CIÊNCIA E TÉCNICA VITIVINÍCOLA
Ciência Téc. Vitiv. 40(1) 53-62. 2025

Article

PRELIMINARY INVESTIGATION ON NUTRITIONAL VALUES OF GRAPES FROM THREE GRAPEVINE VARIETIES (*VITIS VINIFERA* L.) PLANTED IN NINH THUAN PROVINCE

INVESTIGAÇÃO PRELIMINAR SOBRE OS VALORES NUTRICIONAIS DE UVAS DE TRÊS VARIEDADES DE VIDEIRA (*VITIS VINIFERA* L.) CULTIVADAS NA PROVÍNCIA DE NINH THUAN

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(Received 03.12.2024. Accepted 03.04.2025)

SUMMARY

The study aimed to preliminarily evaluate the nutritional values of the grapes from three table grape varieties (*Vitis vinifera* L.) including green grape, 'Cardinal' grape, and 'Mariaue Finger' grape from Ninh Thuan province, Vietnam. The analyses were conducted as per standard test methods. There were generally significant differences in energy-yielding nutrients among the three studied samples. These grapes presented moderate concentrations of carbohydrates and proteins ranging from 10.08 ± 0.48 to 12.07 ± 0.28 mg/100 g and from 0.37 ± 0.05 to 0.42 ± 0.04 mg/100 g, respectively, but no lipids content. The analysis revealed the presence of vitamin C and five minerals including Na, K, Mg, Fe, and Ca. The contents of Na, K, and Fe in green grapes were significantly higher than those of the two others. The phytochemical screening indicated the presence of flavonoids, steroids, and saponins, but not alkaloids, tannins, and terpenoids. The phenolic content in the three grape varieties was quantified at a moderate level, but low flavonoid content was found. The same pattern was also observed in the antioxidant activity (DPPH IC_{50}), positively correlating to phenolic and flavonoid compounds contents. These findings scientifically contribute to the food database system, particularly those related to the new variety- the 'Mariaue Finger' grape -, which can be exploited for diet planning.

RESUMO

O estudo teve como objetivo avaliar preliminarmente os valores nutricionais de uvas de três variedades de uva de mesa (*Vitis vinifera* L.), incluindo uva verde, uva 'Cardinal' e uva 'Mariaue Finger' da província de Ninh Thuan, Vietname. As análises foram realizadas através dos métodos de ensaio padrão. Foram observadas diferenças geralmente significativas entre as três amostras estudadas nos nutrientes fornecedores de energia. Estas uvas possuíam concentrações moderadas de hidratos de carbono e proteínas, variando entre 10,08 ± 0,48 e 12,07 ± 0,28 mg/100 g e entre 0,37 ± 0,05 e 0,42 ± 0,04 mg/100 g, respetivamente, mas sem a presença de lípidos. A análise revelou a presença de vitamina C e de cinco minerais, incluindo Na, K, Mg, Fe e Ca. Os teores de Na, K e Fe nas uvas verdes foram significativamente superiores aos das outras duas. O rastreio fitoquímico indicou a presença de flavonóides, esteróides e saponinas, mas não de alcalóides, taninos e terpenóides. O teor fenólico nas três variedades de uva foi quantificado a um nível moderado, mas com um baixo teor de flavonóides. O mesmo padrão foi também observado na atividade antioxidante (DPPH IC_{50}), correlacionando-se positivamente com os teores de compostos fenólicos e flavonóides. Estes resultados contribuem cientificamente para o sistema de base de dados de alimentos, particularmente no respeitante à nova variedade - a uva 'Mariaue Finger' -, que pode ser explorada para o planeamento da dieta.

Keywords: *Vitis vinifera* L., table grapes, antioxidant, nutrients, phytochemicals.
Palavras-chave: *Vitis vinifera* L., uvas de mesa, antioxidante, nutrientes, fitoquímicos.

