ISSN (Online): 2367-6957 ISSN (Print): 2367-6361

Izvestiya Journal of Varna University of Economics 1 (2019)

IZVESTIYA

Journal of Varna University of Economics

http://journal.ue-varna.bg

STUDY OF THE MINERAL COMPOSITION OF BROCCOLI AND BRUSSELS SPROUTS FOOD WASTE

Vanya ZHIVKOVA[1], Denka ZLATEVA[2]

[1] Department of Commodity Science, University of Economics, Varna, Bulgaria. E-mail: v_jivkova@ue-varna.bg

[2] Department of Commodity Science, University of Economics, Varna, Bulgaria. E-mail: zlateva@ue-varna.bg

JEL Q100

Abstract

At present, there is a need to develop and implement effective waste management strategies for fruit and vegetables and to find opportunities for their future utilization. Vegetables from the *Brassicaceae* family have important economic significance and are consumed in many countries worldwide. The purpose of this article is to investigate the mineral composition of the waste portions of broccoli and Brussels sprouts. The establishment of the mineral composition of these wastes would provide guidelines for their further utilization. It was found that in the non-edible parts of broccoli and Brussels sprouts the highest content is that of potassium – respectively 3880 mg/kg in Brussels sprouts and 3254 mg/kg in broccoli, sulfur (1695 mg/kg in wastes from broccoli, and 1187 mg/kg in wastes from Brussels sprouts) and phosphorus – 1216 mg/kg in broccoli wastes and 686 mg/kg in Brussels sprouts wastes. The following elements in the reduction of their contents are: calcium, magnesium, sodium, iron, copper, zinc, boron, manganese, aluminum.

Key words:

food waste; broccoli; Brussels sprouts; mineral composition.

Citation: ZHIVKOVA, V., ZLATEVA, D. (2019). Study of the Mineral Composition of Broccoli and Brussels Sprouts Food Waste. *Izvestiya Journal of Varna University of Economics*. 63 (1). p. 69 - 80.

Introduction

The wastes emitted in the production and processing of fruit and vegetables are increasingly being considered as a potential danger to human health and one of the reasons for the deterioration of the environment. This determines the need to develop and implement effective strategies for environmentally sound management of wastes from fruit and vegetables in order to identify opportunities for future utilization.

Typically, the term "fruit and vegetable wastes" means the non-edible parts of fruit and vegetables that are discarded when collected, processed, transported and rehashed; i.e. this waste is generated throughout the food supply chain (agricultural production, storage, post-storage processing, consumer phase) (Plazzotta et al., 2017). It has been found that in Europe fruit and vegetable wastes accounts for 8% of total food wastes (Banerjee et al., 2017). Corrado & Sala review the existing studies on the generation of food wastes on a global and European scale. They point out that the available data provide an overview of the generation of food wastes, but they are not sufficient to identify specific interventions and monitor their accumulation (Corrado and Sala, 2018). According to surveys conducted in EU countries, non-edible parts of fruit and vegetables account for 44% – 47% of food wastes generated by households. Recently, there have been an increasing number of publications on the quantification of food wastes across the supply chain on a global and regional scale. In order to investigate how the consumption of fresh fruit and vegetables contributes to the generation of domestic waste in the European Union, De Laurentiis and co-authors create a model for the evaluation of household wastes from fresh fruit and vegetables (De Laurentiis et al., 2018). Proper treatment of such waste biomass is essential to reduce environmental pollution (Di Donato et al., 2014). Of particular interest is the search for innovative, cost-effective and efficient techniques for the recycling of fruit and vegetable wastes (Wu et al., 2017).

Lam et al. state that fruit wastes are a renewable and sustainable resource that should not be treated as other solid wastes. Methods of composting, landfilling or incineration are not suitable for their destruction, as they can lead to environmental problems. Release of unpleasant odor during composting would result in deterioration of air quality; greenhouse gases (e.g. methane) emitted during landfilling contribute to global warming; the possible formation of toxic compounds (such as dioxin) upon incineration can lead to headaches, fatigue, insomnia (Lam et al., 2016).

