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Evaluation of Acıkara (*Vitis vinifera* L.) native grape variety of anatolia for red wine production potential

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Abstract. The Acıkara grape variety, a nearly forgotten native black variety in Anatolia/Turkey, has recently gained interest in its potential for producing high-quality wine from producers and consumers. The potential of producing high-quality red wine from the Acıkara grape variety (Vitis vinifera), which is cultivated on the Elmalı/Antalya in the highland (1100 m altitude) of western Mediterranean region, was investigated, and the suitability of the wine's characteristics associated with high-quality red wine was determined. The study investigated the phenolic compounds, variety characteristics, and phenolic maturity of the Acıkara grapes. Additionally, the general composition, colour characteristics, phenolic compounds, and aroma profiles of Acıkara wines were assessed. The spectrophotometer and HPLC-DAD are used for evaluating the phenolic composition of grapes and wines. The GC-FID-MS is utilized to identify and quantify the aroma compounds in wines. A descriptive sensory analysis was carried out to evaluate the sensory characteristics. The grape was determined to have small-sized, round, and short-shaped fruit with a blue-black skin colour and colourless flesh. The total phenolic compound in the whole berry, skin, and seed was determined as 47.6 (A_{280}), 1332 mg/100g, and 6554 mg/100g (dry weight), respectively. The grape skin has been found to have a total anthocyanin amount of 640.25 mg/100g (dry weight), while the seed was determined to have a total tannin amount of 52.96 mg/g (dry weight). A total of 15 anthocyanin compounds were identified in the grape skin, with a total amount of 13625.02 mg/kg (dry weight). The wine indicated a total phenolic content of 2212.33 mg/L and a total tannin content of 2.52 g/L. In Acıkara wine, a total of 15 anthocyanin compounds were identified and quantified as composing 1852.16 mg/L. The wine contained 7 major and 47 minor aroma compounds, corresponding to a total amount of 315.7 mg/L. Esters are primarily responsible for the characteristic aroma of Acıkara wine. Upon evaluating the sensory characteristics of the wine, it can be observed that it has a deep shade of red-violet colour, a medium plus body, and prominent odours of prunes, cherries, and spices.

1. Introduction

The history of grapes and wine can be traced back to the Neolithic period (8500-4000 BC), that is considered to be the earliest period when the essential conditions for the development of viticulture were present. The origin of wild vines is traced back to the Caucasus region, which lies along the coasts of Eastern Anatolia, the Mediterranean, and the Black Sea in Turkey, as well as present-day Lebanon, Northern Syria, and Iran. Wine is considered to have originated in the regions of Georgia, Armenia, and Anatolia in today's world, and it is thought that wine was introduced to the civilizations of Mesopotamia and Egypt from these regions [1, 2]. Consequently, Turkey is a historical geographic region where Vitis vinifera was domesticated and is the cultivation area for many different varieties [1].

Wine quality is determined by the grape variety and the composition, fermentation, ageing and the winemaking processes [3]. To ensure the production of high-quality red wine, it is essential for the grape variety to possess several key characteristics. These include the ability to provide a rich colour, adequate levels of sugar, tannin, and acid, as well as a significant potential for phenolic and aroma compounds [4, 5]. Aroma is a significant quality parameter that emphasizes wine's sensory attributes and plays a critical role in consumer preference. Aroma compounds are present in varying quantities in wine, which contributes to its unique value and quality [5]. The other important factor is phenolic compounds, containing aromatic rings attached to hydroxyl groups, significantly influence the quality of wine and consumer preference. Therefore, they are regarded as a critical component that establishes the sensory properties and colour of the wine. Wine primarily derives its phenolic compounds from grapes. The majority of phenolic compounds in grapes are mainly located in the grape's peel and seed, whereas they are present in lower concentrations in the pulp [6]. Anthocyanins and colourless phenolic compounds (tannins and phenolic acids) present in the solid parts of the grape diffuse into the

wine during maceration process that is utilized in the production of red wine and contributes a distinctive colour and sensory quality [7, 8].

The "National Collection Vineyard" project, which was initiated by the Tekirdağ Viticulture Research Institute of Turkey in 1965, has reported 1439 distinct grape varieties in Turkey as of 2020 [9]. Öküzgözü, Boğazkere, Kalecik Karası, and Çal Karası are among the black grape varieties that are frequently used in the wine production of Turkey. Some examples of foreign varieties, including Cabernet Sauvignon, Merlot, Syrah, and Cabernet Franc, have also been used in the sector [10]. Moreover, wine producers have recently rediscovered some promising varieties that Anatolia had previously overlooked, in addition to these varieties. The growing interest of consumers worldwide in native varieties and new flavours has led to the application of many native varieties to Turkey's wine production industry. Nevertheless, a growing number of chateau and boutique wineries have highlighted the potential to produce high-quality wine, and the application of these native varieties extends beyond table wine production [9]. These promising native varieties include Kösetevek, Patkara, and Acıkara [4]. Limited academic research has been conducted on the ampelographic and berry characteristics of the Acıkara grape variety [11,12]. However, there is no detailed research on its winemaking potential. The Acıkara wines, especially those that came from vineyards on the Elmalı/Antalya in the highland (1100 m altitude) of the western Mediterranean region, have begun to establish a reputation in the wine industry in recent years, winning awards in national and international wine competitions. As a result of these developments, Acıkara vineyards began to be established also in the Aegean region, capturing the interest of certain wine producers. This study was therefore conducted to evaluate the phenolic compounds, variety characteristics, and phenolic maturity of the Acıkara grapes, which are obtained from the Elmalı/Antalya location. In addition, aroma and phenolic components, colour characteristics, and overall composition of Acıkara wines were also evaluated.

2. Materials and method

2.1. Grapes and winemaking

The Acıkara grape used in the research was obtained from the vineyard (36°43'49"N 29°52'37"E) in the Elmalı district of Antalya province in the highland of the western Mediterranean region. The vineyard was established in 2002 on land with a slope of 5-6%, consisting of stony, red, and calcareous soil. The altitude of the vineyard is 1100 meters. Due to the high altitude, the temperature difference between day and night can reach 18–20 °C. In the vineyards of Acıkara, cultivation is carried out according to organic viticulture principles without the use of any chemical pesticides. The grape cultivars were manually harvested on October 3, 2022, at optimum maturity. Acıkara grape had a 5.1 g/l of titratable acidity (as tartaric acid), 3.43 of pH, and 231.2 g/l of reducing sugar.

Acıkara grapes were processed into wine according to traditional red winemaking techniques. Grapes were destemmed and crushed. Before alcoholic fermentation, cold macerations were carried out at 10–12 °C for 48 h. Alcoholic fermentations were conducted by RX60 yeast culture (25 g/hL) (Lafford Oenologie, Bordeaux, France) at room temperature (25 °C). During alcoholic fermentation, temperature and density of must were monitored twice a day. Alcoholic fermentation took 15 days. After alcohol fermentation was completed, wines were pressed following malolactic fermentation (MLF) with inoculating *Oenococcus oeni*. MLF was accomplished at 18-20 °C with controlled paper chromatography. After MLF finished, 50 g/hL of SO_2 was added. Then, the wines were cooled for ranking and stored at 12–15 °C prior to further analysis.

