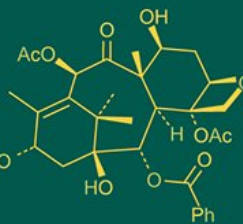
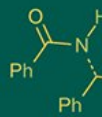


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## Quality traits and Functional potential of avocado (*Persea Americana* Mill) grown in the Jammu Region

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### Abstract

Avocado (*Persea americana* Mill.) is a nutritionally important sub-tropical fruit valued for its healthy lipids, bioactive compounds and anti-oxidant properties. The present study evaluated the physical, physico-chemical, nutritional and anti-oxidant characteristics of fresh avocado fruits collected from the Jammu region of India. Morphological traits were recorded using standard avocado descriptors, while biochemical analyses were performed using AOAC-recommended methods. The fruits exhibited desirable commercial attributes with an average weight of 270.81 g, fruit length of 9.68 cm, equatorial diameter of 7.22 cm and peel thickness of 3.02 mm. The physico-chemical analysis revealed 5.42 °Brix total soluble solids, 1.02 per cent titratable acidity, pH 6.28, and 26.88 per cent physiological loss in weight. The fruits contained 0.81 per cent total sugars, 2.71 per cent carbohydrates, 8.97 per cent protein, 3.68 per cent fat, 0.53 per cent ash and 7.29 per cent vitamin C. Anti-oxidant activity was confirmed by DPPH (4.03), ABTS (2.54) and FRAP (0.14) assays, indicating the presence of bioactive anti-oxidant compounds. Overall, the study demonstrates that avocados grown in the Jammu region possess favorable physical quality, appreciable nutritional composition and significant anti-oxidant potential, highlighting their suitability for fresh consumption, value-added processing and the expansion of avocado cultivation in northern India.

**Keywords:** Avocado; *persea americana* mill.; Jammu region; fruit quality; physico-chemical characteristics; nutritional composition; antioxidant activity; dpph; abts; frap; postharvest quality; functional food

### Introduction

Avocado (*Persea americana*), commonly referred to as butter fruit, is a sub-tropical fruit tree belonging to the family Lauraceae. It is native to the tropical regions of Central and South America and remained largely confined to these areas until its introduction to other parts of the world following the Spanish conquest. Among sub-tropical fruit crops, avocado has emerged as one of the most significant, accounting for over 50 per cent of the global tropical fruit trade. In India, the total area under avocado cultivation was approximately 1,328 hectares during 2019-20, producing around 2,538 metric tonnes. Globally, avocado exports have shown a steady increase, rising by about 11 per cent in 2021 to reach 2.5 million tonnes, underscoring its expanding role in international markets (Lieu *et al.*, 2024) [13]. Nutritionally, avocado is recognized as a functional food due to its rich composition of Avocado pulp is highly nutritious, containing about 4 per cent protein and 30 per cent fat, while its carbohydrate content is comparatively low. The fat is mainly composed of healthy unsaturated fatty acids and has a composition similar to olive oil, making it useful in both food preparations and cosmetic products. Among fresh fruits, avocado has one of the highest energy values, providing approximately 245 kcal per 100 g. It is also a rich source of essential vitamins and minerals. The creamy flesh contains beneficial monounsaturated fatty acids, dietary fiber, anti-oxidants and essential minerals such as potassium, magnesium, phosphorus, calcium and trace elements like iron and zinc (Alvarez *et al.*, 2012) [1]. Fresh avocado pulp is also rich in carotenoids. On average, 100 g contains about 24 µg of alpha-carotene, 62 µg of beta-carotene, 28 µg of beta-cryptoxanthin and 271 µg of lutein. These bioactive compounds possess anti-oxidant properties and may help reduce the risk of chronic diseases such as cardio-vascular disease, diabetes and certain types of cancer. The

