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ORIGINAL PAPER

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IMPACTS OF ORGANIC AND ORGANO-MINERAL FERTILIZERS ON TOTAL PHENOLIC, FLAVONOID, ANTHOCYANIN AND ANTIRADICAL ACTIVITY OF OKUZGOZU (*Vitis vinifera* L.) GRAPES

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ABSTRACT

A present study was conducted to determine the impacts of organic and organo-mineral fertilizers on total phenolic, flavonoid, anthocyanin and antiradical activities of Okuzgozu (*Vitis vinifera* L. cv.) grapes. Study treatments included organic fertilizers (green fertilizer (vetch), green fertilizer (barley), green fertilizer (vetch + barley), farmyard manure, bactoguard, lifebac NP, humanica) and organo-mineral fertilizers (bactolife quality organo, bactolife high organo, bactolife high organo, bactolife super organo power). The control treatment did not receive any application. The organic, and organo-mineral fertilizers applications positively influenced the total phenolic, flavonoid and anthocyanin productions, and antiradical activity (DPPH). The maximum total phenolic production was significantly higher under Bactolife Super Organo Power (785.49 µg GAE/mg in pulp) application, followed by those under bactolife high organo 5-5-5 (780.40 µg GAE/mg in pulp). The total flavonoid production in berry skin (34.26 µg QUE/mg), pulp (137.00 µg QUE/mg) and seed (23.52 µg QUE/mg) were the highest under the bactolife super organo power whereas the antiradical activities (DPPH) of berry pulp and seed were at the maximum level under the bactolife quality organo treatment. Total anthocyanin content of berry skin and pulp of Okuzgozu grape cultivar was the highest under the organic humanica.

Key words: organic farming, microbial fertilizer, viticulture, green fertilizer

INTRODUCTION

Organic farming had been experienced worldwide and showed a significant enhancement [Yagmur et al. 2017]. For instance, Willer and Lernoud [2017] reported 8% annual increase in organic farming from 2001 to 2015 in terms of area. Similar to the world market, organic agriculture is an important management practice in Turkey. The organic farming practices started since 1984–1985 in Turkey by growing traditional Turkish export product, the organic grapes. Turkey is the world leader in the production and exports in organic raisins which constitutes 1.80% of the total grape production area [Soylemezoglu et al. 2016]. Turkey is 5th and 6th country in terms of area and net production amount grapevine producing countries by about 4.01 million tons of production [Yagmur et al. 2017]. Therefore, its im-

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pacts on Turkish national economy is well documented. Besides Turkey, European countries are major exported of dried grapes whereas inorganic fertilizers recently had been reported to cause possible negative impacts on human health by Ozlu [2017]. The production of the healthy and sufficient number of grapes are consequently important for food security and human health. To do this, qualitative organic fertility practices may alter the negative impacts from other agricultural management and fertility practices.

The present study indicates the qualitative perspective of organic viticulture farming by considering that the consumption of grapes has increased considerably due to its phytochemical properties [Schreiner et al. 2014, Ozdemir et al. 2016, Felhi et al. 2016, Pantelić et al. 2016, Cirqueira et al. 2017], its cholesterol reducing properties [Ngamukote et al. 2011, Downing et al. 2015, Heidker et al. 2016], and hypoglycemic effect [Chang-Sook et al. 2010, Rahbar et al. 2015]. The total phenolic content of grape varies due to tillage practices, soil composition, climate, geographic origin, and/or exposure to diseases such as fungal infections [Bruno and Sparapano 2007]. The compounds mainly included proanthocyanidins, anthocyanin, flavones, resveratrol and phenolic acids [Maza, 2007, Hernandez-Jimenez et al. 2009]. Proanthocyanidins are the major phenolic compounds in grape's seed and skin [Henandez Jimenez et al. 2009]. Anthocyanin is a pigment and responsible for the color of grape fruits whereas flesh does not contain anthocyanin. In red wine, anthocyanin and flavonoids are the major two groups of phenolic compounds where (+)-catechin is an abundant flavonoid [Bell et al. 2000].