Article available at https://www.ctv-jve-journal.org or https://doi.org/10.1051/ctv/2025400153

INTRODUCTION

Vitis vinifera L., commonly known as the grapevine, belongs to the genus *Vitis* of the *Vitaceae* family. Grapes, classified as berries, grow in clusters on stems and are valued for their nutritional and medicinal properties (Yadav *et al.*, 2009). The fruit is widely consumed in fresh forms, known as table grapes, and in various processed forms like wine, juice, molasses, and raisins. Grapevine is cultivated in tropical and subtropical regions such as Bolivia, Brazil, Madagascar, Vietnam, China, and India, where grape production has notably increased (Satisha *et al.*, 2013). The chemical composition of grapes varies depending on cultivation conditions; for instance, those grown in cooler climates may have lower sugar content and higher acidity (Ullah *et al.*, 2019). Grapes were first introduced to Vietnam in the 1960s and commercially cultivated in Ninh Thuan province from the 1980s, establishing it as Vietnam's main grape-growing region.

Ninh Thuan, a coastal province of south-central Vietnam, typically has challenging climate conditions, with abundant sunshine, minimal rainfalls, and strong winds. This province is best known as "the most unique grassland region in Southeast Asia", boasting approximately 2900 hours of annual sunshine, the highest in the nation. However, this harsh environment has proved beneficial for growing specific crops, particularly vines. Three varieties of *Vitis vinifera* have been extensively cultivated in Ninh Thuan province (Figure 1): 'Cardinal' grape (VIVC nº 2091), 'NH01-152' grape, and 'NH01-48' grape (FAO Office Regional Asia and the Pacific, 2001; VIVC, 2025).

Figure 1. Geographical region of Ninh Thuan as highlighted in red.

Vitis vinifera 'NH01-48', commonly known as green grapes (GG), is a hybrid of 'NH01' (Japanese grape) and '48' (Chinese grape). These grapes are known for their sweet fruit, thin skin, and small seeds. 'NH01-48' grapes are oval-shaped, with deep green skin covered in a thin layer of white powder (Goto-Yamamoto *et al.*, 2015). The pulp is firm, sweet, slightly tart, and contains small seeds. 'NH01-48' combines the strengths of both parent varieties, making it well-suited for Vietnam's hot and humid climate. These grapes exhibit drought resistance and low susceptibility to diseases, reducing the need for pesticides.

Vitis vinifera Red 'Cardinal' (RCG) grape (VIVC nº 2091) (VIVC, 2025), originating from California in 1939, is a table grape variety known for its round shape and sweet flavor. Red 'Cardinal' grapes cultivated in Ninh Thuan are spherical, about the size of a thumb, with thin skin and ripe fruits ranging from bright red to dark red, offering a sweet taste with mild sourness. The elongated grape clusters weigh between 150 and 350 g per bunch, with tightly packed grapes and minimal fragmentation. Red 'Cardinal' grapes are known to lower blood cholesterol and fat, making them suitable for those with high blood pressure and the elderly. They are also rich in minerals, particularly sodium (Dohadwala and Vita, 2009).

Vitis vinifera 'NH01-152', known as 'Mariaue Finger' grapes (MFG), is a result of genetic engineering by the Institute for Cotton Research and Agricultural Development in Nha Ho, Ninh Thuan province (Mai *et al.*, 2022). This grape variety, bred from wild grape varieties on grafted rootstock, using the Couderc 1613- a Vitis interspecific hybrid grape variety developed in France by Georges Couderc in 1881, has several advantages. It can thrive on various soils, withstand challenging flowering conditions during the rainy season, and endure hot, sunny weather while maintaining a high fruit set with good resistance to pests and diseases. 'NH01-152' grapes have thick skin, firm pulp, moderate sweetness, and turn red and yellow when ripe.

In this regard, this study thus focused on the preliminary investigation of the differences in nutritional values, phytoconstituents, and antioxidants of three table grape varieties, especially the newly developed 'Mariaue Finger' grape ('NH01-152'), to empower consumers to make informed choices in their daily dietary habits and further development towards nutraceuticals or cosmeceuticals.

MATERIALS AND METHODS

Sample preparation

Fresh fruits from the three grapevine varieties (Figure 2) were collected on the same day 18/4/2024 from various vineyards across Ninh Thuan province (*11°45′N 108°50′E*). The samples were promptly air-dried at 60 ºC for 16 hours, ground into fine powder, and then stored at -10 ºC for subsequent use (Sousa *et al.*, 2014).

