Food Science and Engineering
http://ojs.wiserpub.com/index.php/FSE/

Research Article

Cold Pressed vs. Centrifugal Juice: Comparison in Terms of the Juice Yield, Physicochemical and Phytochemical Properties

Gokcen Baykus, Sevcan Unluturk*

Department of Food Engineering, Izmir Institute of Technology, Izmir, Turkey
Email: sevcanunluturk@iyte.edu.tr

Received: 31 October 2023; **Revised:** 21 February 2024; **Accepted:** 7 March 2024

Abstract: In this study, a juice beverage was prepared from pineapple, green apple, and kiwifruit using cold press and centrifugal juice extraction methods. In the first stage, the most preferred beverage formulation (60% pineapple, 35% green apple, and 5% kiwifruit) was selected according to the acceptance index (AI) calculated based on sensory analysis scores. Next, the performance of home-type cold-pressed juicers (CPJ) and centrifugal juicers (CDJ) was compared, considering the physical, chemical, and phytochemical properties of the mixed beverage. It has been determined that the juice yield performance of the cold pressing technique is better than the centrifuge method. For example, the juice yield of pineapple obtained by a cold press juicer (92%) was found to be higher than the centrifugal extraction method (47%). Although the pH of CDJ and CPJ beverages were similar, the total soluble solids content (°Brix), the color parameters (a*, b*, L*), the browning index (BI), and the turbidity of both beverages were significantly different. While the browning index (BI), L*, and b* values of the CPJ beverage were higher, the a* value was lower than that of the CDJ beverage. Additionally, the CPJ juice mixture was more turbid and phase separation was not observed as in the CDJ beverage. This study revealed that juices obtained by both squeezing methods contained comparable total phenolic content (TPC). For example, the amount of TPC for CPJ and CDJ was 867.25 ± 0.01 mg GAE/L and 922 ± 0.01 mg GAE/L, respectively. Furthermore, the 1,1-diphenyl-2-picrylhydrazyl (DPPH) radical scavenging activity of both beverages was not significantly different. It was concluded that the physical properties of juices extracted by CPJ were more satisfactory than those of CDJ. However, more studies are needed to compare the data obtained on the antioxidant activity and TPC amount of fruit juices using different measurement methods.

***Keywords*:** cold-pressed juicer, centrifugal juicer, juice extraction, DPPH radical scavenging activity, total phenolic content, mixed beverage

1. Introduction

Fruit juices are non-alcoholic beverages mostly preferred due to their nutritional value, taste, and easy consumption [1]. The potential health benefits of fruit juices are extensively studied [2]. Due to the increasing awareness of the health effects of consuming fruit juices, the demand for the fruit juice industry is increasing day by day. However, from the consumer's point of view, juice extraction techniques have become an important consideration to ensure that the health-related substances in the fruit are incorporated into the final product.

The demand of consumers forces the fruit juice industry to find innovative techniques that could be used on both

DOI: https://doi.org/10.37256/fse.5120243849

household and industrial scales. Conventional centrifugal juicers are widely used at home to extract juice from fruits and vegetables. They are easy to use to obtain freshly squeezed fruit and vegetable juices. In this extraction method fruit is crushed by the blades of the centrifugal juicer rotating at high speed and the juice is separated from the pulp by centrifugal force [3]. However, when the metal blades rotate rapidly at high speed, heat is released due to the friction force. The high amount of heat generated in the centrifugal juicer may negatively affect the health-related (bioactive) compounds of the fruit juices.

In recent years, the cold press juice industry has become a rapidly growing sector in the world [4]. The market prices of cold-pressed fruit juices are also high. Cold pressing takes place in two stages; fruit and vegetables are cut into small pieces, and then small pieces of vegetables and fruits are extracted physically by applying pressure. The process is followed by filtration [4]. Crushing and extraction are slower and take longer than a centrifugal juicer. Almost no heat is generated due to this slow extraction process [3].

Additionally, it is reported that the cold-pressing technique yields more juice than the conventional centrifugal juicing technique [5]. Cold pressed technique is also used effectively in the preparation of beverages from green leafy vegetables that are low in calories and sugar and have high nutritional value [6]. In addition, the retention of vitamin C and antioxidant activity in grape juice and purple prickly pear juice is reported to be higher than in the juice extracted using a centrifugal juicer [7-8]. On the other hand, Miguel et al. [9] investigated the effects of two different juice extraction methods on the quality of pomegranate juice. They reported that the two extraction methods had no different effect on the quality parameters. Besides, it has been reported that blending is a more effective approach compared to mechanical press juice extraction to preserve the nutritional quality of the juice [10].

