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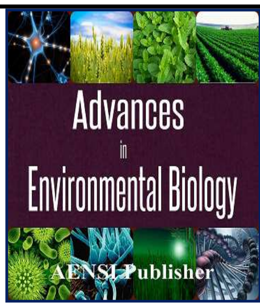


# Nutritional Quality and Bioactive Compounds of Some Fruit Juices

**[1]Farida Benmeziane, [2]Abdou Moussa Abdourhamane, [3]Assia Guedaoura**

*[1,2,3]University Chadli Bendjedid, El-Tarf, Department of Agronomy, Faculty of Natural Science and Life, Box 73, El Tarf, Algeria*

**Address For Correspondence:**
Farida Derradji - Benmeziane, university chadli Bendjedid, El- Tarf, Department of Agronomy, Faculty of Natural Science and Life, Box 73, El Tarf city, Algeria
E-mail: benmezianefarida@yahoo.fr



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## ABSTRACT

**Background:** fruit juices are a ready and rich sources of vitamins, fiber and minerals for human consumption due to its uses as medecin, food and appetites. Juices are more convenient to consume, and have in general a longer shelf-life than fresh fruit. **Objective:** The present study was aimed to determine the physicochemical characteristic of some fruit juices including Commercial Grape Nectar (CGN), Fresh Grape Must (FGM) Tangerine Juice Pasteurized in Bath-water (TJPB) and in Micro-wave oven (TJPM) and to determine some bioactive compounds in grape juices. **Results:** obtained results show that all juices analyzed had relevant physicochemical composition; however, the quantity of analyzed compounds was different in each case. **Conclusion:** Given the obtained characterization, the beverages analyzed in this work can be considered as good sources of nutritive compounds that are indispensable to healthy feeding habits, thus, their consumption should be stimulated**.**

**KEYWORDS:** Fuit juice, physicochemical characteristics, bioactive compounds,

## INTRODUCTION

Fruit provides important nutrients for overall health and are critical to good health, and certainly good for all age categories as it forms an important portion of a healthy diet [1], fruit juices are a popular way of consuming them. Juices are low in compounds such as sodium and fat which are believed to have negative health impacts when ingested in large amounts. Conversely, juices contain a variety of beneficial micronutrients, including significant quantities of minerals, like potassium as the major mineral, followed by calcium and magnesium, vitamins (vitamin C and B), fiber, volatile components, organic acids, polysaccharides and many bioactive compounds [2, 3]. In the tropics, a great variety of fruits are produced all year round [4, 5]. Many authors stated that consumed in adequate amounts (about 600 g / day), fruits and vegetables contribute to the prevention of the main diseases that affect our societies: cancer, heart disease and coronary diseases, diabetes (type 2), mouth, stomach, colorectal cancer, prevent developing kidney stones, help decreases bone loss, obesity, hypertension. This is due to the presence of some components called antioxidants such as carotenoïds, polyphenols (anthocyanins, flavonoïds, tannins) [6 - 10] , so much so that an incentive for the consumption of fruit and vegetables has become one of the main recommendations made by the public health authorities. If the juice from fresh fruits respect the rules derived from Guide to Good Hygienic, Agricultural and Manufacturing Practices for the primary production, conditioning, packing, storage and transportation of fresh fruits, proposed by López Camelo [11], and then drinking fresh fruits juice would be a very good habit for babies, children, adults, and old people to enhance their health status. In Algeria, fruit juices are highly demanded among people of different age groups and this has led to influx of varieties of local juices into the market.

This is the case of the grapes produced from the genus *Vitis* which is a fruit first among the fruit crops in the world an in Algeria, from the point of view of its production and its economic importance. This can be consumed in various forms, raisins, juice or nectar; and the tangerine from the genus *Citrus*, which is consumed as fruit or a juice. Accordingly, the purpose of this study was (i) to compare two products derived from grape, juice and nectar to determine the physicochemical differences and the antioxidant content which may contribute to the quality control ; (ii) to compare the physicochemical characteristics of tangerine juices pasteurized in Bath water and in Microwave oven, in the other hand.

## MATERIALS AND METHODS

*Sources of Materials:*

The tangerine (*Citrus tangerina*) fruits were purchased directly from a orchard at the region of Drean, El-Tarf city, Algeria on February 2016; The fruits are selected from a tree one by one and are mature and show no injury or infection. The sample of the commercial grape nectar was purchased from a supermarket in the city of Annaba (Algeria) on April 13, 2012. Based on the details indicated on the packaging, nectar is composed of grape juice concentrate at 50%, sugar, water and citric acid (E330). Whereas, the sample of the red grape (*Vitis vinifera*), Red glob variety, was purchased in the supermarkets of the same city on April 23, 2012. The samples were immediately stored in a refrigerator (4°C - 6°C) until the implementation of analyzes.

