stability, color, and pH [26], [27].

Regarding the slight reduction (0.08%) of titratable acidity and enhancement of the level of fructose in the second harvested period caused the keeping of the taste properties of the fruit after 90 days of storage of grapevine variety "Iveria". Meanwhile, the first harvested grapes showed degradation of the marketable properties at the end of storage, which was caused by the decrease of a large amount of acids.

The minor change of ascorbic acid and amino acid, in the second period of harvested grapevine is associated with the maturity level of the grapes [28], [29]. The maturation factor is especially interesting because the synthesis of many of the aroma compounds occurs during ripening [30]. Different studies demonstrate that the amino acid composition affects the grape ripeness, quality, and aromatic profile of the wine [31].

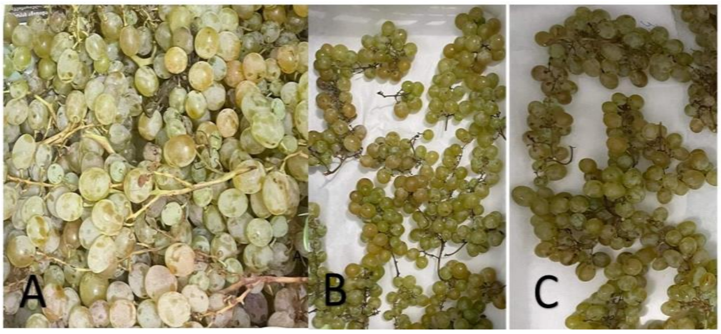
Weight loss is mainly due to water evaporation in fruit caused by transpiration and respiration processes during storage periods. Based on the weight loss we can estimate the response of horticultural products to treatments [32].

As usual, during storage grapes lose their useful substance, in this period the fruit loses vitamins and amino acids, the loss of useful substances is caused by disorders of the biochemical process in grape berries which are activated at high temperatures and high circulation of oxygen during storage. [33], [34].

The low temperature used during storage promoted the grapes' maturity and also slowed down the physiological process and pathogens weaker [35] which led to a small reduction of biochemical parameters in the grapevine variety “Iveria”, therefore in the experiment showed that the early harvested grapes lose vitamins more rapidly than the late harvested grapevines.

In conclusion: It was found that a significant reduction of biochemical parameters was presented in the first harvested grapes after 90 days of storage, which resulted in the deterioration of some biochemical parameters. (See figure 1) It is related to the fact that, the chemical composition of substances that ensured the quality indicators in early harvested grapes could not be accumulated at the end of storage.

Fugure 1. Grapevine variety “Iveria” A- before storage, B- after storage of pirst hatvested grapes C- after storage of second harvested grapes.



Grape maturity at harvest strongly affects storage quality and, therefore, an adequate strategy of selection harvest date is a key issue to provide high-quality grapes during long storage.

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