There is no consistency between the results of studies examining the effects of cold press and centrifugal juice extraction methods on the quality of fruit juices. Therefore, this study aimed to compare some physical and phytochemical properties of fruit juices obtained from fruit juicers commonly used at home and to contribute to the literature in terms of eliminating uncertainty on this subject. Additionally, the range of plant bioactive compounds is extensive. For example, apple juice contains chlorogenic acid, pineapple is a source of ascorbic acid, folate, niacin, and thiamine, and kiwi contains potassium, polyphenols, and flavonoids as antioxidants [2, 11]. Therefore, three different fruits were used in this study. It was aimed to obtain mixed fruit juice from different fruits, to combine different bioactive components from each fruit, and to increase the health-related substances of the mixed fruit juice.

This study investigated and compared the physicochemical (pH, total soluble solid content, turbidity, color) and phytochemical properties (total phenolic content, total antioxidant activity), including juice extraction efficiency, of a juice beverage prepared from pineapple, green apple, and kiwifruit using cold press and centrifugal juice extraction methods.

2. Materials and methods

2.1 *Formulation of mixed fruit juice beverage*

In this study, mixed fruit juice beverages were formulated by considering the different bioactive substances and aromas of fruits. The mixed fruit juice beverages were prepared using pineapple, green apple, and kiwifruit. Pineapple (Smooth Cayenne), green apple (Granny Smith), and kiwifruit (Hayward) were purchased from a local supermarket in Izmir, Turkey. These fruits were chosen because they contain different bioactive substances [2, 11].

The fruits were rinsed with tap water, wiped dry, peeled, and cut into small pieces. Fruit juices were extracted by two different techniques: centrifugal and cold press juicing at room temperature. For these purposes, juices from pineapple, green apple, and kiwifruit were extracted using two different household tabletop juice extractors including a cold press juicer (Kuvings B6000S, Istanbul, Turkey) and a centrifugal juicer (Tefal, Easy Fruit, France). The rotation speed of the cold press and centrifugal juicer was 60 rpm and 12,600 rpm, respectively. Juicing time varies depending on the fruit type and size. The extracted juices were then filtered through a strainer to remove big particles. The mixed fruit juice beverages were prepared according to the formulation given in Table 1.

Three types of formulations were prepared using different amounts of pineapple juice, green apple juice, and kiwifruit juice. Fruit juice formulations were prepared by considering the percentages of different juices per unit volume. CPJ and CDJ refer to cold-pressed juice and centrifugal juice beverages, respectively.

Table 1. Mixed fruit juice formulations

Fruit	Formulation 1 (645)	Formulation 2 (831)	Formulation 3 (569)
Pineapple	60%	40%	50%
Green Apple	35%	40%	35%
Kiwifruit	5%	20%	15%

2.2 *Sensory analysis*

Sensory evaluation was performed with sixty (female and male) panelists from the academic staff of the Izmir Institute of Technology Food Engineering Department. A sensorial protocol described by Stone and Siedel was adopted for this research [12]. The panelists were between the ages ranging from 12 to 50. All panelists were familiar with the sensorial attributes of all ingredients used in the mixed fruit juice formulation and acquainted with the scoring technique. The most liked formulation was determined according to the acceptance index (AI) based on the study of Oliveira et al. [13]. AI is considered as the ratio of the average score to the maximum score.

An internal consistency test was applied to calculate Cronbach's alpha (CA) coefficient using Minitab 16 (Minitab Inc., State College, PA, USA). CA measures the similarity between evaluation profiles from different panelists. An evaluation profile corresponds to assessments made by a panelist on a given attribute of products [14].

Sensory testing was applied to determine the most liked option among the formulated mixed juices. Based on a 9-point hedonic scale, the panelists evaluated the attributes-appearance, odor, text, flavor, and overall acceptance. The higher rating reflected excellent quality attributes. Samples of mixed beverage juice (40 mL) were presented in random three-digit coded white disposable cups, and sensory analyses were conducted in individual booths with white light. Panelists were advised to rinse their mouths with water between samples. It is worth mentioning that the data reported were only preliminary and a much larger number will be needed to verify these initial results.

The results of the sensory evaluation were assessed using analysis of variance (ANOVA) and Tukey's pairwise comparison test ($p < 0.05$). The formulation which was scored the highest in the sensory evaluation was used in the following studies. The results of the sensory analysis were evaluated with a radar graph plotted in Excel® (2010).

2.3 *Physico-chemical properties*

Some physical, chemical, and optical properties of the mixed fruit juice beverages were measured after the fruit juice formulation was prepared using cold-pressed juices and centrifugal juices. pH and the total soluble solid content (°Brix) of fruit juice beverages were determined by a benchtop pH meter (HANNA Instruments, USA) and a refractometer (Mettler-Toledo RE40D, AEA Investors Inc., ABD) at room temperature (25 °C) [15]. Turbidity measurement was done by using the HACH 2100AN IS Turbidimeter. The results were given as the Nephelometric Turbidity Unit (NTU) [16]. Color parameters were measured using a chromameter (Konica Minolta CR 400, Japan). Browning Index was calculated using Equations (1) [15-16]:

$$BI = 100 \times \frac{\dfrac{\left(a^* + 1.75L^*\right)}{\left(5.645L^* + a^* - 3.012b^*\right)} - 0.31}{0.172} \quad (1)$$

2.4 *Juice yield*

An equal amount of (50 g) fruits were weighed and the juice was extracted by a cold-press juicer and centrifugal juicer. The performance of the juice extractors was evaluated based on juice yield given in percentage. It was calculated by dividing the juice volume (mL) by the total fruit weight (g) and multiplying this by one hundred to get the percentage juice content [17].