Grapes are rich in vitamins B1 and B2, and minerals including calcium, phosphorus, iron, and potassium [Senthilkumar et al. 2015]. Grape is one of the most important protective food [Pirinccioglu et al. 2012, Miao et al. 2016] not only due to its special nutritive value but also owing to its wide spread production. It responds well to the external application of nutrients. Grape yields and quality were mainly affected by soil fertility and fertilization [Ozdemir et al. 2008, Oner et al. 2015]. Fertilizer management one of the main factors responsible for grapes phytochemical profiles. Very little work has been reported on the effect of organic and organo-mineral fertilizers on grapes in Turkey [Altindisli 2005, Tangolar et al. 2007, Yagmur et al. 2017]. However, as with other grape cultivars grown using conventional cultural practices, excessive fertilization of grapes can lead to several problems including soluble solids accumulation in the soil and nutrient leaching [Guinto 2016]. Thus, there is a growing need to develop environmentally friendly strategies for sustainable culturing of grapes with high yields with less environmental damage.

There are various types of fertilizers available for use in vineyards. Currently, the use of organic and organo-mineral fertilizers has attracted the interest of producers focus on improving the productive performance cultivated grape cultivars [Colapietro 2011, Mehofer et al. 2013, Turan et al. 2016]. Altindisli [2005], reported that the effects of some organic fertilizers on yield and quality of Round seedless grape variety. He reported different combinations of farmyard manure, green manure and E-2001 tested in the trial did not have any statistically significant effect on table grape yield, average bunch weight, 100 berry weight, total soluble solids, and titratable acidity in both vineyards. Tangolar et al. [2007] reported the effects of some organic fertilizer applications on phenological growth with cluster berry and must characteristics of grapevine (*Vitis vinifera* L. Cilores). According to the study results, mean cluster weight, cluster volume, berry weight, berry volume, skin rate, must rate, total soluble solids (TSS) and acidity were observed as 198.9, 216.4, 2.59, 2.50%, 12.8%, 70.5%, 14.1%, and 0.501, respectively.

The objective of the present study was to determine the impacts of organic and organo-mineral fertilizers on total phenolic, flavonoid, anthocyanin and antiradical activity of Okuzgozu (*Vitis vinifera* L.) grape berries skin, pulp and seed.

MATERIALS AND METHODS

Study site and experimental design. The experiments were carried out in a 10 years old private vineyard in Dicle town, which is located in Diyarbakir province of Turkey, in the years of 2015 and 2016. The study site was initiated on a Vertisol soil with parent materials mostly consisting of marn and lacustrine transported material. The experiment was con-

Table 1. Chemical properties of the experimental field soils before the experiment (mean ± standard deviation, n = 20)

Soil Properties	Unit	Means	Soil Properties	Unit	Means
pH (1:2 soil:water)	-	7.82 ±0.30	Electric conductivity	dS m^{-1}	0.95 ±0.04
Clay	%	39.12 ±1.2	Organic matter	%	2.36 ±0.23
Silt	%	28.23 ±1.1	$CaCO_3$	%	7.80 ±0.11
Sand	%	32.65 ±2.3	Plant available P	mg kg^{-1}	3.15 ±1.20
CEC†	-	20.44 ±1.4	Available Fe	mg kg^{-1}	3.40 ±0.60
Exchangeable Mg	$cmol_c$ kg^{-1}	2.10 ±0.40	Available Mn	mg kg^{-1}	7.10 ±1.10
Exchangeable Ca	$cmol_c$ kg^{-1}	14.35 ±1.40	Available Zn	mg kg^{-1}	2.20 ±0.88
Exchangeable K	$cmol_c$ kg^{-1}	3.20 ±0.73	Available Cu	mg kg^{-1}	5.40 ±1.10
Exchangeable Na	$cmol_c$ kg^{-1}	0.40 ±0.07	Available B	mg kg^{-1}	0.20 ±0.06

†CEC: Cation Exchange Capacity

ducted under a semi-arid climate with a mean maximum air temperature of 28–38°C and minimum air temperature 10–12°C during growing season, respectively. The study was performed under Okuzgozu (*Vitis vinifera* L) local grape variety.

The reduced tillage was conducted at 2-3 cm depth of soil in October and November in the years of 2015 and 2016. Some physical and chemical properties are tabulated (tab. 1).

