THE FUNCTIONAL NUTRITIONAL VALUE AND THE HEALTH BENEFITS OF CONSUMING EGGPLANT

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RESEARCH ARTICLE

Abstract

Eggplants, due to their multiple functional properties and metabolic benefits on several pathologies, proven by repeated research, are also considered medicinal plants or foods. They have a low caloric content but an increased content of mineral elements, representing a complete food through the content of vitamins, fibers, and phytochemical nutrients with antioxidant activity. The positive metabolic effects of eggplants are given by the content of anthocyanins, present in the purple skin, of glycoalkaloids with anticancer effect and of solasodine, an aglycol with an effect on lung cancer.

The pharmacological properties of eggplants, due to functional nutrients, have the effect of reducing LDL-c, triglycerides and blood sugar, contributing significantly to weight reduction.

Eggplants are important plants from an agronomic and economic point of view but also from a nutritional point of view, representing a significant base source for various pharmaceutical products and essential nutraceutical compounds.

Keywords: eggplant, Solanum melongena, functional components, metabolic effect

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INTRODUCTION

The consumption of vegetables, as safe sources of vitamins and minerals, due to their functional nature, contributes to the improvement of metabolic disorders, protecting the body from various diseases and illnesses (Apahidean et al., 2000).

Eggplants are grown mainly as vegetables but are also grown for medicinal purposes. The analysis of the content in phytochemical compounds of eggplant shows that these vegetables are a rich source of some essential compounds such as: aspartic acid, tropane, flavonoids, lanosterol, gramisterol, steroid alkaloids, glycoalkaloids, histidine, nasunin, oxalic acid, solasodine, ascorbic acid and tryptophan (Nishimura, et al. 2019). Added to these functional nutrients are significant amounts of choline and acetylcholine esters with antihypertensive and stress-reducing effects, suppressing sympathetic nervous activity (Yamaguchi et al, 2019). They are also low in calories and high in water. These compounds show functional properties on cancer, with anti-inflammatory, anti-asthmatic, hypolipidemic and hypocholesterolemic, antiplatelet and hypotensive effects and improving glycemic levels in type II diabetes (Naeem and Ugur, 2019; Yarmohammadi et all, 2021).

Tropical species of eggplant, such as Solanum kumba, Solanum aethiopicum and Solanum gilo, had positive metabolic effects following daily consumption over a period of 12 weeks in various forms, prepared or raw (Nwanna et all, 2018).

Solanum melongena extract has a significant beneficial effect on the treatment of Bowen's disease. The extract could inhibit cell cycle progression into S phase, inducing progressive cell apoptosis and ultimately cell death (Sarah and Misbahuddin, 2018).

Amides (n-trans-p-coumaroyltyramine, feruloyldopamine) have been shown to inhibit bacteria (Zacares et al., 2007). N-trans-coumaroyltyramine, n-trans-feruloyltyramine and n-trans-feruloyloctopamine have demonstrated effective free radical scavenging activity (Li et al., 2012). Neochlorogenic acid, a phenylpropanoid compound showed antioxidant activity, in vitro, analyzed by three methods (ABTS, DPPH and FRAP) (Zielinski et al., 2020). A variety of alkaloids can inhibit anticholinesterase activity related to the treatment of Alzheimer's disease (Lelario et al., 2019).

MATERIAL AND METHOD

The so varied and rich nutritional components of eggplants, presented in the specialized literature, depend on numerous

factors, such as the variety, harvest period, storage and preservation conditions, processing and cooking conditions, and the environment in which they grow.

Starting from these factors, in our study we analyzed the quality of eggplant varieties of different colors, cultivated in an ecological system, in the western part of Romania. The ecological system of eggplant cultivation ensures superior quality products, without pesticide residues, being requested by consumers in ever-increasing quantities.

The biological material was represented by the varieties Violetta di Firenze, Carina, Black Beauty, Dourga, Jilo Tingua Verde, Japanese Pickling, Orange de Turquie (Fig. 1).