2.2. Maturity Analysis of Phenolic Compounds in Grapes

200 grapes were blended for 2 minutes. Then, 50 grams of the obtained mixture were transferred to solutions with pH 1 and 3.2, each containing 50 ml, and allowed to stand for 4 hours. When this period concludes, the preparations were filtered, and then each filtrate was subjected to anthocyanin analysis (by using the bisulfite method). A1 represents the total anthocyanin concentration in the pH 1 solution, A3.2 represents the anthocyanin concentration in pH 3.2 solution to calculate the total anthocyanin (ApH1, mg/L malvidin-3-O-glucoside) and extractable anthocyanins concentration (ApH3.2, mg/L malvidin-3-O-glucoside). The cellular maturation index (the extractability index, EA%), the tannin index of the skin (dpell) and seeds (dTpep), and their relative ratio as maturity (dpell% and Mp%) were calculated. And also, total phenolic compound index (A_{280}) was analysed. [3].

2.3. General Chemical Analysis

Total phenolic compounds, tannin, [3, 13] total acidity, pH, and reducing sugar analysis [14] were performed in the grape and wines. All the spectrometric analyses were carried out in a Shimadzu UV-1201 (Tokyo, Japan) spectrophotometer triplicate with a 1 mm quartz cell. Additionally, the wines were analysed for density, ethanol, volatile acidity, free and total SO_2 [14], HCl and Gelatin index [3]. Absorbance (A) of the wines at 420, 520, and 620 nm was performed using a spectrophotometer. Colour intensity (CI) was computed as the sum of 420 nm, 520 nm, and 620 nm absorbencies; tonality (shade) was calculated by dividing the absorbance at 420 by the absorbance at 520 nm, respectively, and proportion of red colour produced by flavylium cations of the free and bound anthocyanins (dA%) [15].

2.4. Extraction of anthocyanin compounds

The extraction method reported by Rusjan and Korosec [16] was applied with modifications for anthocyanin compounds of grape skin. A 100 g skin of randomly sampled grapes was used. The skin has been a short time blended into a homogeneous mixture using a high-speed Waring blender. A homogeneous sample of skin weighing

1 g was placed in a Teflon tube, and 20 mL of 80% methanol (acidified with 0.1% HCl) was added. After being mixed at room temperature manually, they were homogenised with UltraTurrax at approximately 10000 rpm for 1 minute. Later, it was kept in an ultrasonic bath at 20 ˚C for 10 minutes. Then, it was centrifuged at 4 °C for 10 minutes at 6000 rpm. The clear portion was taken after centrifugation and passed through a membrane filter with 0.45 µm to be directly injected into HPLC to determine the quantities and profiles of anthocyanin compounds. The wine samples were directly filtered through a 0.45 µm filter and then injected into HPLC to determine the amounts and profiles of anthocyanin compounds of the wine.

2.4.1. HPLC conditions for anthocyanin compounds

The detailed analysis of grape skin and the wine anthocyanins was conducted using an Agilent 1100 HPLC system (Agilent Technologies, Palo Alto, California, USA), equipped with an autosampler and a diode-array detector (DAD) according to the OIV [14] method, including mobile phases and elution system used. The analysis was performed with the separation of anthocyanin compounds was performed on reversed-phase HiChrom Ultrasphere C18 ODS (250 x 4.6 mm x 5µ) coupled with a pre-column having identical granulometry. The ultra-violet–visible spectra (scanning from 200 nm to 600 nm) were recorded for all peaks. Identification of anthocyanins was obtained by using reference standards and by comparing the retention times and ultra-violet–visible spectra with those found in the literature and also confirmed by an Agilent 6430 LC-MS/MS spectrometer equipped with and electrospray ionization source. The quantification was performed in triplicate using an external standard calibration curve based on the peak areas at 520nm. Delphinidin-3-glucoside, cyanidin-3-glucoside, petunidin-3-glucoside, peonidin3-glucoside, and malvidin-3-glucoside were used as standards for their respective peaks and derivatives (Table 1) [7].

2.5. Analysis of micro aroma compounds

2.5.1. Extraction

The liquid-liquid extraction method has been used in the extraction of aroma compounds. The aroma compounds were extracted using a 100 ml wine sample. A 100 ml sample was taken into an Erlenmeyer flask, and subsequently, 40 ml of dichloromethane and the internal standard (3.9 mg/ml) were added to the wine. The mixture obtained was stirred for 30 minutes and subjected to an extraction process under nitrogen gas at 4-5°C. Later, it was centrifuged at 9000 rpm for 15 minutes at 4°C. After the centrifugation, phase separation was carried out using a separation funnel. The obtained phase has been filtered through anhydrous sodium sulfate. Then, the extract was concentrated until approximately 0.5 ml remained and was taken into the vial. The extract was directly injected into GC-FID-MS to identify the aroma compounds. [17].

Table 1. The retention times, concentration ranges, calibration equations, and maximum absorbance wavelengths for anthocyanin identified in wines.

Compound	Rt (min)	Range (mg/L)	R^2	λ_{max} (nm)	Calib. equation
Delphinidin-3-O-glu	6.77	0.6 - 20	0.9999	526	y=102.6x-13.9
Cyanidin-3-O-glu	7.95	0.9 - 30	0.9997	516	y=65.0x-27.2
Petunidin-3-O-glu	9.27	0.2 - 9	0.9999	527	y=160.9x-9.2
Peonidin-3-O-glu	10.86	0.6 - 20	0.9999	516	y=169.1x-15.7
Malvidin-3-O-glu	12.02	0.3 - 12	0.9999	527	y=183.5x-13.7
Vitisin A	13.51	0.3 -12	0.9999	518	y=183.5x-13.7
Delphinidin-3-O-acet-glu	15.75	0.6 -20	0.9999	529	y=102.6x-13.9
Cyanidin-3-O-acet-glu	17.36	0.9 - 30	0.9996	517	y=65.0x-27.2
Petunidin-3-O-acet-glu	19.14	0.2 - 9	0.9999	529	y=160.9x-9.2
Peonidin-3-O-acet-glu	19.61	0.6 - 20	0.9999	517	y=169.1x-15.7
Malvidin-3-O-acet-glu	20.53	0.3 - 12	0.9999	529	y=183.5x-13.7
Delphinidin-3-O-p-coum-glu	22.61	0.6 - 20	0.9999	527	y=102.6x-13.9
Petunidin-3-O-p-coum-glu	22.88	0.2 - 9	0.9999	527	y=160.9x-9.2
Peonidin-3-O-p-coum-glu	25.56	0.6 - 20	0.9999	525	y=169.1x-15.7
Malvidin-3-O-p-coum-glu	26.51	0.3 - 12	0.9999	530	y=183.5x-13.7

