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Vinegar Production from Bayramiç Beyazı (*Prunus persica var. nucipersica*) and Bayramiç Apple (*Malus domestica*) Fruits with Natural Fermentation and Determination of Some Physicochemical and Antioxidant Properties

Tuğba Güngör Ertuğral[1*], Gülen Türker[2], Yalçın Coşkun[3], Ebru Karahan[4]
[1]*Department of Food Technology, Faculty of Canakkale Applied Sciences, Canakkale Onsekiz Mart University, Türkiye*
[2]*Department of Food Technology, Faculty of Canakkale Applied Sciences, Canakkale Onsekiz Mart University, Türkiye*
[3]*Department of Plant Production and Animal Husbandry, Lapseki Vocational School, Çanakkale Onsekiz Mart University, Türkiye*
[4]*Department of Food Technology, Faculty of Canakkale Applied Sciences, Canakkale Onsekiz Mart University, Türkiye*

----------*ABSTRACT*----------
Vinegar has been used in gastronomy culture throughout history. Bayramiç Beyazı (Prunus persica var. nucipersica) and Bayramiç apple (Malus domestica) are geographically indicated fruits grown in Turkey. In this study, Bayramiç Beyazı and Bayramiç apple vinegars were produced by traditional method and some chemical properties; pH, total dry matter, total acidity, color analysis (L, a*, b*) together with antioxidant activities and total flavonoid content were calculated. DPPH free radical scavenging activities of vinegars produced from Bayramiç Beyazı and Bayramiç apples were 14% and 20%, respectively and their Total flavonoid content were determined as 1.932 and 1.873, respectively. Some quality characteristics were determined by comparing obtained results.*

Keywords: *Bayramiç Beyazı vinegar, Bayramiç apple vinegar, antioxidant, flavonoid.*

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I. INTRODUCTION

Vinegar is a fermented food that is effective in cancer, chronic diseases, diabetes and hypertension diseases with its antioxidant and antimicrobial properties [1]. *Saccharomyces cerevisiae* performs most important task during fermentation and various *non-Saccharomyces* microorganisms can also produce aromatic compounds [2]. Vinegar, which has a high acetic acid compound, is an effective disinfectant on SARS-Cov-1 and SARS-Cov-2 viruses with the inhibition of hemagglutinin glycoproteins, and viral envelope can be destroyed with a low pH [3]. Inhibitory effect of some apple vinegars with different concentrations was observed against bacterial strains and it was observed that production method contributed to antibacterial activity by affecting physicochemical composition properties of vinegar [4]. Anti-inflammatory effect of *P. persica* fruits is among research topics in recent years [5]. Apple vinegar has antibacterial properties and can inhibit *S. aureus* at certain concentrations [6]. In addition, hazelnut shell vinegar can inhibit mycelial growth of *A. niger* and *P. digitatum* [7]. A mixture containing vinegar was used to determine the effect of high-pressure thermal sterilization on the inactivation of *Geobacillus stearothermophilus* spores in ready meals [8].

In ancient times if left to their own devices in an open container alcoholic beverages such as wine and beer become vinegar and thought to have been corrupted however over time, it has been realized that it is a useful food. Circus BC. historical artifacts show that it has been produced in many different societies since 2000s [9]. Vinegars produced by the traditional method are usually produced from the juices of foods such as grapes, apples, plums, coconuts, tomatoes, rice and potatoes. Yeasts are found in soil, sweet and juicy fruits in nature [10].

Although acetic acid bacteria are common in nature that loves environments with sugar and alcohol, a total of 19 genera, mainly *Acetobacter* and *Gluconobacter* are defined [11]. In vinegar production, ethanol is first formed by yeast (*S. cerevisiae*) fermentation and then acetic bacterial fermentation takes place. In traditional productions, this period is quite long and may take at least a month [12]. Fermentation occurs naturally in surface culture fermentation, which is a traditional method. In this method, the mash to be vinegared is kept in barrels for a long time, allowing start of yeast fermentation and alcohol is formed. Untreated vinegar (25-30%) is infused into the resulting alcoholic mash and acetic acid fermentation begins at 28-30 °C. In about 7 days, membrane formation is observed on the liquid surface and this membrane thickens and turns into mother of vinegar. The collapse of mother of vinegar to bottom of liquid indicates completion of vinegar, and this process takes approximately 60-90 days[13].