1.1. **Violetta di Firenze**

1.2. **Carina**

1.3. **Black Beauty**

1.4. **Dourga**

1.5. **Jilo Tingua Verde**

1.6. **Japanese Pickling**

1.7. **Orange de Turquie**

Figure 1. **Eggplant variety**

The nutri-functional quality was evaluated based on the content of bioactive compounds: polyphenols (TPC), flavonoids (TF), monomeric anthocyanins from the fresh peel and pulp, and the antioxidant activity by the FRAP method.

The analyzes were performed on the fresh sample without heat treatment.

-Total phenol content (TPC) – was analyzed by the Folin-Ciocâlteu spectrophotometric method, with absorbance measurement at 765 nm, using gallic acid as a standard.

-The total content of flavonoids (TF) – was analyzed by the AlCl3 spectrophotometric method (Atanassova et al., 2011). Absorbance was measured at 510 nm after 30 minutes. As a standard quercitin was used.

-FRAP antioxidant activity - The reducing capacity of the samples was tested with the original method of Benzie and Strain. The expression was made by correspondence with the FeSO4 activity for the sample extract, the concentration was calculated using the calibration curve (0-1000pM FeSO4).

-Monomeric anthocyanins - the difference in absorption of the pigments at 520 nm is proportional to the concentration of the pigment. Results are expressed on the basis of cyanidin-3-glucoside (AOAC method).

RESULTS AND DISCUSSIONS

Eggplant is the third most important crop in the genus Solanum after potatoes and tomatoes (Zhang, 2013). Being a thermophilic species, the cultivation area is limited by the climatic conditions, and the rather high requirements regarding the quality of the soil, but the high requirements regarding the soil moisture, consider eggplants to be the most demanding Solanoaceae vegetables in terms of pedoclimatic factors.

For all the samples, 3 repetitions were made, from fruits coming from organic culture, and the results presented in figures 2., 3., 4., 5., 6., represent the average values.

The highest amount of anthocyanins in fresh eggplant peel (figure 2) was recorded in the cultivar Japanese Pickling (39.49 mg/100g) and the lowest value was recorded in the cultivar Carina (10.42 mg/100g).

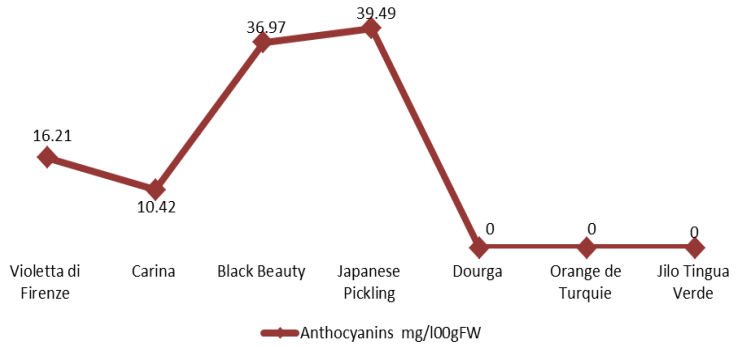

Figure 2. **Content of Anthocyanins from the peel of the eggplant fruit (fresh product)**

Anthocyanins have been associated with both the prevention and management of type 2 diabetes in both animal and human studies (Xiao and Hogger, 2015). The metabolic benefits correlate faithfully with the polyphenolic compound, with protective actions on pancreatic beta cells, improving glucose tolerance and insulin sensitivity through the antioxidant and anti-inflammatory effect (Xiao and Hogger, 2015).

The data presented in figure 2 indicate a null content in anthocyanins in the Dourga, Orange de Turquie and Jilo Tingua Verde cultivars, which led to the determination of the content in other compounds with antioxidant activity such as lycopene and carotene. The data are presented in figure 3.

In the cultivar Dourga, it was not possible to determine the content in carotene and lycopene, due to the white color of the peel.