unsaponifiable fraction of avocado oil is dominated by sterols, with  $\beta$ -sitosterol accounting for nearly 80 per cent of the total sterol content. Other sterols present include campesterol, stigmasterol and cholesterol. In addition, avocado contains D-mannoheptulose, a naturally occurring seven-carbon sugar that has been associated with improved insulin regulation, weight management and anti-oxidant activity by reducing the harmful effects of free radicals. However, despite its high nutritional and economic value, avocado faces considerable post harvest challenges due to its climacteric nature. As a climacteric fruit, it exhibits a marked surge in ethylene production and respiration rate during the ripening process, triggering a series of physiological and biochemical transformations, including tissue softening, peel color change, pigment degradation and loss of firmness. These changes ultimately culminate in senescence and spoilage. Interestingly, freshly harvested avocados display a brief period of natural resistance to ripening lasting approximately 1-2 days, after which they become increasingly sensitive to ethylene exposure, leading to rapid ripening under ambient conditions (Yahia & Woolf, 2023) [22]. Once ripening commences, the fruit typically attains edible ripeness within 5-7 days at room temperature (Wang *et al.*, 2010) [21]. This narrow post harvest window and high perishability lead to substantial post harvest losses, particularly when fruits are handled, transported or stored under suboptimal conditions. Common quality-degrading factors include excessive softening, water loss, decay, chilling injury and uneven ripening, all of which reduce marketability and consumer satisfaction. Given the increasing globalization of avocado trade and the need to preserve fruit quality over long distances, there is a critical demand for effective postharvest technologies to delay ripening and extend shelf life.

## Materials and Methods

### Plant Material and Sampling

Fully mature, disease-free avocado (*Persea americana*) fruits of uniform maturity stage were harvested from Jammu regions cultivars e.g., Hass. Fruits were selected randomly, washed, air-dried and used for morphological and biochemical analysis.

## Methods

### Fruit shape

A representative sample of mature fruits was visually examined for external morphology. Fruit shape was assessed by comparing each fruit with the standard descriptors provided in the IPGRI/UPOV avocado descriptor list. Based on visual observation, fruits were classified into one of the following categories: ovate, pyriform, spherical or elliptic.

### Fruit length and diameter (MM)

Fruit length and equatorial diameter were measured using a Digital Vernier Caliper (Aerospace, China). Fruit length was recorded as the distance from the stem end to the blossom end, while fruit diameter was measured at the widest equatorial portion of the fruit. Measurements were expressed in millimetres (mm) (Ramos-Aguilar *et al.*, 2021) [14].

### Fruit size (MM)

Fruit size was determined by measuring the fruit length and equatorial diameter using a digital vernier caliper (Aerospace, China). Based on these measurements, fruits

were categorized according to the standard size classification adopted for the study.

### Fruit eight (G)

Fruit weight was determined by weighing individual fruits using an electronic precision balance (Excell) capacity 2-1000 g. The weight of each fruit was recorded in grams (g) (Ramos-Aguilar *et al.*, 2021) [14].

### Fruit firmness (MM)

A computerized penetrometer was used to measure the firmness of the fruit. After removing the skin at the chosen location, the probe was applied to the fruit flesh to take the measurement. The firmness value was noted and given the proper unit of measurement.

### Total soluble solids (TSS)

Measured using a hand refractometer (Atago N, Japan) with a range of 0-32 °Brix. Values were corrected to 20 °C. Fruits were divided into 3 replicates of 5 fruits each. Juice was extracted using an Omni juice extractor and filtered through muslin cloth. Two to three drops of filtered juice were placed on the refractometer lens for TSS reading. TSS expressed in °Brix (A.O.A.C., 1975).

### Titrateable acidity (%)

A known weight of fruit juice was diluted to a known volume with distilled water. A known volume of this diluted juice was titrated against 0.1 N sodium hydroxide, using phenolphthalein as an indicator (Ranganna, 1997) [15].

### PH

pH was determined using a calibrated digital pH meter. The electrode was immersed in the prepared fruit sample solution, and the pH reading was recorded

### Moisture content (%)

Moisture content was determined by drying the sample in a hot air oven at 105°C until a constant weight was achieved, following AOAC (1965) guidelines.

### Crude protein (%)

Crude protein content was determined using the Kjeldahl method. A known quantity of sample was digested with concentrated sulphuric acid in the presence of a catalyst until a clear digest was obtained. The digested sample was then made alkaline and distilled to release ammonia, which was collected in a boric acid solution. The collected ammonia was titrated with standard acid, and the nitrogen content was calculated. The crude protein content was determined by multiplying the nitrogen percentage by the conversion factor 6.25 and expressed as percentage (%) of the sample.

### Ash content

Take a clean, dry crucible and weigh it ( $W_1$ ). Add a known amount of sample and weigh again ( $W_2$ ). Burn the sample in a muffle furnace at 550-600 °C until only ash remains. Cool the crucible in a desiccator and weigh it ( $W_3$ ). Calculate ash content.