Study treatments. The present study included twelve fertilizer applications; (1) control, (2) green fertilizer (vetch; 90 kg ha^{-1}), (3) green fertilizer (barley; 30 kg ha^{-1}), (4) green fertilizer (mixture of vetch (75%) and barley (25%); 9 kg da^{-1} vetch and 3 kg da^{-1} barley), (5) farm manure (3 tons da^{-1}), (6) Bactoguard (35% organic matter, 24% organic carbon, and 2.5% organic N), (7) Lifebac-NP (containing natural *Bacillus subtilis* and *Bacillus megatherium* isolate 1×10^9 cfu/ml), (8) Humanica (50% organic matter, 40% humic + 15% fulvic acid), (9) Bactolife Quality Organo (4% N, 0% P_2O_5, 8% K_2O, 2% Fe, 2% Mn, 2% Zn and 2% Cu), (10) Bactolife High Organo (5% N, 5% P_2O_5, 0% K_2O, 2% Fe, 2% Mn, 2% Zn and 2% Cu), (11) Bactolife High Organo (5% N, 5% P_2O_5, 5% K_2O, 2% Fe, 2% Mn, 2% Zn and 2% Cu), and (12) Bactolife Super Organo Power (10% N, 0% P_2O_5, 0% K_2O, 2% Fe, 2% Mn, 2% Zn and 2% Cu).

The control plots did not receive any applications from any fertilizers. The crop was grinded and mixed in the soil when vetch bloomed was 50% whereas farmyard manure was incorporated within 0–20 cm soil depth during the spring plowing under consideration of the worked had been done by same researchers [Ozdemir et al. 2008]. Each treatment had replicated three times in the randomized block design for two years. Bactoguard, Lifeback-NP and Humanica fertilizers were used as commercial organic treatments [Turan et al. 2016]. Bactoguard (20 L with 1 tons of water ha^{-1}) and organo-mineral fertilizers (30 L with 1 tons of water ha^{-1}) were applied 3 times in soil starting with leaf formation with 25-day intervals until harvesting (before and after flowering and when grape reaches the size of a nut). Bactoguard derived from plants which liquid organic fertilizer, provides effective protection against cold, hail, water, and salt stresses due to containing organic acids, amino acids, antioxidant enzymes and hormones in natural form. Bactoguard had 35% organic matter; 2.5% nitrogen (N); 24% organic carbon. Lifeback-NP was sprayed 100 mL per vine with sap water to holes opening to coral trace of vines and going down to hair roots. Lifeback-NP is a microbial fertilizer containing natural *Bacillus subtilis* and *Bacillus megaterium* isolates and proliferates rapidly by covering plant roots/ leaves and generates nutrient-intake promoting secretions without feeding from plants. In addition, Lifeback-NP enables plants to fix free nitrogen in the atmosphere through their leaves and roots. Humanica was applied 3 kg per vine to crown trace of vines mixed with soil between February and March. Humanica contained organic matter (40%), total acid (Humic + Fulvic; 50%), and maximum humidity (35%) and soil conditioning fertilizer based on Leonardite which has a dark color and soft texture. Soils properties require reconditioning if their structures suffer disruption along with efficiency and productivity losses. Organo-mineral applications contained Bactolife Super Organo Power, Bactolife Quality Organo, Bactolife High Organo (Nitrogen – 5%, P_2O_5 – 5%), and Bactolife High Organo (Nitrogen – 5%, P_2O_5 – 5%, and K_2O – 5%) organic matter content (20%) [Turan et al. 2016].

Total phenolic, flavonoid, anthocyanin and antiradical activity analysis. The content of total phenolic in the grape berry skin, pulp and seed were determined according to the Folin-Ciocalteau method [Singleton and Rossi 1965]. Gallic acid was employed as the calibration standard and the results were expressed as gallic acid equivalents (GAE) (µg GAE/mg of berry sample). The absorbance was measured using a UV-vis spectrophotometer at a wavelength of 765 nm [Ozdemir et al. 2016]. Fresh sample (1 gram) was homogenized with ultraturraks, incubated at 4°C for 12 hours, and centrifuged at 1200 rpm for 50 min whereas supernatants were filtered through 0.22 m. Measurement of the flavonoid concentration of the grape berry skin, pulp and seed were based on the method described by Park et al. [1997], with a slight modification. A 1 ml aliquot of the sample was added to a test tube containing 0.1 ml of 10% aluminum nitrate, 0.1 ml of 1 M potassium acetate and 3.8 ml of methanol. The mixture was then incubated for 40 min at room temperature and the absorbance was determined at 415 nm. Spectrophotometric analysis was performed using a five-point calibration curve generated with pure quercetin (Sigma) as the standard. The flavonoid content in the Okuzgozu berry samples were expressed in micrograms of quercetin equivalents (QUE) per ml of a sample [Ozdemir et al. 2016]. The total anthocyanin of grape berry pulp and seed extracts were measured [Giusti and Wrolstad 2001] pH differential method. The antiradical activity of grape berry pulp and seed extracts were measured using DPPH method [Sanchez-Moreno et al. 1998] and expressed as EC_{50} (µg/ml), the concentration necessary for 50% reduction of DPPH.