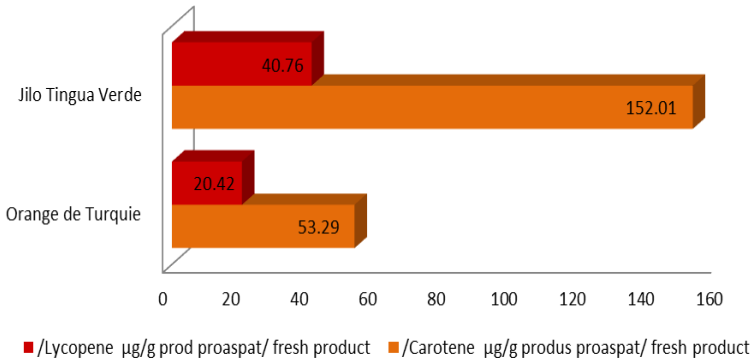

Figure 3. **Content of carotene and lycopene from the peel of the Orange de Turquie and Jilo Tingua Verde variety**

In the cultivar Jilo Tingua Verde, the lycopene content was approximately three times higher (152.01 µg/g) compared to Orange de Turquie (53.29 µg/g). The lycopene content was also much higher in the cultivar Jilo Tingua Verde, being 40.76 µg/g compared to Orange de Turquie, which recorded a content of 20.42 µg/g (figure 3).

Both the lycopene content and the carotene content recorded significant values, so these two eggplant cultivars can represent functional foods with an effect on some metabolic disorders.

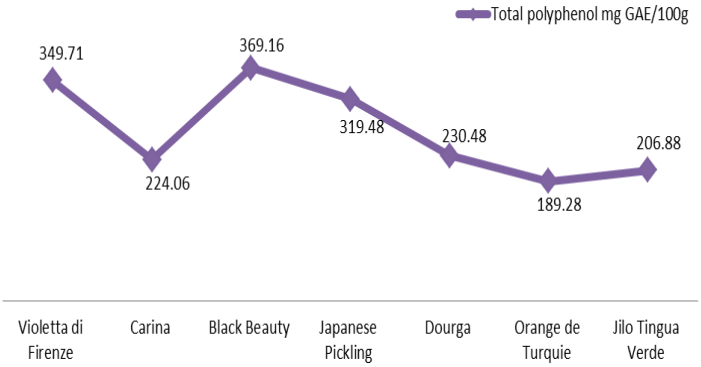

Figure 4. **Content of Polyphenols from the peel of the eggplant fruit (fresh product)**

The amount of polyphenols (figure 4), determined from the eggplant skin, recorded values between 189.28 mg GAE / 100g for Orange de Turquie and 369.16 mg GAE / 100g for Black Beauty.

Polyphenols have become an emerging area of interest in nutrition in recent decades due to their vital role in health through their putative protective effect on acute and chronic diseases, including obesity, neurodegenerative diseases, type 2 diabetes and cardiovascular diseases (Cory, et all, 2018).

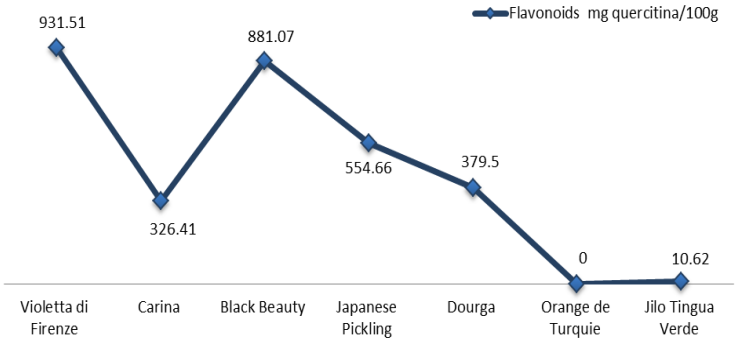

Figure 5. **Content of Flavonoids from the peel of the eggplant fruit (fresh product)**

The total flavonoids in the eggplant skin (figure 5) varied within very wide limits, between 10.62 mg quercitin/100 mg in the cultivar Jilo Tingua Verde 100g and 931.51 mg quercitin/100g in the cultivar Violetta di Firenze, and in cultivar Orange de Turquie flavonoids were not identified.

Culinary preparation plays a significant role on the content of polyphenols. Quercetin content can be reduced by up to 80% by boiling, 65% by microwaving and 30% by frying (Pandey and, 2009).