### Carbohydrates

Total carbohydrate content was determined by the difference method. The percentages of moisture, crude protein, crude fat, ash and dietary fibre were first

determined. The carbohydrate content was calculated using the formula:

$$\text{Carbohydrate (\%)} = 100 - [\text{Moisture (\%)} + \text{Protein (\%)} + \text{Fat (\%)} + \text{Ash (\%)} + \text{Dietary fibre (\%)}]$$

The carbohydrate content was expressed as percentage (%) of the sample weight.

#### Crude fat (%)

Crude fat content was determined by the Soxhlet extraction (Pelican Equipments, India: Model SCS-06) method using petroleum ether/hexane as the solvent. A known amount of sample was extracted, the solvent was removed and the extracted fat was weighed. The fat content was expressed as percentage (%) of the sample.

#### Total sugars and reducing sugars

The Lane and Eynon method (1923) was used to measure total and reducing sugars with modifications as proposed by Ranganna (1997) <sup>[15]</sup>. 5 g of the sample was mixed with 100 ml of distilled water and boiled for 1 hour. Water lost during boiling was replaced with distilled water. The mixture was heated and transferred to a 250 ml flask, then neutralized with sodium hydroxide. 2 ml of 45% lead acetate was

added, shaken well, and left for 10 minutes. Then, 2 ml of potassium oxalate was added to remove the lead, and the volume was adjusted to 250 ml. The solution was filtered and called solution (I). For total sugar estimation, 50 ml of solution (I) was mixed with 5 g of citric acid in a 200 ml flask. This mixture was boiled for 15 to 20 minutes, cooled, and neutralized with 1N sodium hydroxide until it turned pink using phenolphthalein as an indicator. The volume was then made up to 250 ml, and this was called solution II. For titration, 5 ml each of Fehlings solutions A and B were mixed with 25 ml distilled water in a flask. This mixture was titrated against solution II until a red color appeared. Then, 2 drops of methylene blue were added, and titration continued until a brick-red precipitate formed. The flask was kept warm on a burner during the entire titration. The percentage of total sugars was calculated using a specific formula.

#### Ascorbic acid (Vitamin C)

5g of sample was added to 50 mL distilled water to prepare a concentrated juice into a 100 mL volumetric flask, add 25 mL of 20 % metaphosphoric acid as stabilizing agent and dilute to volume. Pipette 10 mL in a small flask. Titrate with indophenols dye solution until a faint pink color persists for 15 seconds.

$$\text{Ascorbic acid} = \frac{\text{Titre X Dye factor X Volume made}}{\text{Weight of sample taken X Volume of filtrate taken}} \times 100$$

$$\text{Where, Dye factor} = \frac{0.5}{\text{Titre value}}$$

#### Total phenolic content

Total phenolic content was determined using the Folin-Ciocalteu method as described by Icier (2012) <sup>[9]</sup>. A sample weighing 1 g was placed in a screw-capped vial, followed by the addition of 10 ml of distilled boiled water. The mixture was heated at 100 °C for 5 minutes to facilitate extraction, then cooled and filtered through a 0.45 µm filter paper. The filtrate (0.5 ml) was reacted with Folin-Ciocalteu reagent and mixed thoroughly, followed by incubation at room temperature for 7 minutes. Thereafter, 1.5 ml of 20% (w/w) sodium carbonate solution was added, and the reaction mixture was kept in darkness for 2 hours. Absorbance was measured at 765 nm using a UV-Visible spectrophotometer, and the total phenolic content was quantified using a previously prepared standard calibration curve.

#### Anti-oxidant activity

##### DPPH

0.1 mM DPPH solution in methanol. Mix 1.0 mL of sample extract with 3.0 mL of DPPH solution. Prepare a control using methanol instead of the sample. Incubate the mixture in the dark at room temperature for 30 minutes. Measure the absorbance at 517 nm against methanol as the blank (Luo *et al.*, 2009).

##### FRAP

Prepare fresh FRAP reagent by mixing 300 mM acetate buffer (pH 3.6), 10 mM TPTZ in 40 mM HCl and 20 mM FeCl<sub>3</sub>·6H<sub>2</sub>O in a 10:1:1 ratio. Add 100 µL of the sample extract to 3.0 mL of the FRAP reagent. Mix the solution

well. Incubate at 37°C for 10 minutes. Measure the absorbance at 593 nm using a UV-Visible spectrophotometer.