Bayramiç Beyazı (*P. persica var. nucipersica*) is in peach class [14]. After Bursa, Mersin and İzmir provinces in peach and nectarine cultivation in Turkey, Çanakkale is the province with most cultivation [15]. Bayramiç Beyazı fruit is grown only Çanakkale in Turkey. It has a different aroma and taste than peach and has become a demanded product. It received its geographical registration certificate under the name of "Bayramiç Beyazı" in 2010 by the Turkish Patent Institute [16]. Bayramiç Beyazı, in Bayramiç district of Çanakkale province, matures in July and August, and the color of fruit is green during at harvest period and turns into a slightly light yellow color as harvest period progresses. Bayramiç apple (*M. domestica*) is a fruit that grows in Çanakkale Bayramiç district and is harvested in September and October. It is a geographically marked product with the name "Bayramiç apple" [17].

Antioxidant property is an important factor, and with amount of antioxidants decrease that can cause wrinkled skin, accelerate aging, diabetes, cancer and cardiovascular diseases in our body [18] and also antihyperlipidemic and antiatherogenic effects of hawthorn fruit extract and fruit vinegar [19] indicate benefits of vinegar.

In this study, Bayramiç Beyazı vinegar (BBV) was used in Çanakkale Bayramiç region and Bayramiç apple vinegar (BAV) is produced by traditional method. DPPH and TFC analyzes were performed for determination of antioxidant activity of vinegars. In order to determine physicochemical properties of vinegar samples, pH, total dissolved solids, total acidity and L (brightness), a (greenness/redness), and b (blueness/yellowness) values were determined by color measurement.

II. MATERIAL and METHOD

2.1. Materials

Raw materials, Bayramiç apple (*Malus domestica*) fruits were harvested during september 2021 and Bayramiç Beyazı were harvested during agust 2021 at Çanakkale Bayramiç province. Phenolphthalein, 2,2-diphenyl-1-picrylhydrazyl (DPPH), NaOH was purchased from Sigma-Aldrich and gallic acid standard was purchased from Fluka.

2.2. Preparation of Bayramiç Beyazı and Bayramiç Apple Vinegars

2 kg of Bayramiç Beyazı seed was separated from its core and cut into cubes and potable spring water, 150 ml of apple cider vinegar, which was previously produced by conventional method and 5.5 g of sugar were added. It was filled into a 2 liter glass jar, 1/3 of which was empty. Covered with a cloth, it was ventilated in a dark environment at approximately 25°C by mixing twice a day for 3 weeks, and when mother of vinegar formation was observed, it was kept in an environment without light for about 90 days and finally decanted. The vinegar, which was separated from residue by decantation, was stored in a glass jar at +4°C with lid closed (Figure 2). Same procedures were applied for BAV product and then analyzed under laboratory conditions [20].

2.3. Physicochemical Analyzes

Vinegars pH were determined at 20°C with a HANNA HI 2211 pH meter [20]. Titration acidity analysis was calculated in terms of acetic acid by placing 5 ml vinegar sample in a beaker for total acidity (%), 3 drops of Phenolphthalein was added, and titrated with 0.1N NaOH until a color change was observed [22]. Total soluble solids (TSS) (% Brix) of vinegars were measured with Hanna HI 96801 (0-85% brix) refractometer at 20°C [23]. Color analysis Chroma Meter Cr400 Konica Minolta color measuring device was used. L*, a* and b* values were checked according to CIELAB color range. The L* value is in the range of bright/dark (white:100, black:0), the a* value is in the range of red/green (red: +, green:-), and the b* value is in the range of yellow/blue (yellow: +, blue:-) [24].