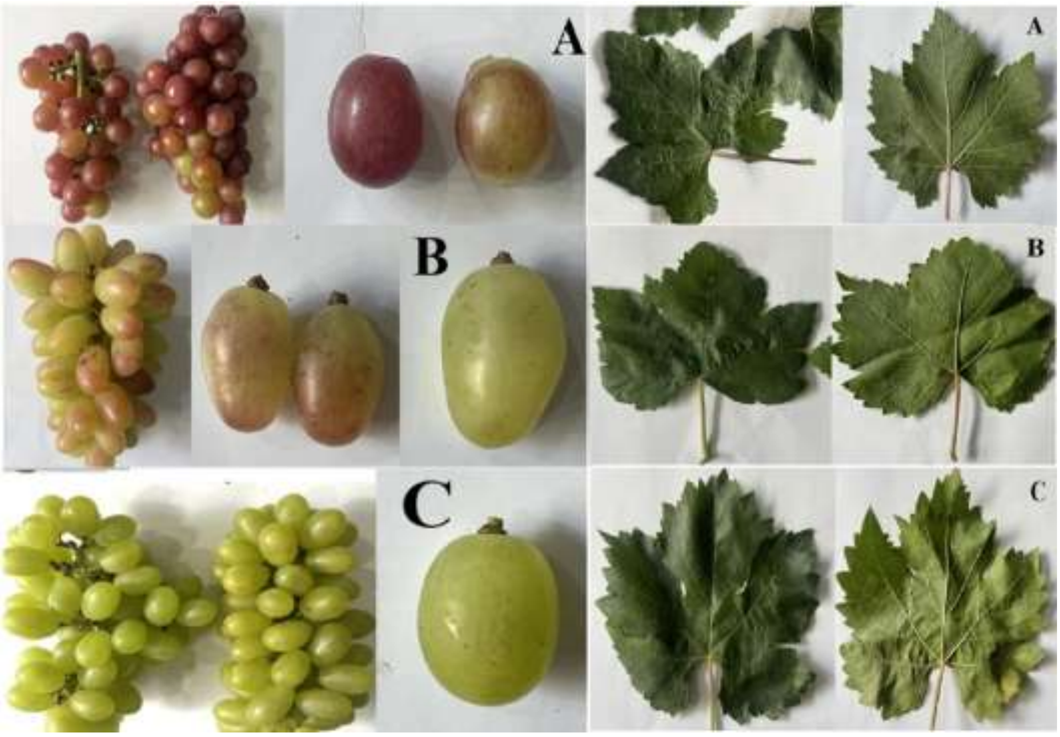

Figure 2. Grape varieties. (A): Red 'Cardinal' grape; (B): 'NH01-152' grape; (C): 'NH01-48' grape.

Carbohydrate content

The total carbohydrate content was determined using the colorimetric method (AOAC 988.12, 1990) described in a study of Nielsen (2010). The assay was started by dissolving 5 g of the grape sample in 45 mL of 80% ethanol within a beaker covered with glass for 15 min. Thereafter, the mixture was transferred to a 50-mL volumetric flask to fill up the volume using 80% ethanol. The mixture was then filtered to obtain 10 mL of filtrate. The colorimetric analysis was carried out by mixing 1 mL of diluted filtrate with 1 mL of 5% phenol and 5 mL of concentrated sulfuric acid, incubated in a water bath for 10 min, and then allowed to cool down for 5 min. The absorbance was spectrophotometrically measured against the blank at 490 nm using a spectrophotometer. The total carbohydrate content was expressed as glucose equivalent (GE) per gram of sample (mg GE/g) and as a percentage of the sample.

