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Seasonal variation of mineral content in some papaya cultivars grown in protected cultivation

Esma Güneş¹, Hatice Reyhan Öziyici², Hamide Gübbük³

¹ Antalya Directorate of Provincial Agriculture and Forestry, Antalya – TURKEY, 07030

² Antalya Bilim University, School of Tourism, Department of Gastronomy and Culinary Arts, Antalya – TURKEY, 07190

³ Akdeniz University, Faculty of Agriculture, Dept. of Horticulture, Antalya – TURKEY, 07058

Abstract

Papaya can be grown the whole year under subtropical condition in protected cultivation. Protected cultivation is improved yield and quality due to the favorable climatic conditions. Beside the yield and quality, nutritional content of the fruit, taste and its contribution to health are also important for the consumers. In this study, the mineral content of *Sel-42* and *Tainung* papaya cultivars grown in protected cultivation system were investigated. In each season (representative season months were January, April, July and October), the fruits were harvested at the same maturity level (one third yellow on fruit peel; Ripening Stage-3 [RST3]) and macro and micro minerals of the fruit samples were analyzed at Ripening Stage-5 (RST5). According to the results; papaya cultivars used in this experiment and different seasons for harvest did not cause any significant difference in terms of macro and micro minerals ($p>0.05$). Both cultivars had the highest concentrations for P and K minerals in the autumn harvest (P_{Sel-42} : 3.55 ± 1.91 g/kg, $P_{Tainung}$: 3.75 ± 2.33 g/kg; K_{Sel-42} : 41.1 ± 25.46 g/kg, $K_{Tainung}$: 39.1 ± 24.04 g/kg). Among the analyzed micro minerals, Fe and B minerals were the highest minerals for both papaya cultivars. In conclusion; the papaya cultivars of *Sel-42* and *Tainung* grown in the protected cultivation system were found high in concentration especially in terms of K, N, Fe, Zn and B minerals.

Key Words: *Sel-42*, *Tainung*, harvest period, fruit quality

Introduction

Papaya fruit is a tropical crop native to tropical America. However it is grown not only in tropical conditions but also subtropical conditions, too. Total production area of papaya has reached to 460 thousand hectares whereas While the total amount of papaya production is 13.7 million tons, its production is made on a total area of 460 thousand hectares. Asia continent dominates the production, followed by America and Africa. In 2019, the countries of India (6.050.000 tons), Dominic Republic (1.171.336 tons), Brazil (1.161.808 tons), Mexico (1.083.133 tons) were reported as the major papaya producing countries (FAO 2019).

Papaya contains high levels of minerals such as calcium, iron and is an excellent source of vitamins such as vitamin C and folic acid (Ramos-Parra et al. 2013, USDA 2017). Compared to other tropical fruits, papaya is a good source of proteins. These proteins are essentially cysteine-type proteases such as papain (Tripathi et al. 2011). The fruit contains relatively high amount (1.7 g) of dietary fiber (USDA 2014). Papaya (fruit, seeds or leaf extracts) consumption is claimed to prevent cancer (Pathak et al. 2014), to regulate lipidaemia (Esmael et al., 2015), type-2 diabetes (Abo et al., 2008), gastric lesions (Murakami et al., 2012), to improve immunity in vitro (Lee et al. 2011).

Some of the advantages of why papaya cultivation is preferred by the farmers are easy propagation, giving fruit at the same year, less labor cost compared to vegetable growing, commercially well-known fruit thus easy to sell. On the other hand, in subtropical conditions the fruit is generally grown with protected cultivation system. This system is popular due to the increase in temperatures during daytime hours in winter, protection of the plants against wind and other unfavorable weather conditions (sunburn, hail, etc.), reduction in water consumption, as evapotranspiration is reduced by up to 25%, increase of light on the leaf surface leading to higher photosynthetic capacity, reduction of the time for growth and the length of developmental phases, improved production, both in quality and in quantity (Galán Saúco, 2002). Salinas et al. (2021) stated that active climatic control improved papaya plant growth, flowering, fruit set and consequently, yields, producing more and heavier fruits.

In this study, seasonal variation the mineral content of different papaya cultivars (*Sel-42* and *Tainung*) grown in cultivated protection were evaluated in terms of seasonal variation.

Materials and Methods

Sel-42 and *Tainung* papaya cultivars were used as experimental material and grown for two-year period (2009-2011). The greenhouse structure consisted of iron and covered plastic. Top height and height from the gutter were 7 and 5 m, respectively. There were 1.8 m and 2.5 m distances between plants and rows, respectively. In the greenhouse, drip and sprinkler irrigation systems were used. Fertilization was based on the ratio of 1:3:1 (Nitrogen-Phosphorous-Potassium) in the first three applications after planting, followed by the ratio of 2:1:3 until fruit development and finally based on the ratio of 3:1:6 during fruit development. During protected cultivation, the temperature of year around was changed 13-30 °C. The fruits of the papaya cultivars were harvested in each season (representative months were January, April, July and October) at the same maturity level (one third yellow on fruit peel; Ripening Stage-3, Fig. 1)

The macro (Phosphorus_P, Potassium_K, Sodium_Na, Calcium_Ca, Magnesium_Mg) and micro minerals (Iron_Fe, Copper_Cu, Zinc_Zn, Manganese_Mn, Boron_B) of the samples were analyzed at the Ripening Stage-5 (Fig. 1). Total nitrogen was measured using Kjeldahl distillation method (Jones 1991). Phosphorus was determined by Spectrophotometer (Chapman and Pratt, 1961; Kacar, 1972). Potassium, calcium, iron, magnesium, manganese, zinc, copper were determined by Atomic Absorption Spectrophotometer. Macro and micro mineral values were given as g/kg and mg/kg.