2.5.2. GC–MS condition of minor aroma compounds

A Shimadzu Nexis GC-2030 chromatograph with a fame ionization detector (FID) and, Shimadzu GCMS-QP2020 NX -mass selective detector (MSD) constituted the gas chromatography (GC) system used to analyse the aroma compounds of the wine samples. A DB-WAX UI capillary column (30 m length×0.25 mm i.d.×0.25 µm thickness;) was used to separate the aroma compounds. The extract (3 µL) was directly injected into the GC–MS system with a pulsed splitless mode (40 psi: 0.5 min). The injector temperature and the FID temperature was 250 °C. The oven temperature of column started at 40 °C (after 3 min holding) and then it increased to 90 °C at a rate of 2 °C/min, to 130 °C at a rate of 3 °C/min, to 240 °C at a rate of 4 °C/min, and to 240 °C for 12 min with a final hold. The MS ionization energy was 70 eV, and mass range m/z was 35–500 a.m.u. in combined SCAN/SCIM mode. The scan rate was 1.0 scan s-1, interface temperature was 250 °C and source temperature was 120 °C. The volatile compounds were identified by comparing their retention index and their mass spectra on the DB-Wax column with those of a commercial spectra database (W10N14, NIST11, NBS 75 k) and of the instrument's internal library created from the previous laboratory studies. Some of the identifications were confirmed by the injection of the chemical standards into the GC-MS system. Retention indices of the compounds were calculated by using a commercial n-alkane (C8–C31) series. After the identification of the volatiles, quantification of volatile compounds was expressed as relative peak area to the internal standard (4-nonanol). The ratio of peak area was corrected with the response factors of the compounds. Then, the mean values of triplicate GC analyses were calculated. [18].

2.6. Analysis of major aroma compounds /Direct Injection to GC-FID/MS

The wine was initially distilled, and the major aroma compounds of the wine samples were determined by direct

injection with a GC-FID/MS in accordance with the OIV, International Methods of Spirituous Beverages of Vitivinicultural [19]. 3-Pentanol is utilized as an internal standard. 0.1 mL of an internal standard solution (30.86 mg/100 mL in 40% ethanol) was combined with a 0.9 mL aliquot of the sample. Then, 1 µL of the mentioned mixture was injected into the GC. Acetal, 2-methylbutan-1-ol (active amyl alcohol), 3-methylbutan-1-ol (isoamyl alcohol), methanol, ethyl acetate, butan-1-ol (n-butanol), butan-2-ol, 2-methylpropan-1-ol (isobutyl alcohol), propan-1-ol (n-propanol), and acetaldehyde were identified as the major compounds. Darıcı et al. [20] previously reported in detail the GC-FID/MS condition, column, identification, and validation parameters of the method. An Agilent 6890N with FID was employed as the GC apparatus. The CP-WAX 57 CB capillary fused silica column (60 m x 0.25 mm i.d. with a 0.4 µm film thickness; Agilent, Netherlands) had been used. The injections had been given in split mode, with a split ratio of 30:1. The oven was configured to maintain a temperature of 40°C for 4 minutes, then increase it by 1.8°C per minute from 40°C to 94°C, and then by 30°C per minute from 94°C to 180°C, with a final hold of 4 minutes at 180°C. The injection temperature was 160°C. The FID temperature was 250 °C, with a flow rate of 30 mL/min for H_2 and 300 mL/min for air. The carrier gas was helium, with a flow rate of 1.3 mL/min. The FID signal was used to determine the concentration in relation to the internal standard from the relative response factors (RF). In order to identify the compounds, the mass spectrum and injection of reference compounds were compared to the retention periods of the compounds.

2.7. Sensory analysis

Descriptive analysis as described by Lawless and Heymann [21] was conducted with fourteen assessors. The panel, composed of nine men and five women (aged 26–57), determined the organoleptic characteristic descriptors. Academic personnel have a minimum of 200 hours of training and experience in descriptive analysis, and they routinely participate in the university's sensory evaluation of research. The assessors participated in seven 2-hour sessions. Assessors participated in an open session to discuss and develop descriptors for the wines during the first and second sessions. According to the open session, the reference standards for each attribute were developed for the following sessions. Assessors presented prepared reference standards during the third and fourth sessions, and a discussion on the reference standards took place during the entire session. In the fifth session, one visual, three taste, four mouthfeel, five aroma and six flavour attributes were selected using a consensus-based approach to define the attributes for descriptive analysis. The sixth, and seventh sessions, assessors used a 15-cm scale to evaluate the intensity of each attribute. Wine (30 mL at 20 °C) was served in random order in International Standard Organization (ISO) wine glasses covered with petri dishes during sessions.

3. Result and discussion

3.1. Phenolic Compound Maturity in Grapes

Many factors, such as sugar/acid balance, aroma potential, and phenolic maturity, are in balance when grapes reach their oenological maturity. This balanced condition may demonstrate the grape's potential for producing high-quality wine [3]. Table 2 provides the data obtained from the phenolic compound maturity analyses performed in order to reveal the potential of the Acıkara grape variety to be processed into quality red wine.

Table 2. Phenolic maturity state of Acıkara Grape.

T. phenolic compound index (A_{280})	47.6 ± 3.0
T. anthocyanin in skin (ApH1) (mg/L)	1127.7 ± 59.6
Extractable anthocyanin in skin (ApH3.2) (mg/L)	684.6 ± 27.1
Extractability index (%EA)	39.3 ± 2.8
Skin tannin index (dpell)	27.4 ± 1.6
Maturity of skin tannin (% dpell)	57.5 ± 4.4
Seed tannin index (dtpep)	20.2 ± 1.8
Maturity of seed tannin (% Mp)	42.5 ± 2.4

Total and extractable anthocyanin amounts in Acıkara grape skins were determined as 1127.73 mg/L and 684.62 mg/L, respectively. The total and extractable anthocyanin potential in grape skins varies according to the variety and is typically over 500 to 2000 mg/L. Considering ideal conditions in wine production, the amounts of extractable anthocyanin reach close to the total amount of anthocyanin [3]. González-Neves et al. [22], conducted research investigating the phenolic potential for Tannat, Cabernet Sauvignon, and Merlot grapes determined that the lowest total potential anthocyanin amount was 707.7 mg/L in Merlot grapes, while the highest amount was 1458.9 mg/L in the Tannat grape. The Acikara variety displays a significantly greater anthocyanin potential in comparison to well-known wine production varieties globally, measuring at 1127.7 mg/L.

The extractability index (EA%) value of the Acıkara variety was found to be 39.3. And the maturity of seed tannin of Acıkara (Mp%) was determined to be 42.5 while the seed tannin index (dtpep) was recorded as 20.3. Additionally, the maturity of skin tannin (%dpell) as 57.5 and the skin tannin index (dpell) as 27.4 were measured. Depending on the grape variety and maturity, the EA% value varies between 70 and 20, with a tendency to decrease during ripening [3]. According to the grape variety, the number of seeds, and the maturity level, the maturity of seed tannin ranges from 60 to 0. According to Ribéreau-Gayon et al. [3], an increase in the Mp% value leads to an increase in the tannin content of the resulting wine. The research carried out by Arpa and Cabaroğlu [4], evaluated the maturity status of phenolic compounds in the Kösetevek variety, which is one of the native grape varieties grown in the Eastern Anatolia Region of Turkey. According to the research, total phenolic compound index (A280) as 56.4, total anthocyanin amount in grape skin as 912.1 mg/L, extractable anthocyanin amount in grape skin

as 503.8 mg/L, extractability index (%EA) as 44.8, tannin index of skin (dpell) as 10.1, maturity of skin tannin (%dpell) as 17.8, tannin index of seed (dtpep) as 46.3 and maturity of seed tannin (%Mp) as 55.3 were reported in Kösetevek variety.