Moisture content

The experiment was performed based on the method of measuring the loss of volatile substances under temperature (AOAC 931.04, 2000). 10 g of samples were weighed in dried petri dishes and recorded as W_0. The sample was kept in a 70 °C-oven overnight until its mass no longer changed (W_1). The moisture formula was calculated according to Equation 1.

$$\% \text{ Moisture} = \frac{W_0 - W_1}{W_0} \times 100 \qquad \textbf{Eq. 1}$$

Protein content

The determination of protein content of the grape samples was conducted by the Kjeldahl method (AOAC 2001.11, 2005; AOAC 991.20, 2005). 1 g of a catalyst (a 9:1 ratio of potassium sulfate and copper sulfate) and 10 mL of concentrated sulfuric acid were added to a Kjeldahl flask containing 1 g of each grape sample. The flask was then heated to 230 °C until the digested sample turned transparent green. The digested sample was then diluted with distilled water to 100 mL solution prior to transferring it to a distillation apparatus. Once 25 mL of sodium hydroxide solution (40%) was added to the system, the mixture was distilled to collect 100 mL distillate into a conical flask containing 15 mL of boric acid solution (4%). A few drops of the bromocresol green indicator were added to the distillate prior to titration against 0.1 N hydrochloric acid until the color turned pink. The protein content was expressed as a percentage of the sample.

Total lipid content

The total lipid content of the three grape samples was analyzed using Randall extraction-submersion method (AOAC 2003.05, 2005; AOAC 2003.06, 2005). 4.5 g of the dried ground sample was accurately transferred to a thimble of the Soxhlet extractor, followed by the addition of 250 mL of n-hexane to a clean and dried flat-bottomed flask of the Soxhlet system. The system was heated, and the petroleum ether solution was refluxed through the sample at an average reflux rate of 5 drops/sec for 6 hours. The flask containing fat was then removed from the Soxhlet system and kept in a 70 °C oven overnight to remove moisture and excessive solvent, followed by the cooling period in a desiccator before weighing. The total lipid content was expressed as a percentage of the sample.

Vitamin and mineral contents

The vitamin contents of the three grape samples were analyzed primarily based on various AOAC methods. Vitamin A, E, C, and vitamins group B including B1, B2, B3, B6, and B12 were determined by HPLC using a Thermo Scientific Ultimate 3000 System (Vries *et al.*, 1979; AOAC 961.14, 1989; European Standard, EN 14122-2003, 2003; Mann *et al.*, 2005; AOAC 2011.10, 2011; AOAC 2001.13, 2011; AOAC 2012.21, 2013; Hossain *et al.*, 2019). Vitamins B5 and B9 were evaluated by UPLC coupled to tandem mass spectrometer (QTRA5500) (AOAC 2011.06, 2011; Andrieux *et al.*, 2013). The vitamin contents were expressed as mg/100 g of the sample.

The determination of mineral contents in three grape samples was conducted by AOAC standard methods. The content of sodium (Na) and potassium (K) were determined by the flame photometer FP910 (AOAC 969.23, 2005). Calcium (Ca), magnesium (Mg), zinc (Zn), copper (Cu), and iron (Fe) were analyzed by atomic absorption spectrophotometer (Infitek SP-IAA4530) (AOAC 968.08, 2000). Manganese (Mn) and selenium (Se) were assessed by the inductively coupled plasma-mass spectrometry (ICP-MS) method (AOAC 2015.01, 2015; Nelson *et al.*, 2019) using an Agilent model 7500cx. Phosphorus (P) was quantified by the spectrophotometric method (AOAC 995.11, 2000). Chlorine (Cl) analysis was conducted by the Volhard method (Nordtest method, 1996).

Phytochemicals screening

Filtrate preparation

2 g of the grape sample was added to a Falcon tube containing 10 mL of methanol. The Falcon tubes were sonicated in a water bath at 60 °C for 25 min, followed by centrifugation at 205.6 g. The solution was filtered to collect the grape extract.

Tannins

A few drops of 0.1% ferric chloride were added to 1 mL of the filtrate solution and the appearance of brownish-green to blue-black precipitation was observed to confirm the presence of tannins (Pant *et al.*, 2017).

Terpenoids

2 mL of chloroform and 2 drops of concentrated sulfuric acid were added to 0.5 mL of each grape sample. The formation of a red-brown color at the interface indicated the presence of terpenoids (Onivogui *et al.*, 2014).