2.5 *Total phenolic content*

The total phenolic content of the fruit juice beverages (CPJ and CDJ) was determined by using the Folin-Ciocalteu method described by Pala and Toklucu [18]. CPJ and CDJ samples were firstly diluted in the ratio of 1:20 with a mixture of MeOH: H_2O (3:2). Three hundred μL of diluted CPJ and CDJ mixed with 1.5 mL of Folin-Ciocalteu reagent (MERCK, Germany, catalog no. 1090010100) diluted with 1:10 with distilled water in a glass tube and 1.2 mL of sodium carbonate (75 g/L) was added. The mixture was thoroughly mixed by using a vortex mixer (ZX3, VELP Scientifica S.r.l., Usmate, Italy) and allowed to stand for a further 90 min in the dark and at room temperature. The absorbance was measured at 765 nm using a UV-visible spectrophotometer (Shimadzu, UV-2450, Japan). The solvent (MeOH: H_2O (3:2)) used to dilute the CPJ and CDJ samples was used to set the instrument to zero. A control sample was prepared like previous samples, except that 300 μL of distilled water was added instead of the CPJ or CDJ. The absorbance of the control sample was then subtracted from the absorbance of CPJ and CDJ samples. All the studied samples were evaluated in triplicate for each sample and the mean values of absorbance were recorded. The same procedure was repeated for the gallic acid, and the calibration curve was construed. The total phenolic content of juice samples was estimated from the calibration curve and the results were expressed as mg gallic acid equivalent per liter of juice (mg GAE/L).

2.6 *Total antioxidant activity-DPPH radical scavenging assay*

Free-radical scavenging activity (RSA) of fruit juice beverages (CPJ and CDJ) was obtained by the stable radical 1,1-diphenyl-2-picrylhydrazyl (DPPH) using the method described by Odriozola-Serrano et al. [19]. In this method, antioxidant activity was measured by their scavenging capacity and activity was proportional to the DPPH inhibition. DPPH solution (25 mg/L) was prepared using methanol. The DPPH solution was prepared freshly at each time before analysis. The solution in the amount of 3.9 mL was added to a glass tube followed by 10 μL CPJ or CDJ and 90 μL deionized water addition. All samples were incubated for 60 min in the dark at room temperature. Following that, absorbance values were recorded at 515 nm.

Blank was prepared by the same procedure with samples by using deionized water. 3.9 mL DPPH solution was added to the glass tube followed by 100 μL deionized water. Blank was also incubated for 60 min in the dark at room temperature. Then, absorbance values were recorded at 515 nm. Methanol was used to set auto zero before measurement. Antioxidant capacities of the sample were then calculated in percentage using Equation (2):

$$\text{DPPH inhibition (\%)} = 100 - \frac{A_s}{A_b} x100 \tag{2}$$

In which A_s and A_b indicate absorbance values of the sample and blank, respectively.

2.7 *Statistical analysis*

The data are expressed as the means and standard deviations. All statistical analyses were performed in triplicate using Minitab 17 (Minitab Inc., State College, PA, ABD). The means of data were compared by Tukey's pairwise comparison test. Data were analyzed using one-way analysis of variance (ANOVA). In all cases, $p < 0.05$ was considered statistically significant.

3. Results and discussion

3.1 *Sensory analysis*

Sensory analysis was performed to assess the likability of the formulated mixed fruit juice beverage. The average scores of the sensory test varied from 5.5 ± 1.10 ('neither like nor dislike') to 7.9 ± 1.3 ('like moderately'). Results were evaluated by using a radar graph (Figure 1). The sample (645) containing 60% pineapple, 35% green apple, and 5% kiwifruit were the most preferred. The scores of that sample were 7.35 ± 1.27, 7.9 ± 1.25, 7.65 ± 1.31, 7.75 ± 0.97, and 7.7 ± 1.08 for the appearance, odor, texture, flavor, and overall acceptance, respectively. Only the appearance of sample 645 differed significantly from other samples ($p < 0.05$). No significant difference was observed between the different sensory properties of the samples.