The composition and content of phenolic compounds in grapes vary depending on the grape variety, and their dispersion in grape parts is also susceptible to variation [23]. Table 3 provides the amount of total phenolic compound, anthocyanin, and tannin in the skin and seed of the Acıkara grape.

Table 3. Total phenolic compounds, anthocyanin and tannins in skin and seed of Acıkara grape.

	*Skin	*Seed
T. phenolic compound (mg/100g)a	1332 ± 4.24	6554 ± 14.14
T. anthocyanin (mg/100g)b	640.25 ± 6.25	-
T. tannin (mg/g)	14.78 ± 0.01	52.96 ± 0.1

[a] as gallic acid, [b] as malvidin-3-glucoside, *on dry weight.

The total phenolic content of the Acıkara skins and seeds was determined to be 13.32 mg/g and 65.54 mg/g, respectively, based on dry weight. According to Pantelić et al. [24], the total phenolic content of Cabernet Sauvignon, Merlot, and Shiraz grape skins was 9.10 mg/g, 8.26 mg/g, and 10.13 mg/g, respectively, based on dry weight. The total phenolic content of its seeds was 69.57 mg/g, 77.38 mg/g, and 50.54 mg/g, respectively, based on dry weight. When contrasted with the Acıkara variety, it is distinct that the skin has a higher total phenolic content, while the seed shows similar outcomes.

Anthocyanin compounds present in grapes are extracted into must and wine during the maceration process. The color potential of grapes is reported to vary based on anthocyanin levels, maturity, and processing techniques [20]. The total amount of anthocyanin in Acıkara skins has been determined to be 640.2 mg/100g on the basis of dry weight. In a recent study conducted by Karaman et al. [25], the researchers reported the levels of anthocyanins in the peels of different grape varieties grown in the Urla/İzmir region. The results showed that Cabernet Sauvignon had a total anthocyanin content of 381.5 mg/100g on dry weight, while Merlot had 672.3 mg/100g, Shiraz had 835.2 mg/100g, and Boğazkere had the highest amount with 969.2 mg/100g. In contrast, the anthocyanin content of Acıkara skins is considerably higher than that of Cabernet Sauvignon skins, and it is similar to that of Merlot peels.

Tannins have a significant role in developing the sensory characteristics of wine. Assessing the level of tannin in grapes and understanding that tannins are distributed in different parts of the grape before harvest is essential in assessing the possibility of extraction during wine production. Therefore, it might increase the probability of obtaining quality wine [26]. The tannin content of the skins and seeds of the Acıkara grape variety was determined to be 14.78 mg/g and 52.96 mg/g on a dry weight basis, respectively. In a study conducted in the Bordeaux region of France, the tannin content of the skins and seeds of the Cabernet Sauvignon was determined to be 57.4 mg/g and 90.1 mg/g on a dry weight basis, respectively. Additionally, the Merlot variety was reported to have values of 63.8 mg/g and 92.2 mg/g on a dry weight basis [27].

3.2. Anthocyanin composition of grape skin

Anthocyanidins and various combinations of these compounds (glycoside, acetyl-glycoside, and coumary-glycoside) vary among different grape varieties. As consequently, the shades of colour of black grape varieties diverge [6, 28]. Table 4 presents the anthocyanin composition of the Acıkara grape skin.

Table 4. Compositions of anthocyanins in Acıkara grape skin.

Anthocyanins (mg/kg*)	Skin
Delphinidin-3-O-glu	3048.07 ± 3.76
Cyanidin-3-O-glu	1399.47 ± 0.24
Petunidin-3-O-glu	2216.24 ± 0.44
Peonidin-3-O-glu	1371.89 ± 0.58
Malvidin-3-O-glu	3605.21 ± 3.28
Vitisin A	53.86 ± 0.09
Delphinidin-3-O-acet-glu	38.08 ± 0.01
Cyanidin-3-O-acet-glu	74.39 ± 0.01
Petunidin-3-O-acet-glu	198.21 ± 0.1
Peonidin-3-O-acet-glu	36.3 ± 0.08
Malvidin-3-O-acet-glu	274.18 ± 0.19
Delphinidin-3-O-p-coum-glu	77.89 ± 0.14
Petunidin-3-O-p-coum-glu	528.38 ± 0.01
Peonidin-3-O-p-coum-glu	120.19 ± 0.11
Malvidin-3-O-p-coum-glu	582.66 ± 0.37
Total	13625.02 ± 8.25

±: Standard deviation values; *: on dry weight; **: acetyl glycosides and coumaryl glycoside forms are calculated in terms of their respective glycoside forms. Vitisin-A is calculated in terms of malvidin-3-glucoside.

The skin was identified as having a total of 15 anthocyanin compounds, which consist of 5 glycosides, 5 acetyl glycosides, 4 coumaryl glycoside forms, and Vitisin-A compounds. Table 3 indicates that the skin contains a higher amount of anthocyanin compounds. This is a predictable occurrence as anthocyanin compounds are highly concentrated in the peel [29].

The Acıkara grape skin contains the majority of anthocyanin compounds in glycoside form. Malvidin-3-glucoside was the most prevalent compound, with a determined amount of 3605.21 mg/kg. Coumaryl glycoside and acetyl glycoside are anthocyanin compounds that followed the glycoside compounds, respectively. The peel contained 13625.02 mg/kg of total anthocyanin on a dry weight basis. Shi et al. [30], conducted a study to investigate the anthocyanin profiles of the peels of Cabernet Sauvignon, Merlot, Shiraz, and Marselan varieties that were sourced from Donghuayuan town in northern China. According to the researchers, the Marselan variety contained the highest anthocyanin

content in terms of dry matter and malvidin-3-glucoside, with 20790.75 mg/kg. The Merlot variety contained the lowest amount, with 10847.02 mg/kg, according to the report. The anthocyanin compound that dominated all varieties, as anticipated, was malvidin-3-glucoside. Acıkara is believed to possess anthocyanin compounds that are comparable to those of well-known varieties. Therefore, the Acıkara variety's anthocyanin content is advantageous for the production of quality red wine.

The Acıkara vineyards utilized in this research are situated at an elevation of 1100 meters. In a review, Mansour et al. [31], observed that the colour quality of the grapes increased as altitude increased. The colour and aroma potential of grapes grown in vineyards with low night temperatures were also higher. Xing et al. [32], conducted a study on Cabernet Sauvignon grapes that were grown at various altitudes (2900 m, 2300 m, and 2150 m) and reported data that supported this notion. The research concluded that the formation of anthocyanin was significantly influenced by high altitude. The research determined that grapes grown at 2900 m altitude had anthocyanin levels that were 1.2 and 2.3 times higher than those grown at 2300 m and 2150 m altitude, respectively.