Alkaloids

5 mL of the filtrate was well-mixed with 2 mL of 1% HCl by sonicating in a water bath at 60 °C for 25 min. The solution was then treated with Mayer's reagent (Warsi and Sholichah, 2017). The precipitation confirmed the presence of alkaloid.

Flavonoids

2 mL of the prepared filtrate was treated with a few drops of concentrated sulfuric acid. Each color displayed indicated the presence of different flavonoids (Youl *et al.*, 2023). A faint yellow-orange hue signaled the presence of anthocyanins, while a yellow-to-orange color suggested the presence of flavonoids, and an orange-to-deep red color indicated the presence of flavanones.

Saponins

1 g of the sample was boiled in 20 mL of distilled water using a water bath and subsequent filtration. The filtrate was then mixed with 10 mL of distilled water and vigorously shaken to generate a stable foam (Dauda *et al.*, 2020). Afterward, 3 drops of olive oil were added and vortexed for 3 min to observe emulsion formation or persistent foam.

Steroids

2 mL of grape filtrate was mixed with 2 mL of chloroform and 2 mL of sulfuric acid by shaking vigorously and then observing the appearance of a slight red color (Takaidza *et al.*, 2018).

Phytochemicals and antioxidant activity

Total phenolic content

The total phenolic content (TPC) was assessed based on the level of gallic acid and expressed as gallic acid equivalents (GAE) per sample (mg GAE/100 g) by Folin–Ciocalteu method (Siddiqui *et al.*, 2017; Guler and Turgut, 2021). The prepared supernatant was used for TPC analysis. The assay was prepared by mixing 150 µL of diluted sample with 375 µL of Folin-Ciocalteu reagent and 375 µL of Na_2CO_3 7.5% solution. The mixture was vortexed for 5 min and incubated in the dark at room temperature for 30 min.

The absorbance was measured against the blank at 765 nm.

Total flavonoid content

The total flavonoid content (TFC) of the three grape samples was determined using aluminum chloride method (Shraim *et al.*, 2021). The prepared supernatant was used for TFC analysis. The assay was prepared by mixing 100 µL of diluted sample with 560 µL of distilled water, 300 µL of methanol solution (80%), 20 µL of $AlCl_3$ solution (10%), and 20 µL of CH_3COOK solution (1M). The mixture was vortexed for 5 min and incubated in the dark at room temperature for 30 min. Quercetin served as a standard for the calibration curve. The absorbance was measured against the blank at 430 nm using a spectrophotometer. TFC was expressed as quercetin equivalents (QE) per sample (mg QE/ g).

Antioxidant activity

The free radical scavenging activities were evaluated using radical 1,1-diphenyl-2- picrylhydrazyl (DPPH) (Baliyan *et al.*, 2022). The prepared supernatant was used to determine the antioxidant activity. 750 µL of 0.1 mM DPPH solution was added to 250 µL of the diluted sample or standard. The tubes were shaken vigorously and then incubated in the dark at room temperature for 30 min. The absorbance was measured in a 96-well plate at 517 nm using a spectrophotometer. The antioxidant activity was calculated as IC_{50}, which was the concentration of the sample required to inhibit 50% of the DPPH free radicals.

Statistical analysis

Experiments were made in triplicate for statistical analysis using IBM SPSS Statistics version 22.0. The results were expressed as Mean ± SD (standard deviation). The results were analyzed by the one-way analysis of variance (ANOVA) and Tukey's multiple comparison test ($\rho < 0.05$).