Different management strategies can be successfully implemented to handle fruit and vegetable wastes. In recent years, the use of functional compounds has found great application which suggests that fruit and vegetable wastes can be regarded as a source of valuable ingredients (Plazzotta et al., 2017). Various studies on the composition of the fruit processing wastes indicate the presence of different bioactive compounds, which are the primary and secondary metabolites of plants (phenols, alkaloids, glycosides, essential oils, resins). Biologically active extracts can be used for their proven health effects (Banerjee et al., 2017). The use of food wastes as a raw material for bio-refineries is still at an early stage of development. Cristóbal and co-authors examine the techno-economic potential and profitability of four bio-refineries that use tomato, potato, oranges and olive oil as raw material. The results show that waste materials have different potential. It is necessary to optimize the sustained availability and transport of wastes in order to prevent negative impact on the environment (Cristóbal et al., 2018).

A Gowe review article focuses on the extraction of bioactive compounds from fruit and vegetable wastes and the possibility of using them as natural additives for the food industry (Gowe, 2015). Kandari & Gupta offer bioconversion of turnip, apple, papaya and banana wastes in order to obtain valuable ingredients (Kandari and Gupta, 2012). Wu and co-authors have developed an electrofluidic pre-treatment system for citrus wastes in order to improve the extraction of essential oil (Wu et al., 2017). A number of authors study fruit and vegetable wastes as a source for extracting polyphenol antioxidants (Peschel et al., 2006, Wijngaard et al., 2009, Savatović et al., 2010, Wijngaard et al., 2012, Kabir et al., 2015).

Singh & Immanuel offer antioxidants extraction from pomegranate and citrus peel and its addition to traditional Indian food products to prevent auto oxidation changes (Singh and Immanuel, 2014). Panda and co-authors discuss the microbiological treatment of fruit and vegetable wastes to produce enzymes and organic acids (Panda et al., 2016). Qureshi and co-authors examine peel of oranges, lemons, bananas, papaya and apple petioles as a source for the production of enzymes - pectinase and lipase (Qureshi et al., 2017). Nawirska & Uklańska investigate the fiber content in the wastes of processed apples, strawberries, aronia, black currant, red cabbage, carrots (Nawirska and Uklańska, 2008). Szymańska-Chargot and co-authors retrieve cellulose from waste pieces of apples, carrots, tomatoes and cucumbers (Szymańska-Chargot et al., 2017). Soquetta and co-authors investigate the physicochemical and microbiological properties as well as the biologically active components contained in the flour from non-edible parts of kiwi (Soquetta et al., 2016).

The search for opportunities to extract the valuable components contained in fruit and vegetable waste can be cited as a major challenge. Sagar and co-authors have reviewed the methods of extraction and possible use of biologically active substances (such as fiber, phenolic compounds, flavoring substances, enzymes, organic acids etc.) from fruit and vegetable waste (Sagar, et. al., 2018).

From the above it is clear that the use of waste products from the processing of fruit and vegetables as a source of various valuable compounds is a promising area of theoretical and practical significance. However, it is noteworthy that most studies have focused on the possibility of extracting substances with antioxidant activity, fiber and enzymes. There are few articles aimed at exploring the mineral composition of fruit and vegetable wastes. Asquer et al. investigate the content of mineral substances in broccoli wastes (Asquer et al., 2013). Vegetables of the Brassicaceae family have important economic significance. Various varieties of cabbage, cauliflower, Brussels sprouts, etc. are used for human food. Interest in the cultivation of Brussels sprouts and broccoli has increased in recent years. It is expected that in the coming years their production will continue to increase (Prohens and Nuez, 2008).

The aim of this paper is to study the mineral composition of the waste portions of broccoli and Brussels sprouts. The determination of the mineral composition of these wastes would provide guidelines for future research with a view to their utilization.

Matherials and methods

Sample collection

As test materials were used non-edible parts (the authors considered waste) from:

- ✓ broccoli – *"Calabrese"* variety;
- ✓ Brussels sprouts – *"Erfurt"* variety.

Broccoli and Brussels sprouts are purchased from retail outlets (local market). Sample vegetables are ripe, symmetrically developed, without mechanical damage and signs of microbiological deterioration. The test is performed on the inedible parts of the sample (stem heads of broccoli, faded and discoloured outer roofing sheets of Brussels sprouts, etc.). Triplicates of each sample run for the determination of mineral content.