3.3. Composition of Acıkara wines

The quality of wine is defined by the combination of desirable characteristics that contains [33] These desired characteristics are influenced by quantitative variables. Therefore, the wine's composition is also important. The general composition of the wines produced from the Acıkara grape is detailed in Table 5.

The alcohol content by volume of the Acıkara wine was determined as 13.7%. In research in Turkey conducted by Darıcı et al. [34], the alcohol content of red wines produced from Boğazkere grapes grown in different locations has been reported to range from 11.6% to 13.9% by volume [34]. The sugar concentration of the Acıkara variety was determined to have reached a sufficient level for red wine production. The outcome's alcohol level was considered suitable for the production of quality wine. In previous studies on red wines, the results regarding alcohol content, pH, titratable acid, and volatile acid have been consistent [34-36].

Phenolic compounds play a crucial role when assessing the quality of wines. Phenolic compounds have a significant impact on the colour and sensory characteristics of black grapes and the its wines [3]. The amount of total phenolic compounds and the tannin in Acıkara wines were found 2212.33 mg/L and 2.52 g/L, respectively. The phenolic content of 110 monosepage wines was determined by Giacosa et al. [37] to be between 1065 mg/L and 3578 mg/L in their investigation of Italian wines. According to another study conducted on Cabernet Sauvignon wines, the total phenol concentrations ranged from 997.29 to 1585.28 mg/L [38]. It was reported in studies conducted on Öküzgözü and Boğazkere wines, which are frequently used in wine production in Turkey, that the total phenolic content in Öküzgözü wines varied between 1360.8-2916.2 mg/L, and in Boğazkere wines, it was reported to be between 2073.6-3355.43 mg/L [34, 36]. Based on the outcomes of thorough studies conducted on both domestic and international wine varieties, it has been defined that the total phenolic compound content of Acıkara wine has been considered sufficient.

Table 5. General composition of Acıkara wine.

	Acıkara wine
Density (g/cm^3)	0.99108 ± 0.01
Alcohol (%v/v)	13.7 ± 0.01
Total acidity (g/L) *	4.5 ± 0.07
pH	3.4 ± 0.02
Volatile acidity (g/L) **	0.4 ± 0.01
Residual sugar (g/L)	3.3 ± 0.09
Free SO_2 (mg/L)	16.44 ± 1.7
Total SO_2 (mg/L)	55.65 ± 2.5
Total phenolic compounds (mg/L) ***	2212.33 ± 0.31
Tannin (g/L)	2.52 ± 0.56
HCl index	27.4 ± 0.1
Gelatin index	47.6 ± 1.0
%OY420	28.12 ± 0.01
%OY520	49.32 ± 0.02
%OY620	22.55 ± 0.08
Colour intensity (%OY $_{420+520+620}$)	2.5 ± 0.01
Colour tonality (%OY $_{420/520}$)	0.57 ± 0.01
Colour brightness (%dA)	35.7 ± 0.1

* In terms of tartaric acid, ** In terms of acetic acid, *** In terms of gallic acid, **** In terms of malvidin-3-glucoside; ±standard deviation.

Anthocyanidins is one of the quality factors are responsible for the colour of red wine. Furthermore, procyanidins, which are also referred to as condensed tannins, enhance colour stability by binding with anthocyanins [3, 39] Therefore, the level of tannins has also closely linked to the factors that influence the quality of red wine [40]. In addition, tannins are associated with texture perceptions such as astringency and body [3]. The total tannin of wines obtained from the Acıkara wine was determined as 2.52 g/L. The total tannin amounts of Shiraz and Cabernet Sauvignon wines were found to be between 1.30 and 2.88 g/L and 1.77 and 2.71 g/L, respectively, in a study that investigated the phenolic composition of 1643 different wines obtained from Australian companies [40]. The tannin content of Acıkara wine has been determined to be equivalent to that of varieties that are suitable for the production of quality wine.

The HCl index value of Acıkara wine was determined to be 27.4, while the gelatin index value was found to be 47.6. The HCl index is indicative of the polymerization degree of tannins in the wine. The HCl index value between 10 and 25 suggests that the wine has a significant concentration of polymerized phenolic compounds, and therefore is appropriate for barrel aging [3]. The gelatin index indicates the ability of tannins to bond with proteins and create persistent complexes. The gelatin index value between 40 and 60 is considered to be the optimal range,

indicating that the tannins in the wine are sufficiently reactive [3].

3.4. Anthocyanin composition of Acıkara Wine

The anthocyanins that are responsible for the colour of red wine are derivatives of five distinct anthocyanidin (delphinidin, cyanidin, petunidin, peonidin, and malvidin monoglucosides, acetyl glycosides, and coumaryl glycosides) compounds [30]. Table 6. presents the anthocyanin composition, amount, and proportional (%) distributions of wines produced from Acıkara grapes, while figure 1 illustrates the chromatogram of the identified anthocyanin compounds.

Table 6. Anthocyanins compositions of Acıkara wine.

Compound	Peak no	Amount* (mg/L)	Relative ratio (%)
Delphinidin-3-O-glu	1	407.07 ± 0.51	22.0
Cyanidin-3-O-glu	2	30.46 ± 0.23	1.6
Petunidin-3-O-glu	3	282.95 ± 0.55	15.3
Peonidin-3-O-glu	4	75.11 ± 0.10	4.1
Malvidin-3-O-glu	5	758.43 ± 1.15	40.9
Vitisin A	6	1.70 ± 0.06	0.1
Delphinidin-3-O-acet-glu	7	20.30 ± 0.42	1.1
Cyanidin-3-O-acet-glu	8	13.33 ± 0.17	0.7
Petunidin-3-O-acet-glu	9	33.79 ± 0.34	1.8
Peonidin-3-O-acet-glu	10	13.65 ± 0.17	0.7
Malvidin-3-O-acet-glu	11	49.80 ± 011	2.7
Delphinidin-3-O-p-coum-glu	12	14.60 ± 2.92	0.8
Petunidin-3-O-p-coum-glu	13	57.19 ± 0.44	3.1
Peonidin-3-O-p-coum-glu	14	15.66 ± 0.06	0.8
Malvidin-3-O-p-coum-glu	15	78.12 ± 0.47	4.2
Total		1852.16 ± 3.15	

±: Standard deviation values; *: acetyl-glucosides and coumaryl-glucoside forms are calculated in terms of their respective glycoside forms. Vitisin-A is calculated in terms of malvidin-3-glucoside; **(%) proportional distributions

Acıkara wine has a total of 15 distinct anthocyanin compounds, comprising 5 in monoglucoside and acetyl-glycoside form, 4 in coumaryl-glycoside form, and a Vitisin-A compound. The monoglucoside structure represents the majority of the identified anthocyanins, a percentage of 83.9 %. It was determined that 23.9% of the anthocyanin compounds (glycoside+glycoside-acetate+glycoside-p-coumarate) identified in Acıkara wine were delphinidin, 2.3% were cyanidin, 20.2% were petunidin, 5.6% were peonidin, and 47.8% were malvidin compounds. Nyman and Kumpulainen [41] conducted a study that determined 20% of the anthocyanin compounds discovered in Cabernet Sauvignon wines were delphinidin, 19% were cyanidin, 6% were petunidin, 3% were peonidin, and 52% were malvidin compounds. The anthocyanin compounds of Acıkara wine and Cabernet Sauvignon wine consisted similar in composition, with the exception of the cyanidin and petunidin ratios. The Cabernet Sauvignon variety contained a higher quantity of cyanidin compounds, whereas the Acıkara variety contained a higher quantity of petunidin.