Additionally, the acceptance index (AI) was calculated to determine the most liked formulation. Oliveira et al. [13] indicated that the scores of AI must be equal to or higher than 70%. In our study, the AI of product formulations 645, 831, and 569 were 85.56%, 80.00% and 80.56%, respectively. The AI results supported the radar plot data and ensured that the most accepted formulation was 645. The appearance attribute of 645 was scored the highest point and this increased the AI value of this formulation. The most important reason for this is that the appearance feature of sample 645 has the highest score and this increased the AI value of this sample formulation.

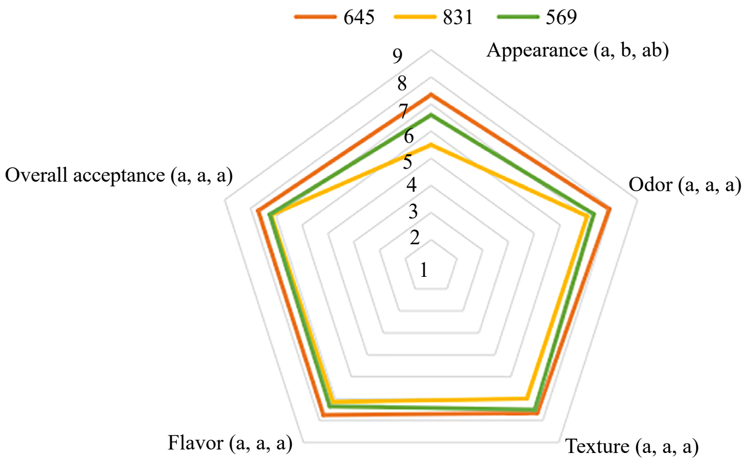


Figure 1. Radar chart for sensory evaluation test of the fruit juice beverage (a-ab quality attributes with different letters are significantly different, $p < 0.05$)

It is also essential to evaluate the reliability of the scores of panelists. In other words, the reliability of the scales should be examined. Cronbach's alpha (CA) is a numerical coefficient that can determine the scale's reliability. According to Nunnally and Bernstein [20], CA values greater than 0.7 are considered acceptable, indicating panelists presenting similar evaluation profiles. The results of our sensory analysis were deemed to be satisfactory and reliable since the CA was calculated as 0.8. In conclusion, formulation 645 was highly preferred, and this formulation was used throughout the study.

3.2 *Fruit juice yield of cold-pressed and centrifugal juice samples*

The juice yield of both the cold pressing method (CPJ) and centrifugal juicing method (CDJ) are compared. (Figure 2). The juice yield of CPJ was higher than the CDJ method, except for the kiwifruit. Especially for pineapple and green apple, the cold pressing method provided a significantly higher amount of juice. Since the pineapple and green apple had a more rigid structure, pressing might be more effective for these fruits [21-22].

Fruit juice yield results are like the results of studies in the literature. Donaldson [5] evaluated the juice yield of different fruits and vegetables, such as carrots, apples, celery, spinach, and their combinations. He found that the yield of apple juice using the cold pressing method (vertical, single auger) was higher than that of the centrifugal juicing method (centrifugal, pulp ejecting). In another study, tomato juice was extracted using a low-speed masticating juicer (cold-pressing) and a high-speed centrifugal juicer [22]. Results showed that the juice yield of a low-speed masticating juicer (79.9 ± 1.6%) was remarkably higher than that of a high-speed centrifugal juicer (54.8 ± 1.3%). That difference was attributed to the blade of the centrifugal juicer. Since the edge of the centrifugal juicer rotates extremely fast, many fruits or vegetables are left without extraction [22].

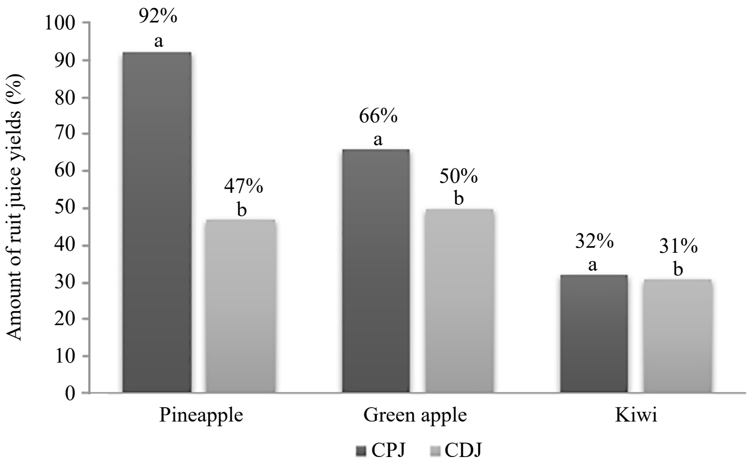


Figure 2. The fruit juice yields obtained by the cold-press and centrifugal juicer (a-b juice yield with different letters are significantly different, $p < 0.05$)

3.3 *Physico-chemical properties of CDJ and CPJ beverages*

To prepare CDJ and CPJ beverages, the juices obtained from the cold press and centrifugal juicers were mixed in the required amount according to the most preferred formulation. Some physicochemical properties of CDJ and CPJ juice mixtures such as turbidity, pH, color, browning index, and total soluble content (°Brix) were evaluated (Table 2).