Statistical analysis. The experiments were performed in a complete randomized block design with three replicates. Each replicate consisted of five vines. The results are expressed in mean ± SD. One-way ANOVA (PROC-GLM procedure) was used to analyze the effects of organic and organo-mineral fertilizers on total phenolic, flavonoid, anthocyanin and antiradical activities of Okuzgozu (*Vitis vinifera* L. cv.) grapes. When statistically significant effects ($P < 0.05$) were detected, the least significant difference (LSD) tests were used to separate means after one-way ANOVA. Data were analyzed using SPSS 15.0 for Windows.

RESULTS AND DISCUSSION

In this study, results showed that different treatment of organic and organo-mineral fertilizers had significant effect on Okuzgozu grape berry total phenolic (berry skin, pulp, seed), total flavonoid (berry skin, pulp, seed), total anthocyanin (berry skin, pulp) and antiradical activity (berry pulp, seed) profiles (tabs 2–5).

Plant-Growth-Promoting Rhizobacteria (PGPR) which can affect plant growth directly or indirectly is one potential way to decrease negative environmental impacts resulting from continued use of chemical fertilizers via inoculation of PGPR. Apart from fixing N, PGPR can affect plant growth directly by the synthesis of phytohormones (auxins, cytokinin's, gibberellins) and vitamins, inhibition of plant ethylene synthesis, enhanced stress resistance and improved nutrient uptake, solubilization of inorganic phosphate and mineralization of organic phosphate. Indirectly, diazotrophs are able to decrease or prevent the deleterious effects of pathogenic microorganisms [Turan et al. 2016].

Total phenolic. The treatments of Bactolife Super Organo Power and Bactolife High Organo 5-5-5 were found more effective in producing total phenolic con-

Table 2. Total phenolic (µg GAE/mg) content of berry skin, pulp, and seed of Okugozu grape cultivar (average of 2015 and 2016 years)

Treatments	Total phenolic (µg GAE/mg) skin	Total phenolic (µg GAE/mg) pulp	Total phenolic (µg GAE/mg) seed
Control	84.02 ±0.10^{a}	749.91 ±0.32^{a}	176.31 ±0.34^{a}
Green fertilize (vetch)	85.89 ±0.44^{b}	752.18 ±0.33^{b}	178.89 ±0.16^{b}
Green fertilizer (barley)	87.33 ±0.19^{c}	755.33 ±0.22^{c}	180.60 ±0.14^{c}
Green fertilize (vetch + barley)	89.32 ±0.21^{d}	757.73 ±0.45^{d}	182.63 ±0.07^{d}
Farm manure	90.12 ±0.07^{d}	767.93 ±0.48^{e}	184.81 ±0.44^{e}
Bactoguard	91.57 ±0.23^{e}	769.40 ±0.19^{e}	186.35 ±0.45^{f}
Lifebac NP	93.21 ±0.14^{f}	771.84 ±0.25^{f}	187.52 ±0.24^{f}
Humanica	95.49 ±0.16^{g}	774.46 ±0.26^{g}	189.46 ±0.13^{g}
Bactolife Quality Organo	97.67 ±0.23^{h}	776.66 ±0.15^{h}	191.87 ±0.06^{h}
Bactolife High Organo 5-5-0	99.54 ±0.20$^{\imath}$	778.34 ±0.02$^{\imath}$	193.65 ±0.19$^{\imath}$
Bactolife High Organo 5-5-5	100.62 ±0.22$^{\imath}$	780.40 ±0.23^{i}	195.74 ±0.18^{i}
Bactolife Super Organo Power	105.17 ±0.13^{i}	785.49 ±0.33^{j}	198.74 ±0.15^{j}
Mean	93.32 ±1.05	768.30 ±1.91	187.21 ±1.12

Values in the same column followed by a different small letter are significantly different (P < 0.05)

Table 3. Total flavonoid (µg QUE/mg) content of berry skin, pulp, and seed of Okugozu grape cultivar (average of 2015 and 2016 years)