*Preparation of Juice Samples:*

Fresh, juicy, good quality grape and tangerine fruits were sorted for processing using physical characteristics such as uniformity of size, color and firmness, freedom from defects such as sunburn, skin abrasions, pitting, insect injury, and blotchy coloration as well as freedom from decay.

For grape juice preparation: The sample of the grape has been cleaned with water then with distilled water. The sample was ground in a mortar and then filtered through filter 0.45µm; the must was recovered and stored in an opaque and clean bottle and kept in a refrigerator after being weighed; for tangerine juice preparation: About 500 g of the tangerine fruit was weighed, washed, peeled, and blended in a domestically electric blender with 500 ml of water and 55 g of sugar. The tangerine juice is then divided into two parts, and each of these two parts is pasteurized differently:

• One part of juice was pasteurized in a bath-water at 80° C for 5 minutes;

• Another part was pasteurized in a domestic microwave oven at 55% power for 8 minutes; Microwave has thermal effect; namely, it causes the friction of polar molecules in material internal and much heat is generated which contribute to pasteurized the product.

The juices obtained (CGN, FGM, TJPB, TJPM) are then stored in refrigerator at about 8 °C until analysis.

*Analyses:*

*Determination of Physicochemical Parameters:*

The juice samples were studied to determine the following parameters: pH measurements were performed using pH-meter at 20°C, after being calibrated. Titratable acidity (TA) was determined by titration with 0.01 N of NaOH solution. The volume of sodium hydroxide was converted to gram of malic acid. The °Brix or total soluble solids (TSS) were determined by measurement of the refraction index with a portable refractometer. Refractive index was recorded and expressed as percentages; measurements were performed at 20°C. Moisture content was determined as described by Lako *et al.* [7], total sugar and total ash were determined by the method of AFNOR [12], while vitamin C was determined by the methods described by Njoku *et al.* [13]. Density and conductivity are measured using a densimeter and conductimeter, respectively.

*Color evaluation (Color Intensity (CI), Tint (T)):*

CI and T were determined using a 1240 mini Uv-Vis Spectrophotometer (*Shimadzu*), the absorbance of the tow grape beverages was recorded at 420 nm (yallow), 520 nm (red), 620 nm (blue) (Glories, 1984 *as cited by* Burin *et al.* [14] and estimated following calculations (Equations 1 and 2):

$$CI = Abs\ 420 + Abs\ 520 + Abs\ 620 \quad (1)$$

$$T = Abs\ 420 / Abs\ 520 \quad (2)$$

*Bioactive contents of grape must and nectar:*
*Extraction and determination of total phenolic contents (TPC):*

Approximately, to 10 g aliquot of liquid samples, 20 ml of 80% aqueous acetone solvent was added and left under stirring at room temperature for 1 h. The mixture was then filtered through Whatman filter paper (prosity of 0.45µm) using a funnel.

The concentration of total phenols was measured by the method using the Folin-Ciocalteu reagent **[15]**. Briefly, 50 µl of appropriately samples extract or standard solutions of gallic acid was pipetted into test tube, along with 2.5 ml of Folin-Ciocalteu reagent (diluted 1/10) and the mixture was allowed to react for 10 min. Then, 2 ml of 7.5 % $Na_2CO_3$ solution was added and mixed well then left in the dark for 30 min at room temperature for color development. Absorbance was measured at 765 nm and the TPC was derived by comparison with a gallic acid standard curve. The estimation of total phenolics in all the extracts was carried out in triplicate in Shimadzu 1240 MINI UV-VIS spectrophotometer (the same equipment was used in other analyses) and the result means were presented and expresses as mg of gallic acid equivalent (GAE)/ 100 ml of juice.

*Determination of total anthocyanins:*

The total anthocyanins content of the samples was measured using colorimetric method of Rapisarda *et al.* **[16]**. Briefly, 1 ml of each extract, obtained previously was mixed with 5 ml of buffer solution pH 1 and pH 4.5, separately. The absorbance of the solutions was measured at 510 nm. The concentration of anthocyanins in grape juices is calculated using the following formula:

$C\ (mg/l) = (A_{pH1} - A_{pH4,5}) \times MW \times Df \times 1000) / (\varepsilon)$
Where: MW: Molecular weight of cyanidin-3-glucoside (484.82)
ε: Molar extinction coefficient of cyanidin-3-glucoside (26900)
Df : Sample dilution factor.