The pH of CDJ and CPJ beverages was not significantly different. Similarly, Kim et al. [22] revealed that the extraction method did not affect the pH of tomato juice. The total soluble solid content (°Brix) of the CDJ beverage was slightly higher and significantly different from that of the CPJ beverage. In contrast, Kim et al. [22] reported that the total soluble content of cold-pressed tomato juice was higher than that of centrifuged tomato juice. Since Pineapple juice was used in much more significant amounts in the formulation, the extraction methods that resulted in different juice yields might have influenced the total soluble solid content.

Table 2. Physicochemical properties of CPJ and CDJ beverages

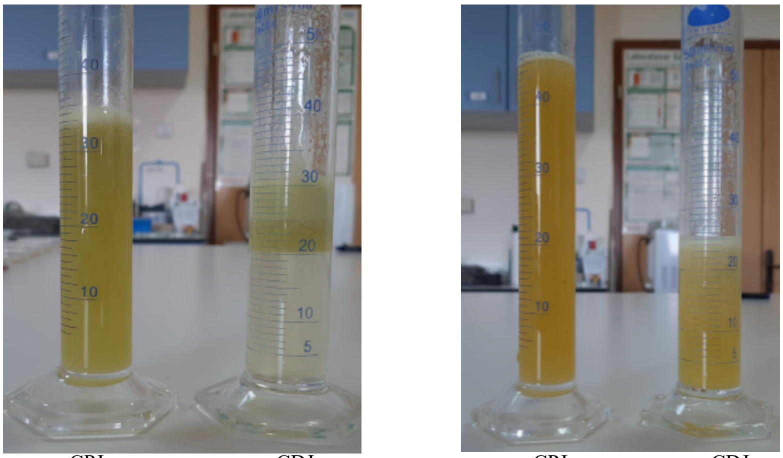
Quality attribute		CPJ	CDJ
Color	L	30.26 ± 0.1^{a}	27.25 ± 0.04^{b}
	a*	-3.94 ± 0.05^{b}	-2.65 ± 0.03^{a}
	b*	8.60 ± 0.15^{a}	6.26 ± 0.08^{b}
Browning index (BI)		22.17 ± 0.62^{a}	17.84 ± 0.37^{b}
Turbidity (NTU)		1621.5 ± 2.12^{a}	756 ± 15.56^{b}
pH		3.77 ± 0.01^{a}	3.75 ± 0.01^{a}
Brix (%)		13.15 ± 0.07^{b}	13.85 ± 0.07^{a}

Results were presented as "means ± standard error." A least significant difference was determined by the Tukey pairwise comparison test. Mean values that do not share the same letter are significantly different ($p < 0.05$). NTU: Nephelometric Turbidity Unit

Color is considered an essential property of the food matrix since it is an indicator of food quality [23]. Therefore, the color parameters of CPJ and CDJ were compared. It was found that the color parameters (a*, b*, L*), BI, and turbidity of both beverages were significantly different. The L* value of CPJ fruit juice was higher than CDJ fruit juice, which means CPJ fruit juice's lightness was higher.

The browning index (BI) of CDJ fruit juice was lower than that of CPJ fruit juice. That difference might be caused by the a* and b* values. These values indicated the existence of browning elements [24-25]. a* value of CDJ beverage was higher than that of CPJ beverage. This was due to the heat the juice was exposed to during extraction with the CDJ method. In addition, it was observed that air bubbles in juice samples were formed by the CDJ method. As a result, it was thought that the oxidation of fruit juice accelerated with increased contact with air, causing the CDJ beverage to have lower L* and higher a* values [22]. Also, a higher b* value of the CPJ beverage indicates more yellowness. The pineapple that was used in the cold-pressed mixed beverage increased the yellowness. Furthermore, a higher b* value caused higher BI for the CPJ method, while the L* value of CDJ was lower than that of the CPJ method.

It was also observed that the CPJ method prevented the formation of phase separation (Figure 3). CPJ juice samples were homogeneous and did not separate into two layers. However, CDJ juice samples were unstable and readily separated into two layers just after extraction. Thus, it was possible to obtain more homogeneous and brightly colored juice with CPJ [22-23].



CPJ CDJ
(a)

CPJ CDJ
(b)

Figure 3. Photos of (a) green apple and (b) pineapple juice immediately after extraction with the CPJ and CDJ methods

3.4 *Phytochemical properties of CDJ and CPJ beverages*

It was found that CDJ and CPJ beverages made of pineapple, green apple, and kiwifruit juices were rich in bioactive substances. This is since pineapple contains important levels of phenolic compounds and vitamin C, and carotenoid content is responsible for about 35% of the total pigments of the fruit [26-27]. Additionally, the green apple is a thorough source of polyphenols, procyanidins, and quercetin glycosides, showing high antioxidant activity [28]. Similarly, kiwifruit also contains a significant level of ascorbic acid which acts as an antioxidant [29]. However, it was shown that the effect on the nutrient and phytochemical content of fruit juice was statistically significant ($p < 0.05$) between different juice extraction methods [7-9]. Thus, the total phenolic content and total antioxidant activity of CPJ and CDJ beverages were compared in this study.