In general, the relationship between cooking method and polyphenol availability is complex and depends on the food, polyphenolic compound, cooking method, and other factors, often showing a U-shaped relationship (Cory, et all, 2018).

The antioxidant activity determined by the FRAP method (figures 6) varied between 26.22 mM FeSO4/g in the cultivar Orange de Turquie and 58.87 mM FeSO4/g in Violetta di Firenze and Black Beauty.

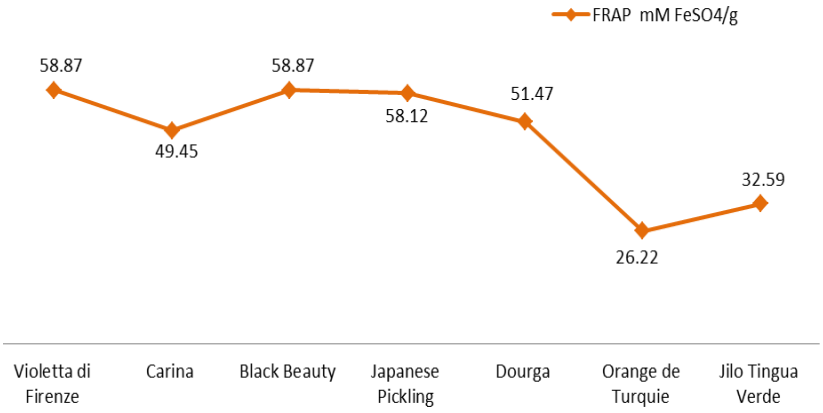

Fig.ure 6. **Antioxidant activity from the peel of the eggplant fruit (fresh product)**

Anthocyanins from vegetables and fruits show strong antioxidant and anti-inflammatory action, to which are also added hepatoprotective, chemo-protective and cardio-protective effects important from the perspective of optimal health.

The dose of 12 mg/kg body administered for 30 days can reduce markers of oxidative stress and lipid peroxidation and doses of 320 mg/day lead to the decrease of IL-6 in obesity and in cardiovascular diseases where oxidative stress causes vascular inflammation. Anthocyanin extracts from berries at a dose of 160 mg twice daily for a period of 12 weeks lead to significant increases in serum HDL-C and decreases in LDL-C. A dose of 150 ml/day

of anthocyanin-rich pomegranate juice consumed between lunch and dinner for 14 days has been shown to significantly reduce both systolic and diastolic BP.

The recommended daily intake of anthocyanins and associated flavonoids according to WHO-FAO, is 200–250 mg/day, while the intake of anthocyanins extracted from grape skin has been established at 2.5 mg/kg. In the United States, according to the US-FDA Flavonoid Nutritional Database the recommended intake of anthocyanins is 12.5 mg/day/person, a dose supported by the US-NHANES (United States National Health and Nutrition Examination Survey).

CONCLUSIONS

The anthocyanin content of the fresh peel was between 10.42 mg/100g in Carina and 39.49 mg/100g in Japanese Pickling. This amount correlated with the degree of damage to the body has a significant effect on the disorders caused by oxidative stress, leading to a decrease in IL-6, a significant increase in HDL-c and a decrease in LDL-c.

Anthocyanins and related flavonoids, even though they are not considered essential components of the human diet, their functional effects and increased content in many fruits and vegetables could reduce morbidity from heart failure, ischemic heart disease and cancers by 9-14%, respectively .

A quantity of 100 g of eggplant consumed per day provides 22.5% of the RDI of health-enhancing anthocyanins.

The eggplant cultivar Violetta di Firenze recorded the highest amount of total flavonoids, determined from the peel, being 931.51 mg quercitin/100g, being one of the most important phenolic protectors on human health. This amount per 100 g of product provides 53.67% of the RDA.

The highest value of the total amount of polyphenols in the eggplant skin was recorded in the Black Beauty variety, namely 359.16 mg GAE/100g, which would provide 143.66% of the RDA with the expected functional effect on the atherosclerotic risk.

The antioxidant activity determined by the FRAP method was the highest in Violetta di Firenze and Black Beauty varieties, 58.87 mM FeSO4/g.

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