Treatments	Total flavonoid (µg QUE/mg) skin	Total flavonoid (µg QUE/mg) pulp	Total flavonoid (µg QUE/mg) seed
Control	13.42 ±0.19^{a}	115.69 ±0.12^{a}	5.11 ±0.00^{a}
Green fertilize (vetch)	16.93 ±0.32^{c}	119.52 ±0.15^{c}	7.42 ±0.12^{b}
Green fertilizer (barley)	15.57 ±0.16^{b}	117.66 ±0.10^{b}	5.48 ±0.15^{a}
Green fertilize (vetch + barley)	18.48 ±0.12^{d}	122.13 ±0.30^{d}	9.03 ±0.12^{c}
Farm manure	19.68 ±0.16^{e}	122.93 ±0.10^{d}	10.17 ±0.08^{c}
Bactoguard	20.39 ±0.19^{e}	124.32 ±0.18^{e}	11.54 ±0.23^{d}
Lifebac NP	22.44 ±0.14^{f}	125.99 ±0.21^{f}	13.38 ±0.15^{e}
Humanica	24.33 ±0.27^{g}	127.98 ±0.36^{g}	15.09 ±0.41^{f}
Bactolife Quality Organo	30.41 ±0.17^{i}	134.56 ±0.15^{i}	20.43 ±0.26$^{\imath}$
Bactolife High Organo 5-5-0	28.51 ±0.14$^{\imath}$	132.51 ±0.08$^{\imath}$	19.19 ±0.38^{h}
Bactolife High Organo 5-5-5	26.68 ±0.16^{h}	130.15 ±0.10^{h}	17.25 ±0.23^{g}
Bactolife Super Organo Power	34.26 ±0.32^{j}	137.00 ±0.47^{j}	23.52 ±0.20^{i}
Mean	22.59 ±1.03	125.87 ±1.09	13.13 ±0.98

Values in the same column followed by a different small letter are significantly different (P < 0.05) tent of grape berry skin, pulp and seed content than other treatments and control. The maximum total phenolic content at 105.17 μg GAE/mg of grape berry skin, at 785.49 μg GAE/mg of berry pulp, at 198.21 μg GAE/mg of berry seed were recorded on organo-mineral fertilizer Bactolife Super Organo Power treatment (tab. 2). The average percentage of total phenolic skin, pulp, and seed increase was 25.1%, 4.7%, and 12.7% when compared to control, respectively. These findings are supported by the findings of Gul et al. [2013], Zhang et al. [2014].

Total flavonoid. The data presented in Table 3 indicated the maximum total flavonoid (μg QUE/mg) content of berry skin (34.26 μg QUE/mg), pulp (137.00 μg QUE/mg) and seed (23.52 μg QUE/mg) of Okugozu grape cultivar were recorded on organo-mineral fertilizer Bactolife Super Organo Power treatment. The next best treatment in this regard was Bactolife High Organo 5-5-5. The average percentage of total flavonoid skin, pulp, and seed increase was 155.2%, 19.1%, and 360.2 % when compared to control, respectively. The lowest total flavonoid content was observed in control vine. The results obtained in the present investigations are in conformity with those obtained by Malusà et al. [2004], Gul et al. [2013] and Zhang et al. [2014] in grapes.

Total anthocyanin. The data in Table 4 reveal that total anthocyanin (Malvidin-3-o-glucoside (mg kg^{-1})) content of berry skin (19.034 mg kg^{-1}) and pulp (9.64 mg kg^{-1}) of Okugozu grape cultivar was the highest in organic treatment Humanica. The lowest total anthocyanin content was observed in control treatment. The average percentage of total anthocyanin skin and pulp increase was 5.6% and 2.9% when compared to control, respectively. The results are supported by the findings reported by Nedelkovski et al. [2017].

Table 4. Total anthocyanin content of berry skin and pulp of Okugozu grape cultivar (average of 2015 and 2016 years)

Treatments	Total anthocyanin (Malvidin-3--o-glucoside (mg kg^{-1})) skin	Total anthocyanin (Malvidin-3--o-glucoside (mg kg^{-1})) pulp
Control	18.005 ±0.68^{a}	9.28 ±0.29^{a}
Green Fertilize (Vetch)	18.007 ±0.59^{b}	9.30 ±0.29^{b}
Green Fertilizer (Barley)	18.009 ±0.41^{b}	9.34 ±0.65^{c}
Green Fertilize (Vetch + Barley)	18.012 ±0.51^{c}	9.38 ±0.30^{d}
Farm Manure	19.017 ±0.87^{d}	9.49 ±0.08^{e}
Bactoguard	19.019 ±0.12^{d}	9.50 ±0.39^{e}
Lifebac NP	19.029 ±0.18^{h}	9.59 ±0.02^{ı}
Humanica	19.034 ±0.14^{ı}	9.64 ±0.41^{j}
Bactolife Quality Organo	19.027 ±0.25^{fg}	9.57 ±0.14^{h}
Bactolife High Organo 5-5-0	19.023 ±0.35^{e}	9.53 ±0.38^{f}
Bactolife High Organo 5-5-5	19.031 ±0.18^{h}	9.61 ±0.15^{i}
Bactolife Super Organo Power	19.025 ±0.20^{ef}	9.55 ±0.14^{g}
Mean	18.687 ±1.05	9.48 ±2.03