Digestion of samples and determination of mineral content

The mineral content was studied in an accredited laboratory of SGS – Bulgaria EOOD, Varna laboratory. The measurement performed by mass spectrometer with a source of excitation inductively coupled plasma ICP-MS Perkin Elmer Nex ION 300X. Minerals were determined by ICP after digestion in a closed microwave oven decomposition system.

The following methodology is applied: on an analytical balance, in a quartz tube weigh to the nearest 1 mg test portion of about 0.5 g (in two replicates). Each of the test portions was wetted with 1 ml of deionized water and 4 ml of HNO_3 were added. Homogenized well by vortexing. The decomposition is performed by a Ultra Wave-Milestone Microwave Decomposition System.

A control sample containing all of the reagents used in the decomposition and preparation of the test samples and developing the same pathway was developed and analyzed with the samples.

The processing of the primary data obtained is performed by external calibration. The calibration graph is drawn at the beginning of each series of analysis.

The measurements are made only in the linear part of the calibration graph. The working calibration solutions were prepared on the day of use.

Statistical analysis

All variables were reported as mean value of three replicates. The differences between the mineral contents of the samples were tested by one-way analysis of variance (ANOVA) followed by the t-test to evaluate the relationship between the variables. The analysis was performed using the software Statistica 7.0 (Statsoft Inc., Tulsa, OK, USA) and differences among means at the 5% level ($p < 0.05$) were considered statistically significant.

Results and discussion

Table 1 presents the experimentally obtained results for the content (in mg/kg) of certain macro- and micro elements in the non-edible parts of broccoli and Brussels sprouts.

Table 1

Content (in mg/kg) of certain macro- and microelements in the non-edible parts of broccoli and Brussels sprouts

Content of macro- and microelements, mg/kg, [a]	Samples	
	non-edible parts of broccoli, [b]	non-edible parts of Brussels sprouts, [b]
Fe	25.5	22.2
Ca	547	964
Cu	7.22	6.53
K	3254	3880
Mg	403	271
Mn	3.23	1.97
Mo	<0.05	<0,05
Na	244	338
Zn	9.89	4.92
P	1216	686
Se	<0.05	<0.05
Cr	<0.05	<0.05
S	1695	1187
Al	0.85	0.54
B	3.97	3.38

a – data are reported on a fresh matter basis
b – mean value, n=3

As can be seen from the results presented, in the non-edible parts of broccoli and Brussels sprouts, the highest content is potassium – respectively 3880 mg/kg for Brussels sprouts and 3254 mg/kg for broccoli. Ong investigates the content of mineral substances in edible parts of Brussels sprouts and broccoli (Ong, 2008). It is noteworthy that the results we obtained are almost identical with regard to Brussels sprouts (it establishes 3890 mg/kg). For broccoli, the result established for the edible parts is 3160 mg/kg, which is lower than our established value, but this may be due to differences in varietal composition or soil and climatic conditions of growing vegetables.

It is well known that potassium helps remove excess water from the body and actively participates in the detoxification process. On the other hand, Sattar and colleagues point out that potassium is an essential nutrient in the soil, with a decisive role in the physiological and metabolic processes of plants and provides resistance to biotic and abiotic stress (Sattar et al., 2019). The results thus obtained reveal the possibility that the wastes generated by the processing and the consumption of broccoli and Brussels sprouts can be used as a potassium fertilizer after suitable treatment.

Sulphur content is also high and the quantity measured in broccoli wastes (1695 mg/kg) is more than 1.4 times higher than that found in Brussels sprouts. According to Doleman and co-authors, cruciferous vegetables are among the most important sources of sulfur-containing amino acids and sulfur for the human body, as their consumption provides nearly 42% of the total amount of sulfur in the feed intake and is associated with a number of health benefits – reducing the risk of certain oncological diseases, cardio vascular disease, reduced risk of type-2 diabetes, protection from neurodegenerative disease (Doleman et al., 2017).