## RESULTS AND DISCUSSION

*Tangerine fruit:*

Table 1 present some physicochemical characteristic of tangerine fresh fruit. The moisture content of tangerine was 84.33%, this value is in the same range with those reported by Boudries *et al.* [17] (81.25 - 86.18%) in citrus fruit including mandarin and those reported by Ywassaki [18] between 81.18 and 89.84%.

In contrast, the % of the dry matter was low (15.66%), this make tangerine a refreshing fruit. The juice yield or % of tangerine juice obtained in this study was very important (68.46%), therefore, the % of pulp was low (22.91%), which makes tangerine fruit very important on the economic plan for the production of juice, saw the high juice yield.

The total ash of tangerine fruit was 0.37 %, this value is very close to that obtained by Corpaş *et al.* [19] whom found 0.365%, but was lower than results recorded by Ywassaki [18] and those reported by Arekemase *et al.* [20]. The content of organic matter of tangerine fresh fruit was 15.33%. The organic material is essentially constituted of organic acids and sugars. The organic acids: citric, malic, oxalic, tartaric, galacturonic, quinic, etc. contribute to the particular flavor of tangerine juice and protect them against microbial growth.

**Table 1:** Some characteristic of tangerine fresh fruit

| *Physicochimical test* | *Tangerine fruit* |
|---|---|
| % of juice | 68,46 ± 3.91 |
| % of pulp | 22,91 ± 0.54 |
| Moisture content (%) | 84,33 ± 0.58 |
| Dry matter (%) | 15,66 ± 0.58 |
| Total ash (%) | 0.37 ± 0.04 |
| Organic matter (%) | 15.33 ± 1.15 |

*Result as mean ± standard deviation of three measurements*

*Tangerine juice:*

Acidity, pH, density, TSS, total sugar, conductivity and vitamin C of the two tangerine juices are illustrated in Table 2.

The pH is a determining factor in the ability of food to be preserved. Thus, a pH ranged between 3 and 6 is very favorable to the growth of yeasts and molds. The pH of *TJPB* (4.22) was slightly higher than the *TJPM* (4.25). Our results are higher than those obtained by Bouderies *et al.* [12] on citrus fruits.

The TA of the two juices varied from 172.91 to 181.45 g/l for TJPB and TJPM, respectively, which explained the acid taste with high acidity compared to orange juices (4.61 – 7.47) studied by Bouderies *et al.* [12].

The °Brix or the TSS recorded was the same for the two tangerine juices (11%), this indicate that the both treatments does not affect the content of TSS (°Brix). In his study, Serpen [21], found on orange fresh juice a content of TTS between 8 - 13%. The TSS recorded by Ameh *et al.* [22] in pawpaw fruit was 7.04% and 2.09% in lime fruit. In general, the level of sugar in the juice of a fruit is correlated to the level of sugar in the fruit itself.

According to FAO [23], fruit juice density is about 1.06, in the present work, TJPB and TJPM density was 1.050 and 1.035 respectively, which are slightly lower than the density of common juices. This may be due to different heat treatments on juices.

Sugar is an important chemical compound with a nutritional value. Few data are available on the influence of microwave treatments on total sugars in tangerine juice. Our results indicate an increase of the total sugar from 24% for JPBW to 26% for TJPM. Value of total sugar in the work of Magerramov *et al.* [24] on tangerine juice was 5.4%. These differences can be due to the different methods of juice preparation and heat treatments used in both studies.

Ascorbic acid or vitamin C is one of the most important parameters of nutritional quality in citrus juice, whose properties as an antioxidant are associated with a reduced risk of cancer, neurological, and cardiovascular diseases. Results obtained showed that the rate of vitamin C was important in the TJPB with value of 58.67 g/l than in the in TJPM with a content of 55.73 g/l, this can be explained by the heat treatment to which the tangerine juice has been subjected during pasteurization. This result is consistent to that observed on juice apple in the work of Zhang and Zhang [25]. Since vitamin C is heat labile, high processing temperatures can degrade this nutrient: several studies have been carried out to quantify the kinetic destruction of vitamin C at different temperatures and processing, and large differences in kinetic parameters have been observed. These variations can be attributed to the fact that nutrient destruction is a complex function of many variables such as pH, oxygen, salt, sugar, presence of enzymes, amino acids and metal catalysis [26].