Figure 4 represents data for the total antioxidant activity and the phenolic content of both CPJ and CDJ beverages. The antioxidant activity of CDJ and CPJ were slightly different, but the difference was not statistically significant ($p > 0.05$). Khaksar et al. [3] studied the effect of cold-pressed and normal centrifugal juicing on the quality attributes of fresh juices. Similarly, they reported no significant differences between several types of extraction methods in terms of the bioactive components. In contrast, Kim et al. [8] achieved significantly higher antioxidant activity in cold-pressed grape juice than that extracted by a centrifugal juicer. Wang et al. [23] compared the total antioxidant activity of green kale juice obtained using a blender, cold press, and centrifugal juicer and revealed that cold-pressed green kale juice had the highest DPPH activity. In another study, the DPPH radical scavenging activity of tomato juice was obtained by using a cold-press and centrifugal juicer. Tomato juice extracted from cold pressing was significantly higher than that from centrifugal juicer [22].

Since the heat generated by the centrifugal juicer increases over time, the difference between the reported results can be attributed to the processing time and the amount of fruit squeezed [3]. In this study, a low amount of fruit juice was extracted, and the extraction time was short (20 to 30 s). Since the extraction time was not long in the process with the centrifugal juice extractor, it was thought that there was not much heat generation. If the juice extraction were done over a longer period, as Khaksar et al. [3] pointed out, when using a centrifugal juicer, the quality of the squeezed juice could be expected to differ due to the more heat produced by the juicer.

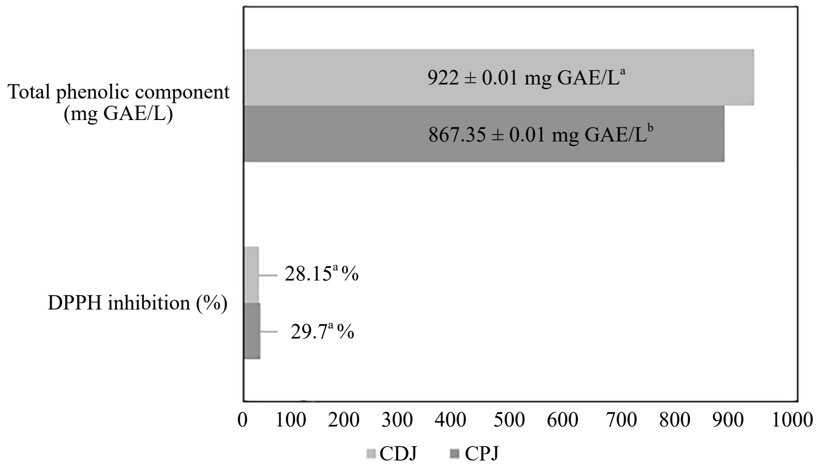


Figure 4. Total antioxidant activity (DPPH inhibition %) and total phenolic component of cold-pressed (CPJ) and centrifuged (CDJ) beverages

The amount of total polyphenol in 1 L of CDJ was 922 ± 0.01 mg GAE, which was significantly higher than that in CPJ beverage (867.25 ± 0.01 mg GAE) (Figure 4). A higher total polyphenol content was detected in the CPJ beverage, although the same amount of fruit was used for juice extraction and the juice yield was lower. This could be explained by how the fruit cells deteriorate during extraction. In the cold press application, the cell structure remains intact. However, in the centrifugal extraction method, the cell wall is significantly disrupted. It was thought that the cell components of the fruit could be released more in the extraction with the CDJ method, and a higher amount of total phenolic compounds was detected in the measurement made immediately after the extraction without allowing the juice to oxidize too much. In contrast, the TPC of grape juice and tomato juice obtained with the low-speed masticating juicer was found to be higher than that of the high-speed centrifugal juicer [8, 22]. This was attributed to the higher juice yield achieved with a low-speed masticating juicer. Wang et al. [23] compared the TPC level of some fruits and vegetables extracted with the blender, the low-speed juicer, and the high-speed centrifugal juicer. They reported that the TPC level was influenced by the genotype, color, and processing technique of different fruits and vegetables.

Overall, the antioxidant activity of CPJ and CDJ beverages was like each other, while the TPC content of the CDJ beverage was found to be significantly higher. Although total vitamin C content was not measured in this study, it is known that the ascorbic acid acts as an antioxidant which plays a role in oxidative defense functions by quenching various free radicals and the singlet form of molecular oxygen [30].