We have found that the phosphorus content in the wastes of Brussels sprouts is 686 mg/kg, the result is comparable with the data published by other authors for phosphorus content in the edible parts of the plant (Ong, 2008). The amount found in wastes from broccoli, is almost twice higher – 1216 mg/kg. A human should daily procure about 700 mg phosphorus intake. The values thus established indicate that the inedible parts of Brussels sprouts and particularly broccoli may be used as a valuable source of phosphorus and sulfur for enriching foods deficient in the above minerals.

The data on the sodium content are comparable to those obtained by Ong in the study of the edible parts of the respective vegetables – according to him, in the edible parts of broccoli there are 330 mg/kg of sodium and in Brussels sprouts – 250 mg/kg (Ong, 2008). Our study found out sodium content of 244 mg/kg of broccoli edible parts, and of Brussels sprout edible parts – 338 mg/kg, respectively.

Brussels sprouts wastes have higher calcium content (964 mg/kg), while for the broccoli the measured value is 547 mg/kg. However, it is noticeable that these results are higher than the published data on calcium content in the edible parts of both vegetables (Ong, 2008). There may be unequal distribution of calcium in the different parts of plants, or differences due to the agricultural methods applied for growing vegetables.

The magnesium content was 271 mg/kg in the waste parts of Brussels sprouts and 48.7% more in the inedible parts of broccoli – 403 mg/kg. According to other authors the quantity of magnesium in the used edible parts of Brussels sprouts is 230 mg/kg, and in broccoli – 210 mg/kg (Ong, 2008), these amounts are lower than the ones established by us.

Iron is an essential element for all living organisms. In relation to its main role in the transmission of oxygen and as a cofactor in many enzymes, iron plays an important role in maintaining the immune system in the human body. Approximately equal iron content was found in the inedible parts of broccoli (25.5 mg/kg), and Brussels sprouts (22.2 mg/kg).

The important role that zinc has for the health and the wide range of biological functions it performs is well known. In this regard, the European Food Safety Authority (EFSA) presents an official position on health claims and the importance of zinc for human health. Its main role is associated with the fact that it is a component of over 200 enzymes that are related to the synthesis of proteins and DNA (Prasad, 2014). In the study conducted by us it was found that broccoli wastes contain twice as much zinc as those of Brussels sprouts – 9.89 mg/kg and 4.92 mg/kg respectively. In other studies, an amount of 40 mg/kg was reported in the edible parts of both vegetables (Ong, 2008). There is evidence that there is zinc deficiency among the population worldwide, as about 40% is affected (Prasad, 2014). Zinc deficiency is responsible for 4.4% of the mortality in Africa, Asia and Latin America (Liberato et al., 2015). The seriousness of the problem is the basis in many countries for developing and implementing programs to increase the intake of this essential element by enriching food products (Brown et al., 2010). The values we have established show that non-edible parts of Brussels sprouts, and especially broccoli non-edible parts, may be used as a valuable source for leaching of calcium, magnesium, iron and zinc, to enrich foodstuffs with established deficiency.

Copper, like zinc, is involved in the form of complex compounds in many metalloenzymes. About 30 – 60% of the copper in food is absorbed in the gastrointestinal tract. We detected 7.22 mg/kg of copper in the broccoli waste parts and a slightly lower amount (6.53 mg/kg) in the Brussels sprouts waste parts.

The content of boron (3.97 mg/kg), manganese (3.23 mg/kg) and aluminum (0.85 mg/kg) in the non-edible parts of broccoli is higher than that in Brussels sprouts wastes. The study found that for some of the elements (molybdenum, selenium and chromium), the quantities available in Brussels sprouts and broccoli wastes are below the detectable minimum of the applied method <0.05 mg/kg, although according to the literature data, Brussels sprouts are among the best sources of molybdenum. According to Asquer et al., in broccoli wastes, the molybdenum content is 0.008 mg/kg, selenium <0.1 mg/kg and chromium 0.002 mg/kg (Asquer et al., 2013). Ong published data on the content of selenium in broccoli 2.5µg%, while in Brussels sprouts – 1.6µg% (Ong, 2008).

