ANNALS OF THE UNIVERSITY OF CRAIOVA

Series: ✓*Biology*
✓*Horticulture*
✓*Food products processing technology*
✓*Environmental engineering*

Vol. XXVIII (LXIV) - 2023

QUANTITATIVE ANALYSIS OF NUTRITIONAL AND BIOACTIVE COMPOUNDS IN BITTER GOURD (*MOMORDICA CHARANTIA* L.) FRUITS

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Keywords*: Momordica charantia, carotenoids, phenolic compounds, ascorbic acid, sugars, lipids*

ABSTRACT

Bitter gourd fruits (Brâncuși cultivar) from local production were studied for their content in some classes of nutritive compounds. Carotenoids (total, β-carotene, lycopene and lutein), phenolic compounds (total, flavonoids, anthocyanins, tannins), ascorbic acid, soluble sugars and lipids were determined.

With 231/251 mg/kg DW (peel/pulp) total carotenoid content in M. charantia fruits was lower than in other known Cucurbitaceae. β-carotene was dominant in the peel while lycopene constituted a large fraction in the pulp. Lutein was found in low amounts (<1 mg/kg) only in the peel. On the contrary, with 13,527/18,598 mg/kg, the total phenolic inventory is richer than in many other related species. Flavonoids (8,763/14,545 mg/kg) were dominant in both peel and pulp. Of these, only a small fraction (267/212 mg/kg) were anthocyanins. Tannins constituted over 9.5% of the phenolic inventory.

Ascorbic acid concentration was high, 14,689 mg/kg in peel and 12,847 mg/kg in pulp. Soluble sugars were 9,035/9,579 while lipids were 3,800/3,200 mg/kg.

INTRODUCTION

Momordica charantia L. (bitter gourd, bitter melon, bitter cucumber, balsam pear) is a member of the Cucurbitaceae family, native of Africa, but widely grown in South Asia, and, in more recent times, in the Caribbean and Australia. Although a culture mostly specific to tropical and subtropical regions, its popularity is rising in other areas too. In Romania it was introduced in the 1990's and since new varieties were developed. While in temperate climate it grows best under greenhouse conditions, it is now considered as the most profitable crop in our country.

It is a perennial (under local conditions in Romania, annual), herbaceous plant, with climbing stems growling up to 5 m. Leaves are up to 5 cm long, with long, pubescent petioles. Spiral tendrils are present to ensure climbing. A monoecious plant, it has solitary yellow flowers, with long peduncles, 10-20 cm long petals. Male flowers outnumber female ones by 20:1. The fruit is a pepo, up to 20 cm long, cylindical, covered with proeminent ridges and warts. Ripe fruits are yellow to orange, with bright yellow pulp and multiple seeds covered by red arils.

It is a plant with known nutraceutical properties, being used as a hypoglycemic, anti-obesity, antibiotic, antimalarial, hepatoprotective, immuno-modulatory food (Șesan 2020).

Figure 1. *Momordica charantia* L.

Plants are known to contain several classes of valuable bioactive compounds.

Carotenoids (including carotenes, lutein, lycopene, zeaxanthin) are accessory photosynthetic pigments. Some of them (especially carotene) are precursors of retinol and key to melanin synthesis, thus important for eye and skin functioning. They are also antioxidant and antiproliferative and researches show that lycopene is among the most important dietary anticarcinogens (Eldahshan & Singab 2013).

Phenolic compounds are a variate group of bioactive compounds, functioning as plant pigments, but also as antimicrobials and antifungals. Flavonoids (among them being anthocyanins – plant pigments and strong antioxidants), phenolic acids and tannins belong to this group (Kivrak & Kivrak 2014). For consumers, phenolic compounds are a key class of antioxidant, reducing and radical scavenging agents (Zymonė et al. 2018).

Ascorbic acid (vitamin C) is a key antioxidant, countering lipid oxidation at cell level in all organisms (Riscahyani et al. 2019).

The objective of this paper was to determine the amount of several nutritional compounds and compound classes in bitter gourd fruit (peel and pulp).

MATERIAL AND METHODS

Mature bitter gourd fruits (Brâncuși cultivar) were collected from the experimental farm of the “Ovidius” University of Constanța. Peel (epicarp) and pulp (meso-and endocarp) were separated, oven dried and ground prior to analysis.

Total carotenoids were determined by 80% acetone extraction and spectrophotometric absorption reading (S106 WPA spectrophotometer) at 470 nm

(Popoviciu et al. 2020). Concentrations were calculated according to Lichtenthaler & Buschmann 2001.