In this study, it was speculated that the heat was generated by a centrifugal juicer during extraction, although the processing time was short. Since ascorbic acid is more sensitive than phenolic compounds, it is thought that the heat generated may have a degradation effect on ascorbic acid, which CDJ contains more than phenolic compounds [31-33]. As a result, based on this reason, it was found that the antioxidant capacity of CPJ and CDJ was not significantly different from each other.

4. Conclusion

In this study, physical, chemical, and optical properties of cold-pressed mixed beverage (CPJ) and centrifugal mixed beverages (CDJ) such as pH, TSS (Brix°), color parameters, browning index (BI), and turbidity were compared. It was found that the total soluble solids content (°Brix), color parameters (a*, b*, L*), browning index (BI), and turbidity values of CPJ and CDJ beverages were significantly different from each other. While the BI, L*, and b* values of the CPJ beverage were higher, the a* value was lower than that of the CDJ beverage. It was concluded that the physical properties of juices extracted by CPJ were more satisfactory than those of CDJ. Also, the CPJ method yielded a higher amount of juice than the CDJ, especially the pineapple juice obtained by the CPJ method was quite high. Besides, there was no phase separation or air bubbles observed after the extraction with the CPJ method.

Consumers demand healthy and nutrient-rich fruit juices, so it is important to demonstrate the nutritional value of extracted fruit juices. For that purpose, the antioxidant activity, and the amount of total phenolic content (TPC) of CPJ and CDJ were determined. While the TPC of CPJ was found to be lower than that of CDJ, the antioxidant activity of CPJ and CDJ samples was not significantly different. However, to evaluate this finding, there is a need to repeat the data with different measurement methods and further studies on this subject. Considering the data obtained, it can be concluded that the antioxidant activity and TPC amount of CPJ are not superior to CDJ.

Acknowledgments

This study is part of Ms. Baykuş's Master's Thesis.

Conflict of interest

The authors declare no competing financial interest.

References

[1] Koutchma T, Popovic V, Ros-polski V, Popielarz A. Effects of ultraviolet light and high-pressure processing on quality and health-related constituents of fresh juice products. *Comprehensive Reviews in Food Science and Food Safety*. 2016; 15(5): 844-867.

[2] Ruxton CHS, Myers M. Fruit juices: Are they helpful or harmful? An evidence review. *Nutrients*. 2021; 13(6): 1815.

[3] Khaksar G, Assatarakul K, Sirikantaramas S. Harbor effect of cold-pressed and normal centrifugal juicing on quality attributes of fresh juices: Do cold-pressed juices a superior nutritional quality and antioxidant capacity? *Heliyon*. 2019; 5(6): e01917.

[4] Biancaniello M, Popović V, Fernandez-Avila C, Ros-Polski V, Koutchma T. Feasibility of a novel industrial-scale treatment of green cold-pressed juices by UV-C light exposure. *Beverages*. 2018; 4(2): 29.

[5] Donaldson M. Household juice extractor comparison and optimization. *Journal of Food Process Technology*. 2020; 11(1): 819.

[6] Pierscianowski J, Popović V, Biancaniello M, Bissonnette S, Zhu Y, Koutchma T. Continuous-flow UV-C processing of kale juice for the inactivation of E. coli and assessment of quality parameters. *Food Research International*. 2021; 140: 110085.

[7] Gouws C, Georgouopoulou E, Mellor D, Naumovski N. The effect of juicing methods on the phytochemical and antioxidant characteristics of the purple prickly pear (opuntia ficus indica)-preliminary findings on juice and pomace. *Beverages*. 2019; 5(2): 28.

[8] Kim MJ, Jun JG, Park SY, Choi MJ, Park E, Kim JI, et al. Antioxidant activities of fresh grape juices prepared using various household processing methods. *Food Science and Biotechnology*. 2017; 26(4): 861-869.

[9] Miguel G, Dandlen S, Antunes D, Neves A, Martins D. The effect of two methods of pomegranate (*Punica granatum* L.) juice extraction on quality during storage at 4 °C. *Journal of Biomedicine and Biotechnology*. 2004; 2024(5): 332-337.

[10] Rajasekar D, Akoh CC, Martino GK, MacLean DD. Physico-chemical characteristics of juice extracted by blender and mechanical press from pomegranate cultivars grown in Georgia. *Food Chemistry*. 2012; 133(4): 1383-1393.