Fig. 1. Ripening index of papaya (*Carica papaya* L.; Reference: Barragán-Iglesias et al. 2018)

The experimental design was completely randomized and data (average mean of two years) were analyzed using the ANOVA procedure and the Tukey test ($p < 0.05$) to compare means.

Results and Discussion

The macro and micro mineral content of *Sel-42* and *Tainung* papaya cultivars harvested at different seasons were monitored. According to the results; the papaya cultivars and different seasons were found as non-significant variables ($p > 0.05$). The reason for this was thought to be the high standard deviation between the values of the samples harvested in different years. On the other hand, K and N minerals were found as the highest macro minerals for both cultivars (Fig. 2). Although the seasonal difference between cultivars was not significant ($p > 0.05$), both cultivars had the highest concentrations for P and K minerals in the autumn harvest (P_{Sel-42} : 3.55 ± 1.91 g/kg, $P_{Tainung}$: 3.75 ± 2.33 g/kg; K_{Sel-42} : 41.1 ± 25.46 g/kg, $K_{Tainung}$: 39.1 ± 24.04 g/kg).

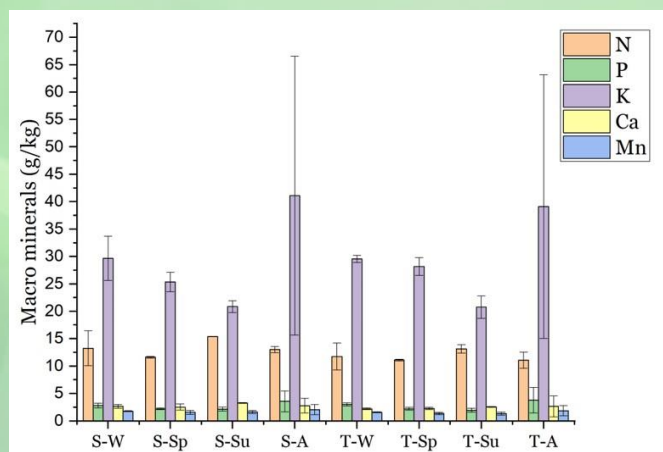


Fig. 2. Variation in macro minerals according to the harvest seasons (S: *Sel-42*, T: *Tainung*, W: Winter, Sp: Spring, Su: Summer, A: Autumn)

Among the analyzed micro minerals, Fe and B minerals were the highest minerals for both papaya cultivars (Fig. 3).

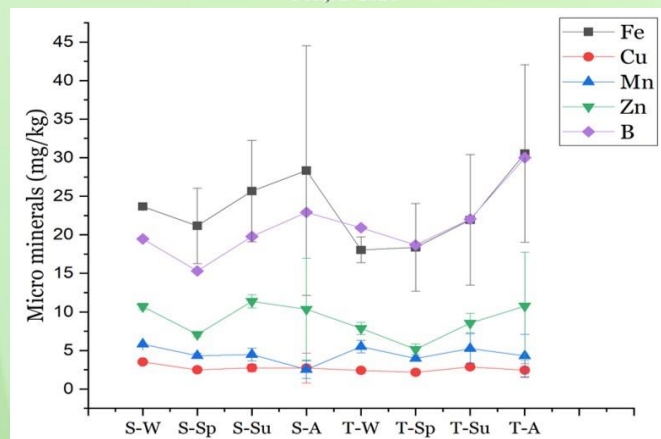


Fig. 3. Variation in micro minerals according to the harvest seasons (S: *Sel-42*, T: *Tainung*, W: Winter, Sp: Spring, Su: Summer, A: Autumn)

The highest values of *Sel-42* papaya cultivar were obtained for Fe mineral in the autumn (28.34 ± 16.18 mg/kg), Cu mineral in the winter (3.51 ± 0.11 mg/kg) and Zn mineral in the winter (10.71 ± 0.43 mg/kg) whereas of *Tainung* papaya cultivar were obtained for Mn mineral in the winter (5.49 ± 0.81) and B mineral in the autumn (30.00 ± 18.25).

Papaya at different ripening stages is reported a good source of minerals such as Ca, Mg and K (Chukwuka et al. 2013). Farina et al. (2020) have also reported that K was the predominant mineral for the different papaya cultivars they analyzed. They also reported that Ca and P minerals were slightly higher in concentration than USDA Nutrition Database. Hardisson et al. (2001) also reported that the papaya variety (*Sunrise*) they worked was mainly rich in K, Mg and B. When the literature studies are observed, it is seen that the findings obtained from this study are almost at a similar level with these studies, although there are slight differences according to the different papaya varieties used in the experiments. In this study; the papaya cultivars of *Sel-42* and *Tainung* grown in the protected cultivation system were found high in concentration especially in terms of K, N, Fe, Zn and B minerals.

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