Among individual carotenoid compounds, β-carotene, lycopene, lutein (and lutein esters), were determined by extraction in acetone:hexane:petroleum ether, respectively petroleum ether and using the spectrophotometric methods of Braniša et al. 2014 and Sujith et al. 2010.

The total concentration of phenolic compounds was determined by extracting plant tissue in methanol and reaction with Folin-Ciocâlteu reagent (10%) and sodium bicarbonate (7.5%) for 30 minutes. Absorbance was read at 765 nm against gallic acid calibration curve (Popoviciu et al. 2020). Flavonoids were determined by precipitation with hydrochloric acid and formaldehyde, followed by quantification of non-flavonoid phenolic content by Folin-Ciocâlteu reaction. Tannins were similarly determined after precipitation in gelatin and NaCl solution (de Lima et al. 2011). Anthocyanins were determined by 70% ethanol extraction and spectrophotometry at 520 and 700 nm (Braniša et al. 2014).

For total ascorbic and dehydroascorbic acid, ethanol extraction, reaction with ammonium molybdate and sulfuric acid, followed by spectrophotometric reading at 494 nm were employed (Riscahyani et al. 2019).

Total soluble carbohydrates were determined by reacting plant ethanolic extract with sulfuric acid and phenol (5%), followed by spectrophotometric reading at 490 nm (Agrawal et al. 2015). Lipids were determined by petroleum ether extraction and gravimetry (Orphanides et al. 2011).

RESULTS AND DISCUSSIONS

The concentrations of various classes of compounds with bioactive potential are shown in Figures 2-4.

Average total carotenoid content was 231 mg/kg in fruit peel and 251 mg/kg in pulp. While β-carotene was dominant in the peel 176 mg/kg and 76% of the total amount), the pulp contained a high amount of lycopene (98 mg/kg and 39%). Lutein was found in peel in low amounts (0.85 mg/kg) and was below detection limits in pulp.

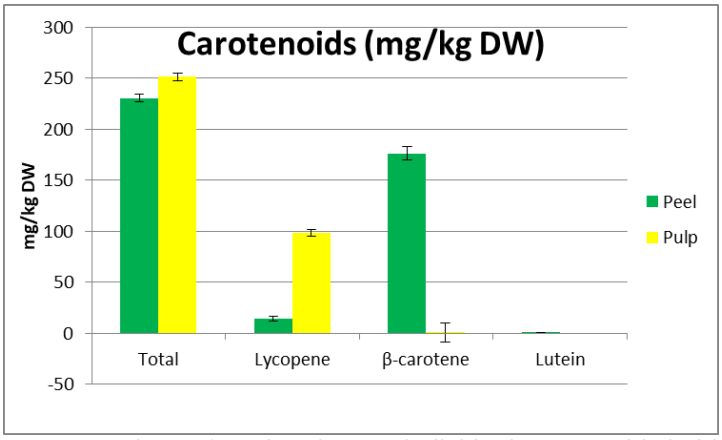

Figure 2. Concentrations of total and some individual carotenoids in bitter gourd fruits (mg/kg DW)

Related *Momordica cochinchinensis* was found to contain highly variable amounts of both β-carotene (200-8,270 mg/kg) and lycopene (270-7,760 mg/kg) (Wimalasiri et al. 2017). Peel and pulp of various *Cucurbita* species (*C. maxima*, *C. moschata*, *C. pepo*) contain 41-3,797 mg/kg total carotenoids (Grassino et al. 2023). For instance, local cultivars of *C. maxima*, *C. moschata* and *C. pepo* in Romania were found to contain 42-65 mg/kg FW total carotenoids (Dinu et al. 2016).

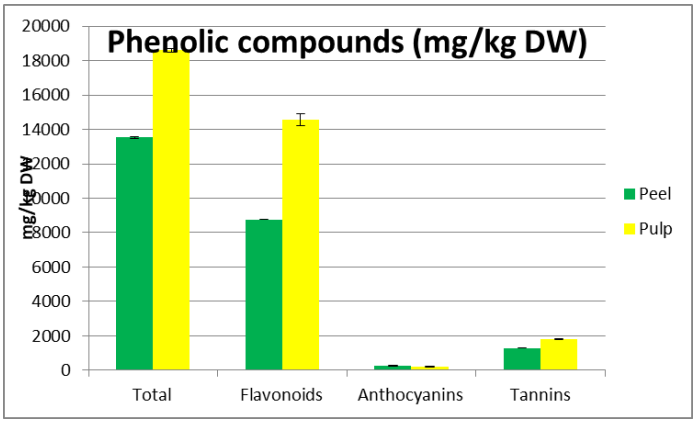

Figure 3. Concentrations of total phenolic compounds, flavonoids, tannins and anthocyanins in bitter gourd fruits (mg/kg DW)