#### ABTS

Prepare 7 mM ABTS solution and 2.45 mM potassium persulfate solution. Mix equal volumes of both solutions and keep the mixture in the dark for 12-16 hours to produce the ABTS radical. Dilute the ABTS solution with ethanol or phosphate buffer until the absorbance is 0.70 ± 0.02 at 734 nm. Add 100 µL of the sample extract to 3.0 mL of the diluted ABTS solution. Mix well and incubate at room temperature for 6 minutes. Measure the absorbance at 734 nm using a UV-Visible spectrophotometer.

#### Color value of pulp

Hunter colorimeter was used to find the L\* (lightness), a\* (redness/greenness), b\* (yellowness/blueness) values. Further, chroma value and hue angle was calculated.

#### Statistical analysis

The data obtained was statistically analyzed following the guidelines provided by Gomez and Gomez (1984) <sup>[8]</sup>. A Factorial Completely Randomized Design (CRD) was employed for the interpretation of results through analysis of variance (ANOVA) at a significance level of P = 0.05. This approach allows for the examination of multiple factors and their interactions in the experimental design, providing insights into the significance of various treatments and their effects on the outcome variables.

## Results and discussion

### Physical attributes of avocado fruits

The oval shape, mid-set pedicel, and central apex position of the avocado fruits sampled from the Jammu region are characteristics that are generally in line with the standard descriptor qualities reported for the avocado cultivar in previous morphological surveys (Schaffer *et al.*, 2012) [17]. The average fruit weight (270.81 g) places the sampled fruits in the medium-to-large category typically associated with commercially preferred avocado grades, while the mean fruit length (9.68 cm) and equatorial diameter (7.22 cm) recorded in this study fall within the size range typically reported for avocado fruit.

The peel-thickness trends reported by Salazar-García *et al.* (2016) [16] are consistent with the skin thickness (3.02 mm) and corresponding peel thickness range (1.3-2.9 mm) obtained in this study, supporting the notion that peel thickness is a relatively stable, genotype-linked trait rather than one that varies significantly with growing region. The documented buttery flesh texture, moderate sweetness and seed-to-pulp ratio (195-208) are consistent with the avocado compositional and textural criteria outlined by Galvao *et al.* (2014) [7].

**Table 1:** Physical and Morphological Characteristics

| Parameter                 | Value                      |
|---------------------------|----------------------------|
| Fruit shape               | Obovate                    |
| Fruit length (cm)         | 9.68                       |
| Fruit diameter (cm)       | 7.22                       |
| Fruit weight (g)          | 270.81                     |
| Fruit size uniformity     | Intermediate               |
| Fruit base shape          | Pointed                    |
| Fruit apex position       | Central                    |
| Ridges on fruit           | Absent                     |
| Gloss on fruit            | Medium                     |
| Pedicel position          | Central                    |
| Fruit skin surface        | Rough                      |
| Fruit skin colour         | 153A Vivid yellowish green |
| Fruit skin thickness (mm) | 3.02                       |
| Fruit skin pliability     | Brittle                    |
| Flesh texture             | Buttery                    |
| Sweetness of flesh        | Intermediate               |
| Peel thickness (mm)       | 1.3-2.9                    |

**Table 2:** Seed Characteristics

| Parameter       | Value   |
|-----------------|---------|
| Seed:Pulp ratio | 195-208 |
| Seed weight (g) | 40-42   |

### Proximate composition

The physico-chemical characteristics of fresh avocado fruits are presented in Table 2. The physiological loss in weight (PLW) was recorded as 26.88 per cent, indicating considerable moisture loss during storage due to transpiration and respiration, which adversely affects fruit freshness and shelf life. The total soluble solids (TSS) content was 5.42 °Brix, reflecting the accumulation of soluble solids during fruit ripening. This value is comparable with those reported by Venditti *et al.* (2016) [19] for mature avocado fruits. The titratable acidity was 1.02 per cent, while the pH of the fruit pulp was 6.28 (Kassim and Workneh, 2020) [11], indicating a slightly acidic nature that contributes to the characteristic flavor of fresh avocado. Similar observations have been reported by Venditti *et al.* (2016) [19]. The total sugar content of the fresh avocado fruit