Compared to Brussels sprouts wastes the broccoli wastes are richer in sulfur, phosphorus, magnesium, iron, zinc, copper, boron, manganese, aluminum, while Brussels sprouts wastes are characterized by a higher content of potassium, calcium, sodium.

From the results obtained it is clear that nonedible parts of broccoli and Brussels sprouts contain valuable mineral substances in significant quantities. This could determine their further use to extract these components and incorporate them into food, soil enrichment, feed or cosmetic products.

The extraction of biologically active compounds from fruits and vegetables involves complex mechanisms and can be achieved by various methods as shown in the review paper by Soquetta et al. (Soquetta, et. al., 2018). Conventional techniques usually require large amounts of organic solvents, high energy consumption, and are time consuming, which has generated interest in new technologies that are referred to as green technologies. These can reduce or eliminate the use of toxic solvents, and thus preserve the natural environment and its resources. The replacement of conventional techniques with green technology methods is promising and expedient (Soquetta, et. al., 2018) and reveals a possibility for further research work in this area.

Conclusions

The increasing amount of wastes generated by household and industrial activities (including processing of fruit and vegetables) imposes the necessity of seeking ways to utilize them in order to reduce environmental pollution. From the study we can conclude that the broccoli and Brussels sprouts wastes are rich in valuable mineral substances. In the non-edible parts of broccoli and Brussels sprouts, the highest is the potassium content – respectively 3880 mg/kg for Brussels sprouts and 3254 mg/kg for broccoli; sulfur (1695 in broccoli wastes and 1187 mg/kg in Brussels sprouts wastes), and phosphorus – 1216 mg/kg in broccoli wastes and 686 mg/kg in Brussels sprouts wastes. This could determine their possible further use to extract these components and incorporate them into food, soil enrichment, feed or cosmetic products.

The content of calcium, magnesium, sodium, iron, copper, zinc, boron, manganese, aluminium was also found. For some of the elements (molybdenum, selenium and chromium), the available quantities in Brussels sprouts and broccoli wastes are below the detection limit of the applied method <0.05 mg/kg.

References

1. ASQUER, C., PISTIS, A., SCANO, E. A. (2013) Characterization of fruit and vegetable wastes as a single substrate for the anaerobic digestion. *Environmental Engineering and Management Journal*, “Gheorghe Asachi” Technical University of Iasi, Romania, vol.12, no. S11, Supplement, pp. 89-92; <http://omicron.ch.tuiasi.ro/EEMJ/>

2. BANERJEE, J., SINGH, R., VIJAYARAGHAVAN, R., MACFARLANE, D., PATTI, A. F., ARORA, A. (2017) Bioactives from fruit processing wastes: Green approaches to valuable chemicals. *Food Chemistry*, vol. 225, pp. 10-22; http://dx.doi.org/10.1016/j.foodchem.2016.12.093

3. BROWN, K. H., HAMBIDGE, K. M., RANUM, P., et al. (2010) Zinc fortification of cereal flours: Current recommendations and research needs. *Food and Nutrition Bulletin*, vol. 31, no. 1, pp. S62-S74; <https://doi.org/10.1177/15648265100311S106>

4. CORRADO, S., SALA, S. (2018) Food waste accounting along global and European food supply chains: State of the art and outlook. *Waste Management*, vol. 79, pp. 120-131; <https://doi.org/10.1016/j.wasman.2018.07.032>

5. CRISTÓBAL, J., CALDEIRA, C., CORRADO, S., SALA, S. (2018) Techno-economic and profitability analysis of food waste biorefineries at European level. *Bioresource Technology*, vol. 259, pp. 244-252; <https://doi.org/10.1016/j.biortech.2018.03.016>

6. DE LAURENTIIS, V., CORRADO, S., SALA, S. (2018) Quantifying household waste of fresh fruit and vegetables in the EU. *Waste Management*, vol. 77, pp. 238-251; <https://doi.org/10.1016/j.wasman.2018.04.001>

7. DI DONATO, P., FINORE, I., ANZELMO, G., LAMA, L., NICOLAUS, B., POLI, A. (2014) Biomass and biopolymer production using vegetable wastes as cheap substrates for extremophiles. *Chemical Engineering Transactions*, vol. 38, pp. 163-168; <DOI: 10.3303/CET1438028>