2.4. Antioxidant Activity

2.4.1. Determination of DPPH Radical Scavenging Activity

DPPH radical scavenging activity of BBV and BAV extract was performed according to the method of Brand-Williams at al [25]. Dilution series (0.25 to 1 mg/ml) were prepared for each of extracts in methanol and after each dilution 3 ml of $6x10^{-5}$ M methanolic DPPH solution was added and vortexed. Mixture was kept at room temperature and in dark for 30 minutes. Decrease in absorbance of final solution against methanol was measured spectroscopically at 515 nm and DPPH radical scavenging activity was calculated (formula 1).

DPPH radical scavenging activity

$$Inh\ (\%) = (A_0 - A_1 / A_0) \times 100 \qquad (1)$$

A_0: absorbance of the control.
A_1: absorbance of the sample

2.4.2. Determination of Total Flavonoid Content (TFC)

TFC was determined using routine as a standard [26]. TFC was determined as milligram/ml extract routine equivalents (formula 2). Three replicates were used to determine mean total flavonoid values of BBV and BAV extract.

$$X=C.V/m \qquad (2)$$

X: Flavonoid Compounds
C: Concentration calculated from the Rutin
V: Stock plant extract volume
m: Gram amount of stock plant

Initial pH and % TSS values of fruits after harvest are given in Table 1. The pH of vinegars decreased significantly towards end of fermentation (Table 2).

III. RESULT and DISCUSION

While pH levels of BBV and BAV were 4.95 and 4.67 respectively, they decreased to 3.42 and 3.26 at the end of fermentation (Table 1, 2). In apple vinegar, this value can be 3.13 [27] and pH can go down to 2.87 (Table 5). TSS is 8.5% for BBV at beginning and %3.8 at end of fermentation, for BAV it is % 10.65 at beginning and % 1.17 at end of fermentation (Table 1,3) and in apple vinegar this value is 1.96 and total acidity value is % 3.21 for BBV and BAV. It can be %3.64 for apple vinegar and % 5.72 for other apple vinegars (Table 5) [28]. For example, BBV and BAV DPPH values were measured as %14 and %20 and TFC 1931.93 and 1873.72 µg rutin/g sample, respectively and DPPH increased up to % 76.74 in mulberry vinegar (Table 7). When the analysis results of different vinegar types are examined, DPPH values are %7.19 in apple vinegar, 1226.83 mg QEE/kg in total flavonoid quercetin equivalent (QEE), %10.59 in grape vinegar and 1017.07 mg QEE/kg in total flavonoid [29]. L*, a*, b* values are 56.68-0.67, 12.13 for BBV and 55.49, 0.11 and 4.70 for BAV, respectively (Table 4). Vinegar colors reflect the color of fruit itself (Figure 1) and L* value is close to peach, cardinal grape (Table 5).

Table 1. Bayramiç Beyazı and Bayramiç apple fruits pH and TSS values.

Fruits	pH	TSS (%)
Bayramiç Beyazı	4.31±0.01	8.5±0.15
Bayramiç apple	3.73±0.02	10.65±0.22