RESULTS AND DISCUSSION

Macronutrients, moisture, and energy content

The values of energy-yielding nutrients in three different grape varieties are detailed in Table I, claiming the absence of lipids in all samples tested. The analysis revealed the low concentrations of both carbohydrates and proteins in all samples. According to the US Department of Agriculture (USDA), green grapes generally provide approximately 18.6 g of carbohydrates/100 g of fresh material (USDA- Green grapes, 2022) and roundly 20.2 g for red grapes (USDA- Red grapes, 2022), which was nearly twice as much as that of this study result. The same pattern was also observed in protein content as the values of protein recorded in this study, ranging from 0.37 ± 0.05 to 0.42 ± 0.04 %, approximately equal to half the protein values issued by the USDA (0.9 g/100 g of fresh material) and the healthy grapes from Nigeria (1.62 ± 0.013 %) investigated by Chuku *et al.* (2020). There were no significant differences in protein contents (ρ=0.609), whereas significant differences were observed in carbohydrates contents (ρ=0.001), with the highest carbohydrate quantity was recorded to be 12.07 ± 0.28 g/100 g in MFG, whereas RG claimed the lowest value of 10.08 ± 0.48 g/100 g. These values were much higher than the healthy grapes collected in Nigeria at 8.10 ± 0.004 % (Chuku *et al.*, 2020). Moreover, the analysis revealed high moisture contents with significant differences among the tested samples (ρ=0.0127). The RCG had the greatest moisture content (89.14 ± 0.83 %), followed by MFG and GG (87.26 ± 0.87 and 86.55 ± 0.44%, respectively). These values were approximately equal to the moisture percentages in the previous research on grape samples cultivated in Niagara and Brazil (87.40 ± 0.18 and 88.67 ± 0.22 %, respectively) (Singh *et al.*, 2023).

Vitamins and Minerals

Nine vitamins (A, E, B1, B2, B3, B5, B6, B12, and C) and eleven minerals (Na, K, Mg, Cu, Fe, Ca, Co, Cr, S, Mn, and P) were investigated; however, the analysis merely revealed the presence of vitamin C and five minerals including Na, K, Mg, Fe, and Ca, as shown in Table II. Na, K and Fe contents of GG were significantly greater than those of the two others ($\rho<0.05$). Na levels varied from 73.55 (RCG) to 109.27 mg/100 g (GG), which were lower than the Morocco sample valued at 137.50 ± 5.73 mg/100 g DW (Kalili *et al.*, 2023). On the other hand, K levels varied from 118.63 (MFG) to 151.77 mg/100 g (GG), which was approximately three-quarters equal to the standard declared at 191 mg/100 g by the USDA (UDSA-Table grapes, 2019). In this study, Ca concentrations varied from 12.10 to 13.70 mg/100 g, which was consistent with the USDA record for grape nutrition information at 12 mg/100 g. In contrast to Ca, Mg was recorded to be extremely low ranging from 4.43 to 5.03 mg/100 g, which was roundly one-tenth of the value (54.74 ± 2.07 mg/100 g) documented from Morocco (Kalili *et al.*, 2023). The content of Ca, Fe, and Mg was relatively consistent with research in Latvia on blueberries - a berry frequently employed in the production of fermented products as grapes, with reported ranges at 6.6-15.2, 0.23-0.59 and 4.5-10.1 mg/100 g, respectively (Karlsons *et al.*, 2018).

All three samples generally provide low amounts of Fe and vitamin C varying from 0.24 to 0.34 mg/100 g, and 2.13 to 2.17 mg/100 g, respectively. Nonetheless, Fe and vitamin C present in these three samples were approximately equivalent to the quantities issued by the USDA valued at 0.36 and 3.20 mg/100 g (UDSA-Table grapes, 2019), respectively.

Table I

Energy-yielding nutrients of grape varieties (*Vitis vinifera* L.)

Parameter	**Unit**	**'NH01-48'** (green grapes)	**Red 'Cardinal'** (red grapes)	**'NH01-152'** ('Mariaue Finger' grapes)
Carbohydrate	%	11.73 ± 0.30^a	10.08 ± 0.48^b	12.07 ± 0.28^a
Protein	%	0.42 ± 0.04^a	0.40 ± 0.08^a	0.37 ± 0.05^a
Fat	%	ND	ND	ND
Moisture	%	86.55 ± 0.44^a	89.14 ± 0.83^b	87.26 ± 0.87^c
Energy	kcal/100 g	49.81	43.04	59.03

ND: not detected. Different letters in the same row indicate significant differences between mean values ($\rho < 0.05$)

Table II

Mineral and vitamin contents in the three grape samples (*Vitis vinifera* L.)