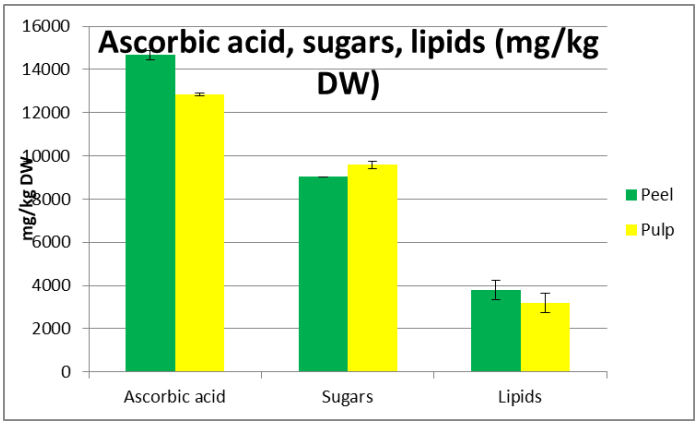

Figure 4. Concentrations of other nutritional compound classes in bitter gourd fruits (mg/kg DW)

Average total phenolic content was 13,527 mg/kg in peel and 18,598 mg/kg in pulp. mg/kg. Of these, the flavonoid fraction was majoritary, with 8,763 mg/kg in peel (64%) and constituted 14,545 mg/kg in pulp (78%). Among flavonoids, anthocyanins were a small fraction, with 267 mg/kg in peel and 212 mg/kg in pulp. Tannins were found at 1,280 mg/kg in peel and 1,808 mg/kg in pulp (below 10% of the phenolic inventory). For comparison, other Cucurbitaceae are known to possess a rich phenolic inventory. Squash (*Cucurbita pepo*) may contain 3,867-5,306 mg/kg FW total phenolic compounds, pumpkin (*Cucurbita maxima*) –

549-921 mg/kg, cucumber (*Cucumis sativus*) – 238-323 mg/kg, bottle gourd (*Lagenaria vulgaris*) – 949-3,000 mg/kg and Colocynth (*Citrullus colocynthis*) – 1,386-1,655 mg/kg (Al-Bakheit & Abu Zahra 2019). *Cucumis melo* peel was found to contain 3,320 mg/kg FW phenolics of which 924 mg/kg FW flavonoids (Mallek-Ayadi et al. 2017). *Coccinia grandis* had 18,960 mg/kg phenolics (3,000 mg/kg flavonoids) in peel and 9,500 (2,870) mg/kg in pulp; *Trichosanthes cucumerina*, 13,920 (3,240) in peel, 9,140 (2,510) in pulp and *Cucurbita moschata*, 15,310 (3,120) in peel and 14,380 (2,950) mg/kg in pulp (Akhter et al. 2022).

Ascorbic acid concentration was higher in peel (14,689 mg/kg) than in pulp (12,847 mg/kg), values much higher than those found, for instance in *Cucurbita maxima* fruits (492-842 mg/kg DW; Kulczyński & Gramza-Michałowska 2019).

Lipid content was also higher in peel (3,800 mg/kg) than in pulp (3,200 mg/kg), while soluble sugars had higher concentrations in pulp (9,579 mg/kg), than in peel (9,035 mg/kg).

CONCLUSIONS

With 231/251 mg/kg DW (peel/pulp) total carotenoid content in *M. charantia* fruits was lower than in other known Cucurbitaceae. β-carotene was dominant in the peel while lycopene constituted a large fraction in the pulp. Lutein was found in low amounts (<1 mg/kg) only in the peel.

On the contrary, with 13,527/18,598 mg/kg, the total phenolic inventory is richer than in many other related species. Flavonoids (8,763/14,545 mg/kg) were dominant in both peel and pulp. Of these, only a small fraction (267/212 mg/kg) were anthocyanins. Tannins constituted over 9.5% of the phenolic inventory.

Ascorbic acid concentration was high, 14,689 mg/kg in peel and 12,847 mg/kg in pulp. Soluble sugars were 9,035/9,579 while lipids were 3,800/3,200 mg/kg.

While phenolic compounds were found in higher concentration in the pulp, the fruit peel was also found to contain valuable nutrients, such as β-carotene and ascorbic acid.

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