[11] Teja CK, Sanganamoni S, Prabhakar B, Rao PS. Effect of UV-C light treatment on physicochemical and bioactive compounds in apple and pineapple juices. *International Journal of Current Microbiology and Applied Sciences*. 2017; 6(6): 2321-2333.
[12] Stone H, Sidel J. *Sensory Evaluation Practices*. 3rd ed. San Diego, CA: Academic Press; 2004.
[13] Oliveira DM, Marques DR, Kwiatkowski A, Monteiro ARG, Clemente E. Sensory analysis and chemical characterization of cereal enriched with grape peel and seed flour. *Acta Scientiarum Technology*. 2013; 35(3): 427-431.
[14] Pinto FST, Fogliatto FS, Qannari EMA. Method for panelists' consistency assessment in sensory evaluations based on the Cronbach's alpha coefficient. *Food Quality and Preference*. 2014; 32: 41-47.
[15] Kaya Z. *Disinfection of white grape juice by using continuous flow UV reactor*. MSc Dissertation, Izmir Institute of Technology, Izmir, Turkey; 2011.
[16] Hakguder B. *UV disinfection of some of the fruit juices*. MSc Dissertation, Izmir Institute of Technology, Izmir, Turkey; 2009.
[17] Fahem NI, Mostafa GA, Omran HT, Buckenhueskes H. Production of clear apple juice using commercial pectinases. *Mansoura University Journals of Agricultural Sciences*. 2009; 4(8): 8761-8772.
[18] Pala ÇU, Toklucu AK. Effect of UV-C light on anthocyanin content and other quality parameters of pomegranate juice. *Journal of Food Composition and Analysis*. 2011; 24(6): 790-795.
[19] Odriozola-Serrano I, Soliva-Fortuny R, Martin-Belloso O. Impact of high-intensity pulsed electric fields variables on vitamin C, anthocyanins and antioxidant capacity of strawberry juice. *LWT-Food Science and Technology*. 2009; 42(1): 93-100.
[20] Nunnally JC, Bernstein IH. The assessment of reliability. *Psychometric Theory*. 1994; 3: 248-292.
[21] Nnamdi UB, Onyejiuwa CT, Ogbuke CR. Review of orange juice extractor machines. *Advances in Science, Technology and Engineering Systems Journal*. 2020; 5(5): 485-492.
[22] Kim MJ, Kim JI, Kang MJ, Kwon B, Jun JG, Choi JH, et al. Quality evaluation of fresh tomato juices prepared using high-speed centrifugal and low-speed masticating household juicers. *Food Science and Biotechnology*. 2015; 24(1): 61-66.
[23] Wang J, Jayaprakasha GK, Patil BS. Untargeted chemometrics evaluation of the effect of juicing technique on phytochemical profiles and antioxidant activities in common vegetables. *ACS Food Science & Technology*. 2021; 1(1): 77-87.
[24] Baykuş G, Akgün MP, Unluturk S. Effects of ultraviolet-light emitting diodes (UV-LEDS) on microbial inactivation and quality attributes of mixed beverage made from blend of carrot, carob, ginger, grape and lemon juice. *Innovative Food Science & Emerging Technologies*. 2021; 67: 102572.
[25] Baykuş G. *Investigation of applicability of UV light emitting diodes (UV-LEDS) as an alternative technology in pasteurization of cold-pressed and newly formulated mixed beverage*. M.Sc. Dissertation, Izmir Institute of Technology, Izmir, Turkey; 2022.
[26] Ferreira EA, Siqueira HE, Boas EVV, Hermes VS, Rios ADO. Bioactive compounds and antioxidant activity of pineapple fruit of different cultivars. *Brazilian Magazine of Fruit Culture*. 2016; 38(3): e146.
[27] Freitas A, Moldao-Martins M, Costa HS, Albuquerque TG, Valentea A, Sanches-Silva A. Effect of UV-C radiation on bioactive compounds of pineapple (*Ananas comosus* L. Merr.) by-products. *Journal of the Science of Food and Agriculture*. 2015; 95(1): 44-52.
[28] Boyer J, Liu RH. Apple phytochemicals and their health benefits. *Nutrition Journal*. 2004; 3: 1-15.
[29] Cassano A, Donato L, Drioli E. Ultrafiltration of kiwifruit juice: Operating parameters, juice quality and membrane fouling. *Journal of Food Engineering*. 2007; 79(2): 613-621.
[30] Gregory III JF. Ascorbic acid bioavailability in foods and supplements. *Nutrition Reviews*. 1993; 51(10): 301-303.
[31] Mrad ND, Nourhène B, Nabil K, Francis C, Bonazzi C. Influence of air drying temperature on kinetics, physicochemical properties, total phenolic content and ascorbic acid of pears. *Food and Bioproducts Processing*. 2012; 90(3): 433-441.
[32] Volf I, Ignat I, Neamtu M, Popa V. Thermal stability, antioxidant activity, and photo-oxidation of natural polyphenols. *Chemical Papers*. 2014; 68(1): 121-129.
[33] Sripakdee T, Sriwicha A, Jansam N, Mahachai R, Chanthai S. Determination of total phenolics and ascorbic acid related to an antioxidant activity and thermal stability of the Mao fruit juice. *International Food Research Journal*. 2015; 22(2): 618-624.