was 0.81 per cent, indicating a relatively low concentration of soluble sugars, which is a characteristic feature of avocado compared with many other tropical fruits. This observation is consistent with the findings of Kilaru *et al.* (2015) and Campos *et al.* (2020) [4], who reported that avocado contains comparatively lower sugar levels because a large proportion of its energy is stored as lipids rather than carbohydrates. The carbohydrate content was 2.71 per cent, whereas the ash content was 0.53 per cent indicating the presence of essential mineral constituents. The fruit contained 8.97 per cent total protein and 3.68 per cent total fat, demonstrating its high nutritional value. Similar nutritional composition has been reported by Galvao *et al.* (2014) [7]. The anti-oxidant activity of fresh avocado fruit was assessed using different assays. The DPPH radical scavenging activity was 4.03, ABTS activity was 2.54 and the FRAP value was 0.14, confirming the presence of anti-oxidant compounds capable of scavenging free radicals. These results are in agreement with the findings of Vinha *et al.* (2013) [20], and Veberic *et al.* (2015) [18]. The vitamin C content was 7.29 per cent contributing to the antioxidant potential and nutritional quality of the fruit. Carotenoids also contribute to the anti-oxidant properties and color of avocado fruits, as reported by Cervantes-Paz *et al.* (2012) [5].

**Table 3:** Physico-chemical and Nutritional Characteristics

| Parameter                             | Value    |
|---------------------------------------|----------|
| Firmness (N)                          | 4.32     |
| Physiological loss in weight (PLW, %) | 26.88    |
| Total soluble solids (°Brix)          | 5.42     |
| Titratable acidity (%)                | 1.02     |
| Sugars (%)                            | 0.81     |
| Dietary fibre (%)                     | 6.7      |
| Carbohydrates (%)                     | 2.71     |
| pH                                    | 6.28     |
| Ash content (%)                       | 0.53     |
| Total fat (%)                         | 3.68     |
| Total protein (%)                     | 8.97     |
| Moisture content (%)                  | 81.95    |
| Vitamin C (mg/100 g)                  | 7.29     |
| Phenols (mg GAE/kg DW)                | 266.83   |
| <b>Anti-oxidants</b>                  |          |
| DPPH                                  | 4.03     |
| ABTS                                  | 2.54     |
| FRAP                                  | 0.14     |
| Crude fibre (%)                       | 5.27     |
| Carotenoids (%)                       | 0.05     |
| <b>Color profile (Pulp)</b>           |          |
| L*                                    | 62.67    |
| a*                                    | -10.78   |
| b*                                    | 32.45    |
| Chroma value                          | 34.19    |
| Hue angle (°)                         | 108.38 ° |

## Conclusion

The present study demonstrated that avocado fruits collected from the Jammu region possess desirable physical, nutritional and anti-oxidant characteristics, indicating their suitability for fresh consumption and value-added processing. The fruits exhibited commercially acceptable morphological attributes, including oval shape, medium-to-large fruit size, appropriate peel thickness, buttery flesh texture and a favorable seed-to-pulp ratio, which are important quality traits for consumer acceptance and marketability.

The physico-chemical analysis revealed that the fruits had moderate total soluble solids (5.42 °Brix), slightly acidic pulp (pH 6.28; titratable acidity 1.02%) and relatively low total sugar content (0.81%), reflecting the characteristic composition of avocado as a low-sugar, lipid-rich fruit. The nutritional composition, comprising 8.97 per cent protein, 3.68 per cent fat, 2.71 per cent carbohydrates and 0.53 per cent ash, confirms that avocado is a valuable source of essential nutrients.

The fruits also exhibited appreciable anti-oxidant potential, as evidenced by DPPH, ABTS, and FRAP assays, together with a vitamin C content of 7.29 per cent indicating the presence of bioactive compounds that may contribute to health-promoting properties. Although a physiological loss in weight of 26.88 per cent was observed during storage, suggesting the need for improved postharvest handling to minimize moisture loss, the overall quality attributes remained comparable with those reported in previous studies.

Overall, the findings indicate that avocado fruits grown in the Jammu region possess good commercial quality, favorable nutritional composition and significant anti-oxidant capacity. These characteristics support their potential for expanding avocado cultivation in the region and for utilization in the fresh fruit market as well as in the development of functional food products. Further studies on postharvest storage technologies, bioactive compound profiling and shelf-life enhancement are recommended to maximize the commercial value and consumer acceptability of locally grown avocado fruits.