The glycoside structure of the Acıkara wine displayed the highest percentage and quantity of these compounds, malvidin-3-glucoside (48.8% of the total glycoside forms). Additionally, malvidin-3-glucoside-acetate comprises 38.1% of the wine's identified acetyl forms of anthocyanins that represent the total acetyl structure. Therefore, malvidin-3-glucoside-coumarate is the most abundant compound in coumaryl form, accounting for 47.2% of the total coumaryl forms, as is the case in other forms.

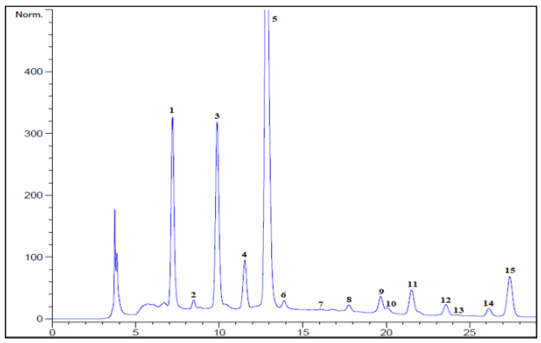


Figure 1. Chromatogram of Anthocyanin Compounds of Acıkara Wine.

The total quantity of anthocyanin compounds that was detected was 1852.16 mg/L. The concentration of glucosylated anthocyanins was 1554.02 mg/L, while the concentration of acetylated anthocyanins was 130.87 mg/L and the concentration of p-coumarylated anthocyanins was 165.57 mg/L. According to Radovanović & Radovanović [42], Cabernet Sauvignon wines from the Balkan Region had a predominant amount of glucosylated anthocyanins, ranging from 146.07 to 1175.03 mg/L. The wine also contained acetylated anthocyanins, ranging from 52.58 to 418.21 mg/L, and p-coumarylated anthocyanins, ranging from 9.53 to 213.94 mg/L.

3.5. Aroma composition of Acıkara wine

A total of 54 aroma compounds were identified in Acıkara wines, with 7 major and 47 minor levels. The compounds that were identified consisted of 16 higher alcohols, 16 esters, 10 volatile acids, 5 carbonyl compounds, 3 lactones, 2 6C compounds, 1 sulfur compound, and 1 volatile phenol compound. The overall concentration of aroma compounds was determined to be 315.7 mg/L. The aroma compounds identified in Acıkara wine, with their quantities and LRI values, are categorized based on their chemical structures and presented in Table 7.

A total of 16 higher alcohol compounds were identified in Acıkara wines, with the total amount detected as 222.23 mg/L. Higher alcohols contribute to the complexity of wine when present in concentrations below 300 mg/L. However, when the concentrations exceed 400 mg/L, they can have a negative effect on the quality of the wine, resulting in undesirable characteristics such as fusel, pungent, and heavy odors [3, 50] The alcohol content in Acıkara wine was determined to be below 300 mg/L. It is

evident that the alcohol content in Acıkara wine falls within the desired range. The most prevalent alcohol in the higher alcohol content was isoamyl alcohol, followed by 1-propanol, isobutyl alcohol, and 2-phenyl ethanol. In accordance to research conducted by Bellincontro et al [51], it has been reported that isoamyl alcohol is the compound responsible for the distinct alcohol scent found in red wine. 2-Phenylethanol is a significant compound that presents the pleasant odours of rose and honey to wine [6, 45]. The content of 2-phenylethanol in Acıkara wine was determined to be 4159.6 µg/L.

Esters are the second-largest group within the aroma compounds of the Acıkara wine. The concentration and formation of esters in wines are influenced by various factors such as the yeast strain, fermentation temperature, aeration, sugar content, and the vinification process [39, 52]. Esters have been widely recognized as significant compounds for enhancing the aroma of wine. Due to their tendency to impart a fruity flavor, these components contribute to the wine's distinctive characteristics [6, 52]. A total of 16 distinct ester compounds were detected in the Acıkara wine, with a determined total amount of 70.3 mg/L. 15 of the identified ester compounds were found at a micro level, while one compound (ethyl acetate) was present at a macro level. The total amount of determined micro level ester compounds was found to be 21.4 mg/L. In addition to ethyl acetate as a major compound, monoethyl succinate was the most prominent ester noticed in the Acıkara wine, followed by ethyl lactate and diethyl succinate. The ethyl acetate content found in Acikara wine is 48.9 mg/L. When ethyl acetate concentrations exceed 150-200 mg/L, it can result in an unpleasant nail polish-like odor and present undesirable or faulty attributes to the wine. At lower concentrations, it gives the wine with fruity aromas [53]. Research has shown that the esters found in young Cabernet Sauvignon wines constitute around 51% of the total volatile compounds. Among those esters, ethyl acetate was found to be the most abundant [54]. Arcari et al. [55], found that the ethyl acetate content of wines produced from Merlot grapes cultivated in 8 distinct harvests and 3 distinct regions ranged from 2.63 to 47.13 mg/L. The levels of monoethyl succinate, ethyl lactate, and diethyl succinate in Acıkara wine were measured at 12.8 mg/L, 6.4 mg/L, and 0.76 mg/L, respectively. There have been reports indicating the significance of diprotic acid esters, such as monoethyl succinate, diethyl succinate, and ethyl lactate, in contributing to the aroma of aged wine. These compounds are particularly noticeable in wines made from grapes grown in warmer regions, and their concentration tends to increase with the years and the development of oxidation. In addition, this substance contributes to the development of the fruity aroma found in wines. [56, 57]. The levels of monoethyl succinate in Kalecik Karası wines from the 1998 and 1999 harvests were measured at 0.8-0.9 mg/L, respectively [58]. In another investigation carried out on Kalecik Karasi wines from the harvests of 2011, 2012, and 2013, the levels of monoethyl succinate have been reported as ranging from 21.2 to 35.7 mg/L in wines from the Ankara region, and from 16.7 to 47.5 mg/L in wines from the Denizli region. Tao et al. [54], have reported that ethyl lactate contributes positively to the wine's aroma as combined with lactic and raspberry odors. According to Çelik et al. [59], the concentration of ethyl lactate in Kalecik Karası wines increased from 0.2 mg/L to 13.5 mg/L following malolactic fermentation. Arcari et al. [55], reported that the concentration of ethyl lactate in wines produced from Merlot grapes harvested from various regions and years varied between 3.7 and 34.5 mg/L. Waterhouse et al. [6], stated that the diethyl succinate compound's positive impact on wine is undeniable, despite its high perception threshold value and low volatility. Arcari et al. [55], have determined that diethyl succinate provides a caramel and floral aroma to wine, with a perceptual threshold value of 200 mg/L. The concentration of diethyl succinate in red wines produced from domestic and foreign varieties varies between 0.2-13.3 mg/L, as indicated by four distinct studies [39, 58, 60, 61].

