Postharvest Biology and Technology 141 (2018) 77–85

Contents lists available at ScienceDirect

Postharvest Biology and Technology

journal homepage: www.elsevier.com/locate/postharvbio

Consumer preference and physicochemical evaluation of organically grown melons

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ARTICLE INFO

Keywords:
Organic practices
Cucumis melo
Consumer preference
Texture
Soluble solids content
Titratable acidity

ABSTRACT

Challenges in cultivar selection and availability has inhibited the expansion of the organic melon market. This study evaluated the sensory and physicochemical properties of four organically grown melon cultivars over a two-year period at three growing locations; two honeydew cultivars: 'Dulce Nectar' and 'Jaune', and two cantaloupe cultivars: 'Athena' and 'Sivan'. Trained and consumer panels evaluated 17 sensory attributes, including appearance, texture, flavor, and overall acceptance. Physicochemical measurements included flesh color, texture, pH, soluble solids content (SSC), and titratable acidity (TA). Results showed that 'Sivan' and 'Athena' were preferred by panelists for their flavor and overall eating quality; these cultivars also had relatively high SSC, high pH, and low TA. Conversely, 'Jaune' was the least preferred, with higher intensities of 'veggie' and 'green' flavors; this cultivar also had relatively low pH and high TA. Overall, 'Sivan' performed consistently better than all other cultivars both years, scoring highest in positive attributes, such as 'sweetness' and 'juiciness'. This research can be used to support the organic melon industry in cultivar selection.

1. Introduction

The cultivation of melons using organic practices has been increasing in the USA with the growth of the certified-organic produce market. Sales of organic melon products, excluding watermelon, increased by 75% in the USA between 2008 and 2015; this equated to an increase in total sales from $9.5 million to $16.7 million (USDA, 2016a). However, organic cantaloupe, muskmelon, and honeydew production comprises a small portion (less than 5%) of the total melon production in the USA (USDA, 2016a,b).

Melon production is well-suited to small-scale vegetable farms, which include many organic farm operations (Orzolek et al., 2006). However organically-grown crops need superior disease resistance because many disease control practices such as some seed-treatments and fungicides, are prohibited under organic production (Lammerts van Brueren et al., 2011). Likewise, most melon cultivars have not been bred specifically for organic production systems, and often lack optimal traits for this production system. Additionally, high quality seeds that are organically produced and not treated with pesticides are expensive, in short supply, or not readily available. Thus, achieving a stable yield is challenging and often requires high rate of external inputs. Cropping practices that integrate the use of cover crops and tillage can alleviate some production challenges and provide ecosystem enrichment (Marine and Everts, 2015). Previous research suggests that plant genotype and unique root exudate profiles are closely related to selective pressure on bacterial assemblages developing in the rhizosphere (Micallef et al., 2009). Soil biodiversity and plant disease suppression associated with different cropping practices during organic production could have varying influence on different melon cultivars e.g. pH level, flavor profile.

Previous studies have evaluated the quality of muskmelon cultivars using physicochemical, sensory, or combined methods (Lester and Shellie, 1992; Abbott, 1999; Guan et al., 2013; Krarup et al., 2016). Aroma and firmness profiles of muskmelon were developed and investigated through descriptive analysis with trained panelists (Bett-Garber et al., 2003; Beaulieu et al., 2004; Hirai et al., 2007). Consumer preference of novel orange-fleshed honeydew melon compared to commercial netted muskmelon and non-netted muskmelon was

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https://doi.org/10.1016/j.postharvbio.2018.03.001
Received 28 September 2017; Received in revised form 9 February 2018; Accepted 1 March 2018
Available online 26 March 2018
0925-5214/ Published by Elsevier B.V.

investigated with more than 600 untrained consumer panelists (Saftner et al., 2006). Guan et al. (2015) conducted acceptance sensory tests with untrained panelists (average 100 panelists per year over a two-year period) on galia and honeydew melons that were grafted using different rootstock and scion combination grown in three different production systems. However, scientific information pertaining to consumer preference of organic melon is limited, as few studies have addressed this topic.

Research on the eating quality of organic melon is needed to help expand the organic melon industry and aid growers in cultivar selection. Preference testing of melon cultivars from organic fields needs to be conducted using both sensory (descriptive and consumer) and physicochemical analyses. The objectives of this study were to (1) determine the consumer preference of organic melon cultivars grown under organic practices in a hairy vetch green manure system, and (2) select the most suitable melon cultivars based on their marketability, critical sensory quality attributes, and physicochemical measurements. Additionally, the interrelationships between sensory attributes and physicochemical measurements were studied to determine the influence of physical attributes on consumers' preference of the melon cultivars.

2. Materials and methods

2.1. Plant material

Certified organic melon seeds were planted in an organic peat-based potting mix (Pro-Mix® MP, Quakertown, PA, USA) at a greenhouse in the University of Maryland's Lower Eastern Shore Research and Education Center (UMD-LESREC) in Salisbury, MD, USA. Four melons were studied, including two honeydew cultivars, 'Dulce Nectar', 'Jaune' (*C. melo* var. *inodorus*), and two cantaloupe cultivars, 'Athena' (*C. melo* var. *reticulatus)* and 'Sivan' (*C. melo* var. *cantalupensis*). 'Athena' is a commonly grown melon cultivar in the southeastern USA (Guan et al., 2013) and was used as a control. Seed sources are shown in Table 1. Seedlings were transplanted into certified organic fields at three locations: UMD-LESREC in 2015, Central Maryland Research and Education Center (UMD-CMREC) in Upper Marlboro, MD, USA in 2015, and Wye Research and Education Center (UMD-WyeREC) in Queenstown, MD, USA in 2016.