Parameters (mg/100 g)	**'NH01-48'** (green grapes)	**Red 'Cardinal'** (red grapes)	**'NH01-152'** ('Mariaue finger' grapes)	***ρ*-value**
Sodium (Na)	10.93 ± 0.01^a	7.36 ± 0.02^b	6.69 ± 0.02^c	4.79×10^{-14}
Potassium (K)	151.77 ± 0.02^a	145.33 ± 0.01^b	118.63 ± 0.02^c	8.41×10^{-10}
Calcium (Ca)	12.10 ± 0.01^a	13.70 ± 0.01^b	12.77 ± 0.01^c	8.10×10^{-6}
Magnesium (Mg)	4.50 ± 0.01^a	5.03 ± 0.01^b	4.43 ± 0.01^a	1.29×10^{-6}
Iron (Fe)	0.34 ± 0.02^a	0.32 ± 0.01^b	0.24 ± 0.00^c	0.02
Vitamin C	2.13 ± 0.00^a	2.14 ± 0.02^a	2.17 ± 0.01^a	0.15

Different letters in the same column indicate significant differences between mean values ($\rho < 0.05$)

Phytochemical screening

Phytochemical screening is used to emphasize the composition of different plant samples and combine with bioactive constituents studies for the development of plant products for various purposes (Adil *et al.*, 2024). The qualitative phytochemicals were screened and presented in Table III. A variety of phytochemicals were investigated; however, flavonoids, steroids, and saponins were detected in all samples, but not alkaloids, tannins, and terpenoids. The presence of flavonoids, steroids, and saponins might contribute to the fruit's biological properties, such as antioxidant, anti-inflammatory, and antimicrobial agents. These biological benefits might explain the effects of *V. vinifera* L. in acne treatment and other dermal problems as the presence of certain phytochemicals including flavonoids, anthocyanidins (Dzialo *et al.*, 2016), and 4-hydroxybenzoic acid (Wang *et al.*, 2017). In addition, the presence of these phytochemicals also exhibited cytotoxic effects that needed to be considered in consumption frequency and dosage (Sharma *et al.*, 2020).

According to Table IV, the *V. vinifera* fruits had significant differences in the three TPC values (ρ=0.7 × 10^{-6}), ranging from 110.62 ± 1.66 mg GAE/100 g to the highest TPC value in MFG (147.46 ± 3.18 mg GAE/100 g), which was higher than the range of 43.8 to 79.40 mg GAE per 100 g dried material from Italy (Di Lorenzo *et al.*, 2019).

TFC values of these three grape extracts were also significantly different (ρ=0.16 × 10^{-4}), and the highest TFC was found in MFG (10.49 ± 0.33 mg QE/g) whereas the lowest value was found in GG (6.59 ± 0.23 mg QE/g). A study conducted in 2011 reported the TPC of four varieties of grapes (USA, green, 'Jufeng' and red grapes) ranging from 19.32 ± 0.67 to 80.28 ± 4.32 mg GAE/g (Fu *et al.*, 2011), which was much lower than the TPC values of grape varieties from Ninh Thuan.

All three different grape varieties generally exhibited moderate values of DPPH IC_{50}, varying from 35.46 ± 1.04 to 57.25 ± 1.16 µg/mL compared to that of ascorbic acid (11.92 ± 1.11 µg/mL) (Table V). However, there were statistically significant differences between the tested samples (ρ=0.58 × 10⁻

[12]). MFG exerted the lowest IC_{50}, followed by RG and GG, denoting the positive correlation between antioxidant activity and phenolic-flavonoid contents. Nevertheless, these findings demonstrated the antioxidant potential of all studied grape varieties compared to IC_{50} recorded in grapes from other regions such as North-East Algeria (270 ± 0.001 µg/mL) (Zeghad *et al.*, 2019), India (80.00 µg/mL) (Dinesh-Kumar and Keerthana, 2019), and Indonesia (21.49 g/mL)(Hartono and Buter, 2022).

It is noteworthy that the conventional methods used in food analysis, such as the determination of TPC, TFC and antioxidant activity (DPPH assay), often have inherent limitations that may influence outcomes and conclusions of the study. Therefore, it is appropriate to compare the results from works that used the same methods, making the comparison more valid. The colorimetric method taking as an example of the absorbance results sometimes be interfered by the particles in a turbid sample, leading to inaccurate measurements of absorbance. Thus, further investigation might consider applying more modern method, such as HPLC, to enhance the accuracy of the measurements.