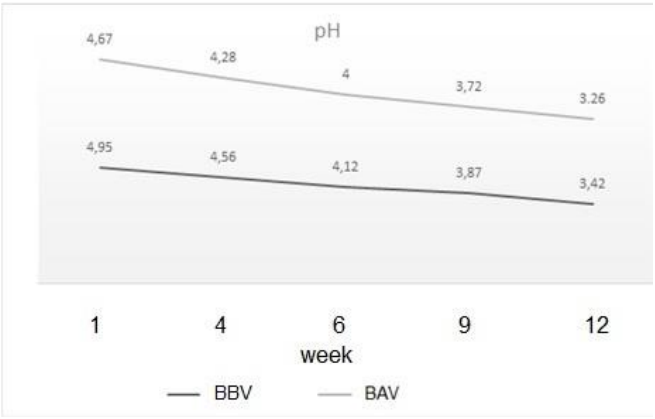

Figure 1. pH value change of BBV and BAV according to weeks

Table 2. BBV and BAV pH, TSS, Total acid, DPPH, TFC analysis

Vinegar	pH	TSS (%)	Total acid (%)	DPPH (%)	TFC(µg rutin/g sample)
BBV	3.42±0.02	3.8±0.05	3.21±0.03	14	1931.93±0.31
BAV	3.26±0.03	1.7±0.04	3.64±0,02	20	1873.72±0.11

Table 3. BBV and BAV color analysis results

Vinegar	L*	a*	b*
BBV	56.68±0.20	-0.67±0.01	12.13±0.01
BAV	55.49±0.13	0.11±0.01	4.7±0.01

Table 3. Physicochemical analysis results of vinegar varieties produced from some fruits

Vinegar	pH	TSS (%)	Total acid (%)	References
Honey	3.16	5.97	3.17	[27]
Grape	2.84	0.65	4.22	[27]
Hawthorn	3.13	1.39	3.51	[27]
Peach	3.63	3.57	1.05	[30]
Kardinal Grape	2.93	3.7	3.23	[30]
Apple	2.87	1.96	5.72	[28]

Table 4. Color analysis of vinegar varieties produced from some fruits

Vinegar	L*	a*	b*	References
Apple-Pine Honey	17,13	7,93	24,56	[31]
Peach	41,39	2,39	20,37	[30]
Cardinal Grape	52,18	0,6	13,19	[30]

Table 5. DPPH and TFC analyzes of mulberry, grape and apple vinegars

Vinegar	DPPH (%)	TFC (mg quercetin equivalent /kg)	References
Traditional Mulberry	76.74	-	[11]
Commercial Mulberry	40.52	-	[11]
Grape	10.59	1017.07	[29]
Apple	7.19	1226.83	[29]

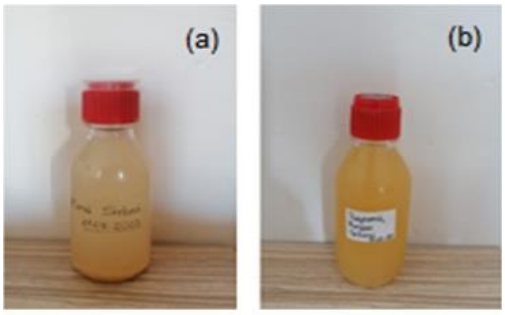

Figure 2. Samples of BAV (a) and BBV (b)

IV. CONCLUSION

Vinegar is a fermented product which is produced in food industry and has positive effects on health. Although apple and grape are generally used as raw materials for production vinegar and other vinegars produced by using all kinds of raw materials such as fruits, vegetables, and some grains containing sugar. In this study, vinegar production was carried out with the traditional method from fruits of Bayramiç Beyazı and Bayramiç apple grown in Çanakkale/TURKEY region. Results close to vinegars produced by other similar methods were obtained. DPPH free radical scavenging activity was 14% and 20% for BBV and BAV, and TFC values were respectively; 1.932 and 1.873. Production of BBV and BAV vinegars can contribute to vinegar industry as an alternative product.

Authors' Contribution

This article is part of the graduation thesis of Çanakkale Faculty of Applied Sciences, Department of Food Technology. All authors contributed equally to the work.

The Declaration of Conflict of Interest/ Common Interest

No conflict of interest or common interest has been declared by the authors.

The Declaration of Ethics Committee Approval

This study does not require ethics committee permission or any special permission.

The Declaration of Research and Publication Ethics

The authors of the paper declare that they comply with the scientific, ethical and quotation rules of SAUJS in all processes of the paper and that they do not make any

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