## References

1. Alvarez J, Valencia-Chamorro SA, Palou L. Effects of maturity stage and cold storage on the quality of Hass avocado treated with 1-methylcyclopropene. *Postharvest Biology and Technology*. 2012; 67:114-122.
2. Association of Official Agricultural Chemists (AOAC). Official methods of analysis. Washington, DC: AOAC; 1965.
3. Association of Official Analytical Chemists (AOAC). Official methods of analysis. 12th ed. Washington, DC: AOAC; 1975.
4. Campos D, Teran-Hilares F, Chirinos R, Aguilar-Galvez A, García-Ríos D, Pacheco-Avalos A, Pedreschi R. Bioactive compounds and antioxidant activity from harvest to edible ripeness of avocado cv. Hass (*Persea americana*) throughout the harvest seasons. *International Journal of Food Science & Technology*. 2020;55(5):2208-2218.
5. Cervantes-Paz B, Yahia EM, Ornelas-Paz JJ, Gardea-Béjar AA, Ibarra-Junquera V, Pérez-Martínez JD. Effect of heat processing on the profile of pigments and antioxidant capacity of green and red jalapeño peppers. *Journal of Agricultural and Food Chemistry*. 2012;60(43):10822-10833.
6. Feldsine P, Abeyta C, Andrews WH. AOAC International methods committee guidelines for validation of qualitative and quantitative food microbiological official methods of analysis. *Journal of AOAC International*. 2002;85(5):1187-1200.
7. Galvao MDS, Narain N, Nigam N. Influence of different cultivars on oil quality and chemical characteristics of avocado fruit. *Food Science and Technology*. 2014; 34:539-546.
8. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York: John Wiley & Sons; 1984.
9. Icier NC. Extraction of pomegranate peels phenolics with water and microencapsulation of the extracts [master's thesis]. Erciyes University, Turkey; 2012.
10. Johnson BC. Method of vitamin C determination. Minneapolis: Burgess Publishing Co.; 1948.
11. Kassim A, Workneh TS. Influence of postharvest treatments and storage conditions on the quality of Hass avocados. *Heliyon*. 2020;6(6).
12. Lu QY, Zhang Y, Wang Y, Wang D, Lee R, Gao K, Heber D. California Hass avocado: profiling of carotenoids, tocopherol, fatty acid, and fat content during maturation and from different growing areas. *Journal of Agricultural and Food Chemistry*. 2009; 57:10408-10413.
13. Lieu MD, Phuong TV, Nguyen TTB, Dang TKT, Nguyen TH. A review of preservation approaches for extending avocado fruit shelf-life. *Journal of Agriculture and Food Research*. 2024; 16:101-102.
14. Ramos-Aguilar AL, Ornelas-Paz J, Tapia-Vargas LM, Gardea-Bejar AA, Yahia EM, De Jesus Ornelas-Paz J, Escalante-Minakata P. Metabolomic analysis and physical attributes of ripe fruits from Mexican Creole (*Persea americana* var. *Drymifolia*) and 'Hass' avocados. *Food Chemistry*. 2021; 354:129571.
15. Ranganna S. Handbook of analysis and quality control for fruit and vegetable products. 2nd ed. New Delhi: Tata McGraw-Hill; 1997.
16. Salazar-García S, Medina-Carrillo RE, Álvarez-Bravo A. Evaluación inicial de algunos aspectos de calidad del fruto de aguacate 'Hass' producido en tres regiones de México. *Revista Mexicana de Ciencias Agrícolas*. 2016; 22:277-289.
17. Schaffer B, Wolstenholme BN, Whaley AW. The avocado: botany, production and uses. 2nd ed. Croydon, UK: CPI Group (UK) Ltd; 2012.
18. Veberic R, Slatnar A, Bizjak J, Stampar F, Mikulic-Petkovsek M. Anthocyanin composition of different wild and cultivated berry species. *LWT-Food Science and Technology*. 2015; 60:509-517.
19. Venditti A, Frezza C, Celona D, Bianco A, Serafini M, Cianfaglione K, Celenza G. Polar constituents, protection against reactive oxygen species, and nutritional value of Chinese artichoke (*Stachys affinis* Bunge). *Food Chemistry*. 2016; 221:473-481.
20. Vinha AF, Moreira J, Barreira SVP. Physicochemical parameters, phytochemical composition and antioxidant activity of the Algarvian avocado (*Persea americana* Mill.). *Journal of Agricultural Science*. 2013; 5:100-109.
21. Wang Y, Bostic TR, Gu L. Antioxidant capacities, procyanidins and pigments in avocados of different strains and maturities. *Food Chemistry*. 2010;122(4):1193-1198.
22. Yahia EM. Sustainable production and postharvest handling of avocado. Vol. 157. Burleigh Dodds Science Publishing; 2023.