Values in the same column followed by a different small letter are significantly different ($P < 0.05$)

Antiradical activity. Significantly higher antiradical activity (DPPH, EC_{50} = μg/ml) was recorded in the organo-mineral fertilizer treatment in berry pulp and seed (tab. 5). The maximum antiradical activity at 560 DPPH, EC_{50} = μg/ml of grape berry pulp, at 4.34 DPPH, EC_{50} = μg/ml of berry seed were recorded on Bactolife Quality Organo treatment. The lowest total anthocyanin content was observed in control treatment (tab. 5). The average percentage of antiradical activity skin, and pulp increase was 7.6% and 77.8 % when compared to control, respectively. These results are supported by the findings of Pirincioglu et al. [2012].

As a result of this work, it was determined that organic and organo-mineral fertilizer applications significantly increased to total phenolic, total flavonoid, total anthocyanin, antiradical activity of berry pulp, seed part of the grapes. The improved parameters of plant content in response to all inoculants compared with the control indicates the beneficial role of these organic compounds and efficiency of organo-mineral fertilizers. PGPR (Plant growth Promoting Bacteria) known as helpful microorganisms that used to improve plant growth, plant yield, crop quality and uptake of plant nutrition from the soil by plant Esitken et al. [2005]. These microorganisms can produce plant hormone such as auxins [Mia et al. 2012, Gunes et al. 2014], and inhibitor of ethylene production from plant tissue [Glick et al. 1995]. Applications of PGPR significantly have increased fruit yield, and plant growth of strawberry [Gunes et al. 2009, Esitken et al. 2010, Karlidag et al. 2013], apple [Karlidag et al. 2007], sweet cherry [Esitken et al. 2006], cabbage [Turan et al. 2014].

Table 5. Antiradical activity (DPPH) of berry pulp and seed of Okugozu grape cultivar (average of 2015 and 2016 years)

Treatments	Antiradical activity (DPPH, EC_{50} = μg/ml) pulp	Antiradical activity (DPPH, EC_{50} = μg/ml) seed
Control	517 ±0.57^{a}	2.44 ±0.00^{a}
Green fertilize (vetch)	521 ±0.57^{b}	2.49 ±0.00^{a}
Green fertilizer (barley)	525 ±1.20^{c}	2.65 ±0.00^{b}
Green fertilize (vetch + barley)	532 ±1.21^{d}	2.81 ±0.01^{c}
Farm manure	540 ±0.57^{e}	2.92 ±0.02^{d}
Bactoguard	543 ±0.57^{ef}	3.06 ±0.01^{e}
Lifebac NP	546 ±0.57^{fg}	4.10 ±0.01^{f}
Humanica	558 ±0.33^{ıj}	4.30 ±0.00^{ıi}
Bactolife Quality Organo	560 ±0.33^{j}	4.34 ±0.00^{i}
Bactolife High Organo 5-5-0	555 ±0.57^{ıi}	4.27 ±0.00^{hı}
Bactolife High Organo 5-5-5	549 ±0.33^{gh}	4.16 ±0.00^{g}
Bactolife Super Organo Power	552 ±0.57^{hı}	4.22 ±0.01^{h}
Mean	541 ±2.40	3.48 ±0.13

Values in the same column followed by a different small letter are significantly different ($P < 0.05$)

CONCLUSION

In this study, results showed that optimum plant nutrition especially organo-mineral application increased the phytochemical potential due to fertilizer use efficiency, enzymatic potential of fertilizer and plant ion balance. The type of fertilizers influences the plant physiology and phytochemical ingredient. Overall, the results of this study suggest that microbial and organo-mineral fertilizer application have the potential to increase the quality of the vine plants. Therefore, integrated use of organic and organo-mineral fertilizer showed promising potential for improving total phenolic, flavonoid, anthocyanin and antiradical activity of Okuzgozu (*Vitis vinifera* L.) gapes.

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