Esters can be classified into two categories based on their sources. Initially, the acetates of higher alcohols, including isoamyl acetate and 2-phenyl acetate, and ethyl esters of fatty acids, including ethyl butanoate, ethyl hexanoate, and ethyl octanoate [3]. The most abundant compounds in Acıkara wines were ethyl lactate, ethyl hexanoate, and ethyl butanoate, among the ethyl esters of fatty acids that influence the fruit odor in red wines. The detection thresholds for these compounds in the wine matrix are as follows: 154000 µg/L for ethyl lactate, 14 µg/L for ethyl hexanoate, 5 µg/L for ethyl octanoate, and 20 µg/L for ethyl butanoate [44, 62]. The levels of these compounds (excluding ethyl lactate) in the wines are significantly greater than the detection threshold values (Table 7). Aznar et al. [63], have reported that ethyl hexanoate imparts a red fruit-strawberry aroma to wine. Moreover, isoamyl acetate, 2-phenylethyl acetate, and ethyl acetate were the most prominent esters in Acıkara wines among the acetates of higher alcohols. Aznar et al. [63] and Escudero et al. [49] have reported that the detection threshold of these compounds in wine matrix is 30 µg/L for isoamyl acetate, 250 µg/L for 2-phenylethyl acetate, and 12300 µg/L for ethyl acetate. Subsequently, these compounds impart a banana, strawberry-fruity, and fruity-apple aroma to wines. It is evident that the concentrations of these compounds in the wines exceed the detection threshold values (Table 7).

The majority of lactones are produced by yeast metabolism and they contribute caramel and sweet odors to the wine. Gamma lactones are the predominant category of lactones discovered in wines and frequently occur in all types of wines [3]. 3 distinct lactone compounds were identified in Acıkara wine. Gamma-butyrolactone was the most prevalent lactone compound, with a total lactone concentration of 0.51 mg/L. According to the research, the total amount of lactones of Kalecik Karası wines from two different region and three different year was reported to be between 0.7 and 1.12 mg/L [56]. Additionally, the amounts of Gamma-butyrolactone in Kalecik Karasi wines were found to range from 0.3 to 0.5 mg/L according to Selli et al. [58], and from 0.15 to 0.37 mg/L according to Darıcı and Cabaroğlu [56]. Furthermore, the second most prevalent lactone in the Acıkara wine was 4-ethoxycarbonyl-gamma-butyrolactone, which had an amount of 148.2 ug/L. The 4-ethoxycarbonyl-gamma-butyrolactone has been reported to contribute a red fruit odor to wines [64]. Selli et al. [58] and Darıcı and Cabaroğlu [56], have identified the 4-ethoxycarbonyl-gamma-butyrolactone compound as one of the aroma-active compounds in Kalecik Karası wines.

Table 7. Aroma composition of Acıkara wine.

Aroma Compounds	LRI	ID	Concentration	Odor Threshold[a]	OAV[b]
Higher alcohols (µg/L)					
1-Propanol*	-	A, C	51900 ± 60		
Isobutyl alcohol*	-	A, C	23500 ± 30	40000[43]	0.59
2-Methyl-2-butanol	1029	A, B, C	24.3 ± 5.1		
1-Butanol*	-	A, C	4900 ± 30	150000[45]	0.03
3-Penten-2-ol	1186	A, B, C	99.9 ± 1.8		
2-Methyl-1-butanol (active amyl alcohol) *	-	A, C	20900± 20		
Isoamyl alcohol*	-	A, C	115400 ± 10	30000[43]	**3.85**
1-Heptanol	1278	A, B, C	3.9 ± 2.6		
4-Methyl 1-pentanol	1428	A, B, C	0.2 ± 0.05		
3-Ethoxy-1-propanol	1435	B, C	95.8 ± 17.8		
2,3–Butanediol	1632	A, B, C	933.8 ± 1003.4		
4-Methyl 2-pentanol	1655	A, B, C	0.6 ± 0.7		
1,3-Butanediol	1680	A, B, C	190.1 ± 188.9		
Methionol	1827	A, B, C	68.1 ± 4.5	1000[44]	0.07
Benzyl alcohol	2001	A, B, C	53.5 ± 5.96	200000[48]	0.0003
2-Phenylethanol	2051	A, B, C	4159.6 ± 217.5	14000[44]	0.3
Total			***222229.8 ± 978.1***		
Esters (µg/L)					
Ethyl acetate*	-	A, C	48900 ± 70	12300[49]	**3.98**
Ethyl butanoate	1057	A, B, C	82.9 ± 22.20	20[44]	**4.15**
Isoamyl acetate	1152	A, B, C	557.1 ± 32.56	30[43]	**18.6**
Ethyl hexanoate	1298	A, B, C	119.8 ± 12.59	14[44]	**8.56**
Ethyl lactate	1396	A, B, C	6364.0 ± 58.95	154000[45]	0.04
Ethyl octanoate	1566	A, B, C	274.9 ± 24.12	5 [44]	**54.9**
Diethyl succinate	1801	A, B, C	758.3 ± 39.26	200000[45]	0.004
1,3-Propylene diacetate	1849	B, C	227.6 ± 34.22		
Ethyl-4-hydroxy-butanoate	1930	A, B, C	435.4 ± 33.94		
2-Phenethyl acetate	1950	A, B, C	10.4 ± 5.48	250[43]	0.04
Diethyl malate	2222	A, B, C	14.9 ± 4.97		
Methyl decanoate	2241	B, C	10.3 ± 1.80		
Diethyl 2-hydroxypentanedioate	2391	B, C	150.5 ± 8.67		
Isobutyl pentanoate	2582	B, C	208.9 ± 73.53		
Monoethyl succinate	2674	A, B, C	12822.7 ± 267.05		
Methyl hexadecanoate	2857	B, C	65.4 ± 14.63		
Total			***70291.0 ± 629.4***		
Acids (µg/L)					
Isobutyric acid	1660	A, B, C	73.3 ± 10.46	50[46]	**1.47**