All fields were planted with a hairy vetch cover crop (Dean and Weil, 2009; Marine and Everts, 2015; Fageria, 2016) in September of the previous year. The cover crop was tilled the following May to incorporate the hairy vetch biomass into the soil as a green manure to suppress plant diseases (Abawi and Widmer, 2000; Zhou and Everts, 2004; Wiggins and Kinkel, 2005; Zhou and Everts, 2012). After the initial tillage, the fields were tilled again about two weeks later to improve the green manure incorporation. All cultivars were harvested by hand when they reached a full slip stage. The melons were transported to the United States Department of Agriculture (USDA) Food Quality Laboratory (FQL) at the Beltsville Agricultural Research Center (BARC) in Beltsville, MD, USA and stored at 1 °C for one to two days before use. The study was repeated in 2016 with the same melon cultivars as in 2015.

2.2. Sample preparation

Sample preparation and processing procedures were adapted from Saftner et al. (2006) and Lester and Saftner (2008). Briefly, melons were inspected and those with no visible signs of damage were randomized and stored at 1 °C for 3 days prior to cutting. On each processing day, 10–12 melons per cultivar were submerged for 5 min in a 200 μL L^{-1} sodium hypochlorite solution that was adjusted to pH 6 using 5 N hydrochloric acid (Fluka, Ronkonkoma, NY, USA). Subsequently, the exterior fruit surface was sprayed with a 70% ethanol solution (Pharmco Aaper, Brookfield, CT, USA); excess water and ethanol were removed with paper towels. Fruit from each cultivar were separated into 3 groups (replicates) and transferred to a 5 °C preparation room for further processing. Each fruit was peeled with a melon peeler (CP-44, Muro Corp., Tokyo, Japan). The blossom and stem ends were removed, and each fruit was cut in half longitudinally. Seeds and placental tissues were removed and each half was cut into 5–6 slices. Each slice was cut into trapezoidal shaped pieces (width = 2–3 cm; height = 1.5–2.0 cm). The melon pieces were randomized and stored in Pactiv® Deli plastic containers with lids (Lake Forest, IL, USA) for one day at 5 °C under aerobic conditions. Prior to all evaluations, the melon pieces were stored for 2 h at room temperature (approximately 22 °C).

2.3. Physicochemical attribute evaluation

Physicochemical analyses were performed on the same day as the sensory evaluation. Methods for the analysis of the color, firmness, SSC, and TA were adapted from Lester and Saftner (2008) and Saftner and Lester (2009). Color measurement was performed on a latitudinally cut melon surface using a calibrated Chroma-meter (CR-400, Konica Minolta Inc., Tokyo, Japan) with a CIE D65 standard illuminant. Calibration was conducted using a manufacturer-supplied white calibration plate (L*: 96.03, a*: 0.20, b*: 2.10). The color of 10 melon pieces per replicate was determined in CIE L*a*b* color space by measuring the lightness or L* (+100 = white, −100 = black), a*(+60 = red, −60 = green), and b*(+60 = yellow, −60 = blue). Including all replicates, a total of 120 melon pieces per cultivar were measured. The a* and b* values were converted to chroma (C* = color intensity) and hue angle (0° = red, 90° = yellow, 180° = green, 270° = blue) by SpectraMagic NX software in the Chroma-meter. Chroma and hue angle were calculated by $C^* = [(a^*)2 + (b^*)2]1/2$ and $h^o = \tan^{-1}[(b^*)/(a^*)]$, respectively according to Lester and Saftner (2008) and Saftner and Lester (2009). After the color measurements were completed, texture analysis was conducted on the pieces of melon mesocarp tissue. Firmness measurements were performed using a texture analyzer (Model TA. XT Plus, Stable Microsystems, Surrey, England) with a 5-kg load cell. A 10-mm diameter cylindrical probe was used to puncture the flat surface of the melon samples at a speed of 1.0 mm s^{-1} to a deformation of 6 mm. Textural parameters were calculated from the deformation curves using the manufacturer's software; maximum force, total area (energy) under the curve, and gradient (slope) were determined for the initial portion of the curve between 0.5 and 1.0 s (Lester and Saftner, 2008; Saftner and Lester, 2009).

Following texture measurement, melon mesocarp tissue samples (100 g) were cut blended, juiced and filtered through a cheese cloth. SSC was determined with a LCD digital refractometer (Model PR-101; Atago Co., Tokyo, Japan). The TA was measured by titration with 0.1 M KOH (≥85% pellets; Sigma Aldrich, St. Louis, MO, USA) according to Mitcham and Kader (1996) and Simandjuntak et al. (1996). The solution pH was measured using a pH meter (Thermo Orion 550A; Thermo Electron Corp., Beverly, MA, USA) at 21 °C.

2.4. Sensory evaluation

Four sensory sessions with a 10-member trained panel were conducted between August and September 2015 to evaluate the cultivars from the UMD-LESREC and UMD-CMREC growing locations. During the sensory sessions, 'Athena' and 'Sivan' were evaluated twice, as these cultivars were grown in both locations. 'Jaune' and 'Dulce Nectar' were only grown at the UMD-LESREC location, and were evaluated once.

In 2016, the sensory evaluation by consumer panelists was performed over a period of 5 d on melon cultivars grown at UMD-WyeREC: 'Athena', 'Sivan', 'Jaune' and 'Dulce Nectar'. A total of 12 sensory sessions were held in August 2016; each session had 10 participants.

2.4.1. Descriptive analysis training

Panel members (six females, four males) were recruited from USDA