**Table 2:** Some physicochemical properties of two tangerine juice

| *Physicochemical test* | *TJPB* | *TJPM* |
|---|---|---|
| pH | 4.22 ± 0.01 | 4.25 ± 0.01 |
| TA (g/l) | 172.91±11,10 | 181.45 ± 9.79 |
| Density | 1.050 ± 0.01 | 1.035 ± 0.01 |
| °Brix (TSS) | 11 ± 0.00 | 11 ± 0.00 |
| Conductivity (ms/cm) | 2.11 ± 0.00 | 2.05 ± 0.04 |
| Total sugar (g/100ml) | 24 ± 1.15 | 26 ± 0.65 |
| Vitamin C (g/l) | 58.67 ± 5.08 | 55.73 ± 5.08 |

*Result as mean ± standard deviation of three measurements*

*Physicochemical properties of grape beverages:*

pH, TA, °Brix, moisture content, density and color evaluation of grape beverages are illustrated in table 3.

The acidity of nectar which was 163.10 g/l, can be explained by the addition of citric acid as food preservative which is mentioned in the list of ingredients (E 330). The pH was ranged between 2.93 and 3.98 for nectar and the must, respectively. These results are close to that found by Rizzon and Miele [27] on grape juice and nectar with pH of 3.31 and 2.92, respectively and those found by Benmeziane *et al.* [28] on must made from five table grape with pH ranging from 3.39 to 3.81; but different from those obtained by Tavakolipour *et la.* [29] on grape juice in Urmia and Sabzevar varieties from Iran.

The results obtained show that grape nectar has higher moisture content (95%) than grape must (85%). This difference may be due to the fact that the grape nectar is prepared with 50% water (diluted juice).

According to FAO [23], grape juice density is 1.054, which is consistent with the results obtained in this study (1.052 and 1.053 for grape nectar and must, respectively).

The samples were found to be a good source of sugars. Grape must contained the highest TSS (17.5%), so, this beverage is recommended as natural sports drink, which is in agreement with findings of Metller *et al.* [30]. The high value of °Brix gave relatively a sweet taste in comparison with other grape juice TSS that was 16.2 % [27]; the same authors found a °Brix value of 14.25% on grape nectar which is lower than our result (16.5%). According to the CODEX STAN 247 [31], the minimum value of °Brix for the grape juice is 16%, samples analyzed in this study have values above 16%, indicating that all samples are in agreement with legislation

The CI is measured by spectrophotometer at different wavelengths (420, 520 and 620 nm). The absorbance at 520 nm is related to the presence of red pigments, anthocyanins. The absorbance at 420 nm is related to yellow brown pigments, flavonols. The results vary between 2.70 for nectar and 8.04 for must, and between 0.48 and 0.79 for CI and tint, respectively. The CI (CI = Abs 420 + Abs 520 + Abs 620) reflects the richness of a product colorants. The tint (T = DO420 / DO 520) reflects the proportion of yellow color compared to the red color, it increases during aging product (decrease in red color). As it can be noted in table 3, the grape nectar present the lowest CI and tint, this can be explain by the fact that the grape nectar in an aging product unlike to grape must which is freshly prepared.

**Table 3:** Physicochemical analysis samples of juice and grape must

| | *Grape nectar* | *Grape Must* |
|---|---|---|
| H (%) | 95 ± 0.5 | 85 ± 0.33 |
| pH | 2.93 ± 0.015 | 3.98 ± 0.05 |
| TA (g/l) | 163.10 ± 13.45 | 364.03 ± 6.7 |
| °Brix (%) | 16.5 ± 0.5 | 17.5 ± 0.05 |
| Density | 1.052 ± 0.0015 | 1.053 ± 0.0005 |
| Tint | 0.45 ± 0.13 | 0.79 ± 0.02 |
| CI | 2.70 ± 0.39 | 8.04 ± 0.093 |

*Result as mean ± standard deviation of three measurements*

*Bioactive compounds of grape must and nectar:*

*TPC:*

Phenolic compounds have been associated with the health benefits derived from consuming high levels of fruits and vegetables as described previously in the work of Eghdami and Sadeghi and those of Valiulina *et al.* [32, 33]. The TPC ranged from 31.13 to 76.82 GAE/100 ml in grape must and nectar, respectively (Fig.1). Comparing these results with literature, different values were reported, Mitić *et al.* [34] in their study on black grape juices (2158.77–2182.10 mg/l), Tosun and Ustun [35] in their work on orange, apricot, peach and sour cherry nectar with 194.20; 457.51; 413.72 and 475.69 mg catechin equivalent/l, respectively. In their study on the juice of the variety *Vitis labrusca*, harvested in February in the state of Santa Catarina, Brazilia traditionally prepared, Burin *et al.* [14] found a phenolics content of 23.509 mg/100ml, which is close to that found for must in this study.