8. DOLEMAN, J. F., GRISAR, K., VAN LIEDEKERKE, L., SAHA, S., ROE, M., TAPP, H.S., MITHEN, R.F. (2017) The contribution of alliaceous and cruciferous vegetables to dietary sulphur intake. *Food Chemistry*, vol. 234, pp. 38-45; <http://dx.doi.org/10.1016/j.foodchem.2017.04.098>

9. GOWE, C. (2015) Review on potential use of fruit and vegetables by-products as a valuable source of natural food additives. *Food Science and Quality Management*, vol. 45, pp. 47-61; <https://www.researchgate.net/publication/28559 2477>

10. KABIR, F., TOW, W. W., HAMAUZU, Y., KATAYAMA, S., TANAKA, S., NAKAMURA, S. (2015) Antioxidant and cytoprotective activities of extracts prepared from fruit and vegetable wastes and by-products. *Food Chemistry*, vol. 167, pp. 358-362; <http://dx.doi.org/10.1016/j.foodchem.2014.06.099>

11. KANDARI, V., GUPTA, S. (2012) Bioconversion of vegetable and fruit peel wastes in viable product. *Journal of Microbiology and Biotechnology Research*, vol. 2, no. 2, pp. 308-312; <https://www.jmbronline.com/index.php/JMBR/article/view/115/115>

12. LAM, S. S., LIEW, R. K., LIM, X. Y., ANI, F. N., JUSOH, A. (2016) Fruit waste as feedstock for recovery by pyrolysis technique. *International Biodeterioration & Biodegradation*, vol. 113, pp. 325-333; <http://dx.doi.org/10.1016/j.ibiod.2016.02.021>

13. LIBERATO, S. C., SINGH, G., MULHOLLAND, K. (2015) Zinc supplementation in young children: A review of the literature focusing on diarrhoea prevention and treatment. *Clinical Nutrition*, vol. 34, no. 2, pp. 181-188; <https://doi.org/10.1016/j.clnu.2014.08.002>

14. NAWIRSKA, A., UKLAŃSKA, C. (2008) Waste products from fruit and vegetable processing as potential sources for food enrichment in dietary fibre. *Acta Sci. Pol. Technol. Aliment.*, vol. 7, no. 2, pp. 35-42; <https://www.food.actapol.net/pub/3_2_2008.pdf>

15. ONG, H. (2008) Vegetables for health and healing. *Utusan Publications*.

16. PANDA, S. K., MISHRA, S. S., KAYITESI, E., RAY, R. C. (2016) Microbial-processing of fruit and vegetable wastes for production of vital enzymes and organic acids: Biotechnology and scopes. *Environmental Research*, vol. 146, pp. 161-172; <http://dx.doi.org/10.1016/j.envres.2015.12.035>

17. PESCHEL, W., SÁNCHEZ-RABANEDA, F., DIEKMANN, W., PLESCHER, A., GARTZÍA, I., JIMÉNEZ, D., LAMUELA-RAVENTÓS, R., BUXADERAS, S., CODINA, C. (2006) An industrial approach in the search of natural antioxidants from vegetable and fruit wastes. *Food Chemistry*, vol. 97, pp. 137-150; <doi:10.1016/j.foodchem.2005.03.033>

18. PLAZZOTTA, S., MANZOCCO, L., NICOLI, M. C. (2017) Fruit and vegetable waste management and the challenge of fresh-cut salad. *Trends in Food Science & Technology*, vol. 63, pp. 51-59; <http://dx.doi.org/10.1016/j.tifs.2017.02.013>

19. PRASAD, A. S. (2014) Impact of the discovery of human zinc deficiency on health. *Journal of Trace Elements in Medicine and Biology*, vol. 28, no. 4, pp. 357-363; <https://doi.org/10.1016/j.jtemb.2014.09.002>

20. PROHENS, J., NUEZ, F. (2008) Vegetables I: Asteraceae, Brassicaceae, Chenopodicaceae and Cucurbitaceae. *Springer-Verlag New York*, pp. 152-154.