Table III

Phytochemicals present in the three different grape samples (*Vitis vinifera* L.)

Phytochemical	**Grape varieties**		
	'NH01-48' (green grapes)	**Red 'Cardinal' (red grapes)**	**'NH01-152' ('Mariaue Finger' grapes)**
Alkaloids	-	-	-
Flavonoids	+	+	+
Steroids	+	+	+
Saponins	+	+	+
Tannins	-	-	-
Terpenoids	-	-	-

(+) present; (-) absent.

Table IV

Total phenolic and total flavonoid contents of grape juice samples (*Vitis vinifera* L.)

Sample	**TPC** (mg GAE/100 g)[1]	**TFC** (mg QE/ g)[2]
'NH01-48' (green grapes)	110.62 ± 1.66[a]	6.59 ± 0.23[a]
Red 'Cardinal' (red grapes)	127.46 ± 1.15[b]	7.88 ± 0.38[b]
'NH01-152' ('Mariaue Finger' grapes)	147.46 ± 3.18[c]	10.49 ± 0.33[c]

Different letters within the same column indicate significant differences ($\rho < 0.05$); 1-TPC standard curve: $y = 0.0034x - 0.0352$ ($R^2 = 0.99$); 2-TFC standard curve: $y = 0.0138x - 0.1510$ ($R^2 = 0.97$).

Table V

Antioxidant activity of *Vitis vinifera* L. juice and ascorbic acid

Samples	**Calibration curve (R^2)**	**IC_{50} (µg/mL)**
Ascorbic acid	$y = 4.4649x – 3.3239$ ($R^2 = 0.99$)	11.92 ± 1.11[a]
'NH01-48' (green grapes)	$y = 0.8271x – 2.6473$ ($R^2 = 0.98$)	57.25 ± 1.16[b]
Red 'Cardinal' (red grapes)	$y = 0.8733x – 5.8434$ ($R^2 = 0.98$)	50.56 ± 0.60[c]
'NH01-152' ('Mariaue Finger' grapes)	$y = 1.2161x – 0.8766$ ($R^2 = 0.99$)	35.46 ± 1.04[d]

Different letters within the column indicate significant differences ($\rho < 0.05$)

CONCLUSIONS

The three grape varieties from Ninh Thuan exhibited generally low concentrations of carbohydrates and proteins, with significant varietal differences observed, but no significant differences in lipids content. Non-energy nutrients, specifically vitamin C and minerals, were present in low-to-moderate values, showing partial consistency with USDA records. Phytochemical screening revealed the presence of flavonoids, steroids, and saponins but an absence of alkaloids, tannins, and terpenoids. The phenolic content was quantified at a moderate level, while flavonoid content was low. Similarly, DPPH IC_{50} values exhibited a positive correlation with both phenolic and flavonoid levels.

However, it is crucial to point out that these results and observed varietal differences are based on a single harvest year. Given the significant impact of the harvest year on grape composition, this limitation must be considered when interpreting the findings. Despite this limitation, the study provides valuable insights. Future research should expand the geographical scope and assess the health benefits of these varieties more comprehensively. Developing novel nutraceutical products and examining a broader range of varieties within this species, considering geographical and environmental factors, is also warranted. Additionally, further studies on the fermentation technology of these grape varieties, particularly for wine production, are essential. This knowledge can contribute to optimized fermentation strategies for specific cultivars, enhancing their competitiveness in the wine market. Furthermore, nutritional investigations on these three grape varieties, particularly 'NH01-15'2 ('Mariaue Finger' grapes), are strongly supported by the Vietnamese government, aligning with policies for sustainable agricultural development aimed at diversifying and enhancing the value of grape-related products such as grape wine and raisins.

ACKNOWLEDGMENTS

This study was conducted at the Department of Applied Biochemistry, International University-National University, Ho Chi Minh City, Vietnam.

CONFLICTS OF INTEREST: The authors declare no conflict of interest.

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