These differences obtained between the results of this study and the literature can be justified by the fact that the fruits, main dietary sources polyphenols, as a function of intrinsic (cultivar, variety, ripening stage) and extrinsic (climatic conditions) factors, present quantitatively and qualitatively, a varied composition of these compounds [36], and also to differences in the juice processing techniques, such as extraction type, time and temperature, and the addition, or not, of enzymes [14]

***Total anthocyanins:***

Among the liquids studied, we highlight the value found for the amount of anthocyanins in the grape nectar of 5.215mg/l, which was superior to the grape must 4.66 mg/l, as it is shown in Figure 1.

The differences between results can be justified by the fact that during the nectar processing stages and, particularly, during their storage, knowing that grape nectar was manufactured on October 27, 2011 (mentioned on the packaging) and the sampling was made on April 13, 2012, during this period, the content of molecules responsible of this color decreased progressively and irreversibly forming more stable polymeric pigments. These pigments are responsible for changing the grape nectar color and flavor.

This difference can be explained also by the extraction process of must because during milling, skin may be incorrectly crushed by mortar, knowing that skin is the seat where anthocyanins are concentrated after their synthesis [37].

Malacrida and Motta [38] determined total anthocyanins in commercial grape juice, the anthocyanin mean values were 28.7 mg/l (juice) and 17.3 mg/l (reconstituted juice), that is, around four times higher than those found in our study. This difference may be due to the type of grape used, the juice processing, and storage methods. The temperature used during the processing and storage of juices can cause changes in the color of the product even the differences in pH values between the two drinks. This is due to the formation of chalcones (yellow) causing loss of color due to anthocyanin transformation.

The determinant factors in the variation of anthocyanin concentration in grape juices are the techniques used in the must processing, such as high temperatures during the extraction and pasteurization, as well as the different forms of storage [39].

However, the results recorded for the CI and the tint range in the opposite direction to those obtained for the anthocyanins with higher values for the must. But according to Fournand *et al.* [37] there is no direct relationship between the amount of red pigments (measured under acidic conditions) and the CI measured at 520 nm (measured in a wine model solution).

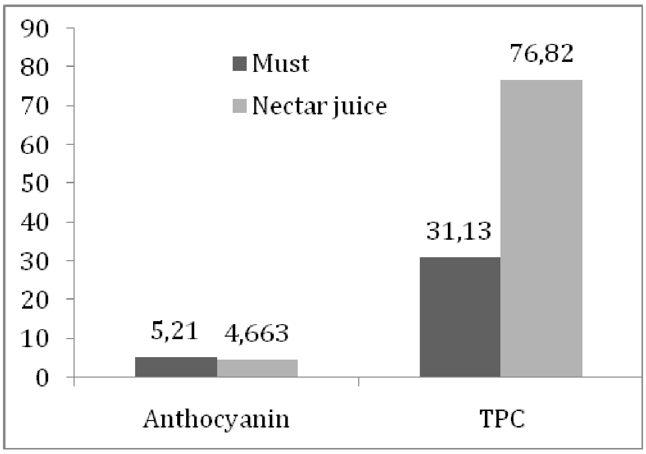


**Fig. 1:** TPC and anthocyanins content of must and nectar

*Conclusion:*

The results of this investigation show that, being more readily digestible than the other plant tissues, grape nectar as well as must and tangerine juices are good sources of antioxidants compounds indispensable for a healthy feeding and sugar which makes them important sports drink which are an indispensable tool to achieve a sufficient daily carbohydrate intake and to postpone fatigue during exercise and competition in many elite sports. Furthermore, this work show that the microwave treatment does not affect significantly the physicochemical properties of the tangerine juice compared to the pasteurization bath-water treatment.

Fresh fruit juices are low in sodium chloride, but very good for hydration – having over 90% of water, and are good drinking natural products for minerals content (ash content) which found in the present study. Thus, it is recommended to consume these beverages for their nutritional values. So, the grape and tangerine can be consumed in various forms and why not develop new products from these noble fruits, for example, the mixture of two drinks for the beneficial effects of each one.

However, it is important to recognize the limitations of this study. The validity of the results could have been affected by the country of origin, surrounding climate, or brand of fresh fruits, among other possible factors.

As final conclusion, the fresh fruits juices are good nutritive products, being natural products with important concentration of some micronutrients and water. If the sanitation conditions are complied, then fresh fruit juices should be a part of everyone’s diet, as healthy diet habits.

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