21. QURESHI, A. S., KHUSHK, I., NAQVI, S. R., SIMIAR, A. A., ALI, C. H., NAQVI, M., DANISH, M., AHMED, A., MAJEED, H., JATT, A. N. M., REHAN, M., NIZAMI, A.-S. (2017) Fruit waste to energy through open fermentation. *9th International Conference on Applied Energy, ICAE2017, 21-24 August 2017, Cardiff, UK, Energy Procedia*, vol. 142, pp. 904-909; <10.1016/j.egypro.2017.12.145>

22. SAGAR, N. A., PAREEK, S., SHARMA, S., YAHIA, E. M., LOBO, M. G. (2018) Fruit and vegetable waste: bioactive compounds, their extraction, and possible utilization. *Comprehensive Reviews in Food Science and Food Safety*, Vol.17, 512-531; <doi: 10.1111/1541-4337.12330>

23. SATTAR, A., NAVEED, M., ALI, M., ZAHIR, Z. A., NADEEM, S. M., YASEEN, M., MEENA, V.S., FAROOQ, M., SINGH, R., RAHMAN, M., MEENA, H.N. (2019) Perspectives of potassium solubilizing microbes in sustainable food production system: A review. *Applied Soil Ecology*, vol. 133, pp. 146-159; <https://doi.org/10.1016/j.apsoil.2018.09.012>

24. SAVATOVIĆ, S.M., ĆETKOVIĆ, G. S., ČANADANOVIĆ-BRUNET, J. M., DJILAS, S. M. (2010) Utilisation of tomato waste as a source of polyphenolic antioxidants. *Acta Periodica Technologica*, vol. 40, pp. 187-194; <DOI: 10.2298 /APT1041187S>; <http://www.tf.uns.ac.rs/dokumenta/Zajednicka/Acta-Periodica-Technologica-41.pdf>

25. SINGH, S., IMMANUEL, G. (2014) Extraction of antioxidants from fruit peels and its utilization in paneer. *Journal of Food Processing & Technology*, vol. 5, no. 7, 349; <http://dx.doi.org/10.4172/2157-7110.1000349>

26. SOQUETTA, M. B., SANTI STEFANELLO, F., DA MOTA HUERTA K., SAUTHIER MONTEIRO, S., SEVERO DA ROSA, C., NASCIMENTO TERRA, N. (2016) Characterization of physiochemical and microbiological properties, and bioactive compounds, of flour made from the skin and bagasse of kiwi fruit (*Actinidia deliciosa*). *Food Chemistry*, vol. 199, pp. 471-478; http://dx.doi.org/10.1016/ j.foodchem.2015.12.022

27. SOQUETTA, M. B., DE MARSILLAC TERRA, L., PEIXOTO BASTOS, C. (2018) Green technologies for the extraction of bioactive compounds in fruits and vegetables. *CyTA – Journal of Food*, 16:1, 400-412; <https://doi.org/10.1080/19476 337.2017.1411978>

28. SZYMAŃSKA-CHARGOT, M., CHYLIŃSKA, M., GDULA, K., KOZIOŁ, A., ZDUNEK, A. (2017) Isolation and characterization of cellulose from different fruit and vegetable pomaces. *Polymers*, vol. 9, 495; <doi:10.3390/polym9100495>

29. WIJNGAARD, H. H., RÖßLE, C., BRUNTON, N. (2009) A survey of Irish fruit and vegetable waste and by-products as a source of polyphenolic antioxidants. *Food Chemistry*, vol. 116, pp. 202-207; <doi:10.1016/j.foodchem.2009.02.033>

30. WIJNGAARD, H. H., BALLAY, M., BRUNTON, N. (2012) The optimisation of extraction of antioxidants from potato peel by pressurised liquids. *Food Chemistry*, vol. 133, pp. 1123-1130; <doi:10.1016/j.foodchem.2011.01.136>

31. WU, F., JIN, Y., XU, X., YANG, N. (2017) Electrofluidic pretreatment for enhancing essential oil extraction from citrus fruit peel waste. *Journal of Cleaner Production*, vol. 159, pp. 85-94; http://dx.doi.org/10.1016/j.jclepro.2017.05.010