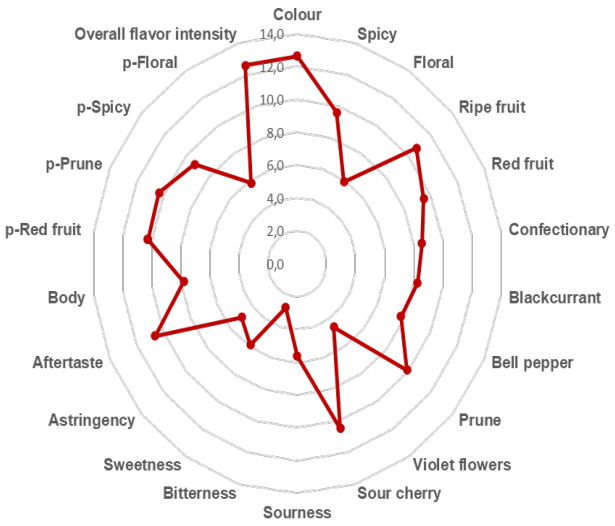
Propanoic acid	1666	A, B, C	25.3 ± 2.60	8100 [44]	0.003
Butanoic acid	1731	A, B, C	70.7 ± 7.99	173[44]	0.41
3-Methyl butanoic acid	1778	A, B, C	112.9 ± 4.31	33[44]	3.42
2-Methyl butanoic acid	1879	A, B, C	4.8 ± 1.58	33[44]	0.15
Hexanoic acid	1975	A, B, C	536.8 ± 21.54	420[44]	**1.28**
Octanoic acid	2254	A, B, C	1071.9 ± 56.29	500[44]	**2.14**
Decanoic acid	2558	A, B, C	278.5 ± 11.17	1000[44]	0.28
Octadecanoic acid	2815	A, B, C	17.5 ± 0.61		
Hexadecanoic acid	2945	A, B, C	110.8 ± 6.60		
Total			***2641.9 ± 202.9***		
6C alcohols (µg/L)					
trans-2-Hexen-1-ol	1350	A, B, C	90.1 ± 8.9	15000 [45]	0.006
1-Hexanol	1423	A, B, C	209.9 ± 21.2	8000[43]	0.03
Total			**300.0 ± 24.4**		
Volatile phenols (µg/L)					
4-Vinylguaiacol	2422	A, B, C	4.1 ± 0.73	1100[47]	0.004
Total			**4.1 ± 0.73**		
Lactones (µg/L)					
γ-Butyrolactone	1706	A, B, C	353.1 ± 18.7	35000[48]	0.01
γ-Pentalactone	2213	A, B, C	3.9 ± 4.1		
4–Ethoxy carbonyl–γ–butanolactone	2458	B, C	148.2 ± 7.9		
Total			***505.2 ± 12.8***		
Carbonyl compounds (µg/L)					
Acetaldehyde*	-	A, C	19400 ± 90	500[43]	**38.8**
Acetoine	1303	A, B, C	182.0 ± 16.3	150000[45]	0.001
2-(trans)-6-(cis)-Nonadienal	1327	B, C	11.4 ± 4.7		
3-Methyl-1,2-cyclopentanediol	2133	B, C	45.2 ± 3.7		
3-Octanone	2368	B, C	7.0 ± 3.1		
Total			**19639.1 ± 11.0**		
Sulphur compounds (µg/L)					
3-Mercapto-2-butanone	2013	B, C	50.5 ± 3.35		
Total			***50.5 ± 3.35***		
General total (µg/L)			***315661.6***		

Each data is the mean of triplicate determinations; ±standard deviations; LRI, Linear retention indices on DB-WAX column., ID; Identification. A: identification with the injection of reference compounds; B: identification by comparison with the mass spectrum from NIST library; C: identification by comparison with data from previous literature. *Compounds were quantified by direct injection into GC-FID. [a]Reference from which the value has been taken is given in parentheses. [b]Odour activity value calculated by dividing concentration to odour threshold value of the compound. In bold, compounds with OAV > 1. [43] The matrix was a 10% water/ethanol solution; [44] The matrix was a 11% water/ethanol solution containing 7 g/l glycerol and 5 g/l tartaric acid, with the pH adjusted to 3.4 with 1 M NaOH; [45] Thresholds were calculated in a 12% water/ethanol mixture; [46] The matrix was water: [47] The matrix was a synthetic wine containing 12% ethanol, 8 g/l glycerol, and different salts; [48] and [49], Orthonasal thresholds were calculated with a 10% water/ethanol mixture containing 5 g/l of tartaric acid at pH 3.2 in the Laboratory.

3.6. Sensory Characteristics of Acıkara Wine

Descriptive analysis was applied to determine the sensory characteristics of Acıkara wine. In order to enhance the visual representation of the results, Figure 2 illustrates the results on the spider web diagram. The assessors assessed the wine's sensory profile using 22 different attributes. One of these attributes was visual (colour), ten were olfactory perception on the nose, three were taste, four were retronasal aroma (on the palate), and four were mouthfeel and flavour attributes (Figure 2).

The Acıkara wine sample was assessed based on its sensory characteristics, including red fruit, ripe fruit, sour cherry, prune, and spicy attributes. In terms of visuals, the wines were rated 12.6 out of 15 for the colour, which was described as a deep shade of red-violet. Assessors identified ripe fruit and sour cherry as the most prominent odours in Acıkara wine, scoring 10.7 and 10.5 out of 15 points, respectively. The predominant odours that followed were prune, spicy, and red fruit aromas. The red fruit attribute received a score of 9.5 in the nose and 10.3



in the palate, while the prune attribute received a score of 9.9 in the nose and 10.4 in the palate. In addition, the spicy attribute received ratings of 9.6 and 9.2 points in terms of nose and palate, respectively.

Figure 2. Sensory characteristic of Acıkara wine. p: on palate.

The Acıkara wine scored 5.9 points for sweetness, 5.7 points for sourness, 10.6 points for aftertaste, 2.8 points for bitterness, and 7.8 points for body. The sensory evaluation revealed that Acıkara wine had a deep red violet colour, a medium plus body, and prominent characteristics of prunes, cherries, and spices. The wine is well balanced, with all its sensory qualities in harmony.

4. Conclusions

This study investigates the varietal characteristics of the Acıkara grape cultivated in the Elmalı location of Antalya province, emphasizing the maturity status of phenolic compounds and the grape's potential for processing into quality red wine. Additionally, the research investigates the overall composition of wines produced from this grape, including the composition of phenolic and aroma compounds, as well as their suitability for quality red wine production. The grapes were discovered to have an appropriate sugar, acid, and pH balance during the period of ripening. They are also abundant in phenolic compounds, particularly anthocyanins. Consequently, they are an appropriate variety for the production of quality red wine. Compounds including monoethyl succinate, diethyl succinate, ethyl hexanoate, and isoamyl acetate, which have been identified in Acıkara wine and provide fruity aromas, play a crucial role in defining the wine's distinctive aroma. Upon assessment of the sensory characteristics, Acıkara wine, the panel determined that fruity notes, specifically red and ripe fruit, were predominant in terms of odour, followed by spicy odours and displaying a deep red-violet colour, characterized by a medium plus body and a long finish. The variety and the wines have been determined to be promising, especially noteworthy for their outstanding colour character, as they independently fulfilled the quality parameters. Based on the data obtained, the Acıkara variety has been assessed that is highly suitable for the production of quality red wine. To elucidate the distinctive characteristics of the Acıkara grape and its corresponding wine in a more thorough and comprehensive manner, it is advisable to undertake long-term research and maintain systematic data records.

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