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A Review on Extraction of Bio Active Compounds from Industrial Tomato Pomace

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Abstract: ***Tomato is most popular fruit in the market due to easy availability and endless health benefits. Food processing industries use tomato for production of tomato jam, puree, sauce, chutney and other products in which tomato peels and seed waste is generated. From recent reviews it is observed that many nutritious and health beneficial properties were found in food waste. This review is focusing on identify the bioactive compounds present in the industrial tomato waste and their industrial application. This finding helps in identification and extraction of valuable bio active compound such as carotenoids and phenolic compounds by green methods such as ohmic heating, super critical co2 extraction. Extracted compound than analyzed by High Performance Liquid Chromatography (HPLC) method, Tomato seed edible oil by Gas Chromatography Mass Spectroscopy method, Drying tomato by Hot air drying and spray drying and freeze drying for further industrial use. Thus this review strongly recommends that Tomato pomace is natural source of value added bio active compounds and its nutritional properties such as high carotenoids, dietary fibers, lipids, protein, amino acid and carbohydrates, it also having health benefits due to anti-microbial, anti-aging and antioxidant properties, which can be extracted from industrial food waste which contributes to reduce environmental burden of waste pomace management and disposal.***

Keywords: Bio active compound, carotenoids, extraction, tomato pomace

1. Introduction

Tomatoes (*Solanum Lycopersium* L.) are most consumed vegetables worldwide due to its nutritional properties and health benefits. Tomato plant is member of the Solanaceae family, which also includes economically valuable plants such as potato, eggplant and pepper which represents one of the most valuable plant family worldwide used vegetable and fruit crops [1]. Tomato is native species of South America and used widely as ornamental plants in Europe. It was earlier considered as very poisonous plant but afterwards it is commercially considered as a useful vegetable. World's largest tomato producing country is China with 36% production while India stands second largest producers with 11% production. (FAO 2021) Gujarat is sixth largest state for manufacturing of tomato at 6.87% of total production share of India. (National Horticulture Board (NHB) 2021-22). There are more than 15000 tomato varieties found in the world among which more than 1000 varieties are cultivated in India. Food processing industries mainly use hybrid tomatoes for their long lifecycles. Indian food processing industries mainly use commercially available species such as Abhinav, Rashmi, Vaishali, Rupali, Ark Rakshak etc. variety for manufacturing tomato base products due to high yielding capacity [2].

1.1 Industrial Food Waste: Food waste is defined as food which was left over and edible but before consumption that is destroyed. Food waste is not only waste of valuable food resources but also it is waste of many important resources such as water, electricity, energy, manpower used for food processing [3]. There are many sources of generation of food waste such as kitchen waste, domestic waste, restaurant waste, institutional canteen waste and industrial food waste. Major process of food industries are plant or fruit crops harvesting, raw material receiving, food processes which includes washing, grinding, cutting, pulping/puree making, sterilization or autoclaving, packaging and storage. Food processing industries mainly use tomatoes to make products like tomato sauce, puree, juice, chutney, dry soup powders and other ready to eat tomato-based by-products which generally creates tomato-based food waste [4]. Waste generated through processing industries, canning food industries and local restaurant chains are having significant impact on environment. Major drawbacks of food processing industry are food waste generation. Hence sustainable management is necessity to utilize and extract by products before waste disposal step. These bio active compounds can be used as raw materials in many industries to compete the global food demand which is increasing due to increasing population. Thus, we can reuse and recycle the bio mass from waste food to make value added products which are cost effective [5]. Bio active compounds such as vitamins, carotenoids, flavonoids, phenolic compounds are major valuable nutrient that presents in tomatoes which are having many health benefits due to anti microbiological and antioxidant properties. [6] [7]. Tomato seed oil can be extracted from waste tomato seeds which are edible food oil [8].

2. Scope and Need of Study

Recent research on meta-analysis of food demand shows that with increasing global population at 10% by 2050, food demand is also increasing with it. If food resources are not capable to meet food demand of global population, high risk of population hunger will affect the globe [9]. The main goal of United Nations Sustainable Development Goal 12.3 is to reduce per capita Food Waste together with its management costs, in addition to maximize the value of leftover undestroyed Food Waste and packaging materials by 2030 [10]. To treat and reuse/recycle industrial food waste in ecofriendly way is major concern for any food industry. India is a major cultivator of tomatoes but there is lack of research in terms of local tomato species of Gujarat, particularly in terms of industrial food waste. So, there is a requirement to identify bio-active compound present in local tomato species and research to be carried out for proper extraction method from waste which can enhance by-product development and increase raw food material generation at national level and global level. A huge amount of tomato pomace (waste tomato peels & seed) is produced from industrial processing; most of the tomato waste that remained as unutilized. This cannot generate only more waste of incredible resources but also pressures the environment for its disposal and other management technologies.

3. Bio Active Compounds

Many bio active compounds derived from food waste can act as value added cost effective material for food processing industry [11]. Carotenoids, flavonoids, seed oils are one of major bio active compounds present in high amount in the processing pomace. Antioxidant properties of lycopene can be beneficial for treatment of chronic disease such as COVID-19 [12]. Hence tomato waste has many neutraceutical and pharmaceutical properties which enhance raw material derivation from the waste tomato pomace.

3.1 Carotenoids

Carotenoids are widely present kind of pigments which can also applicable as natural food coloring agent in many food supply chains [13]. Mainly carotenoids such as lycopene, pectin, α-carotene, β-carotene, γ-carotene, δ-carotene, lutein, phytoene, phytofluene are present in tomato fruit. They are fat soluble pigments structured in 9-11 double bond polygene chain (Figure-1).

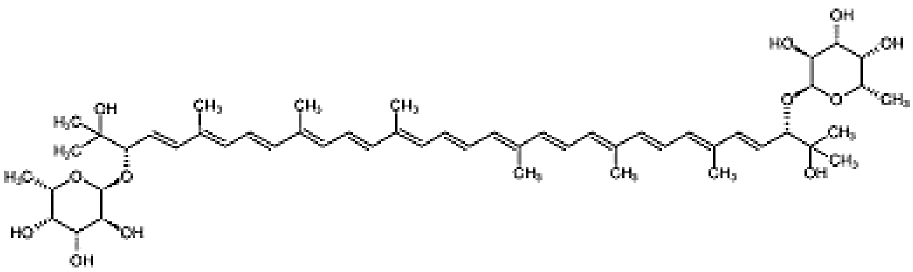

Figure 1: Structure of Carotenoids

3.1.1 β-carotene

β-Carotene is second most found carotenoids recovered from food industries. β-carotene pigments are mostly presents in carrots, tomatoes, spinach, orange, apricots and kale. They are mostly presentin tomato seeds and peels rather than fruit pulp [14] (Figure-2).

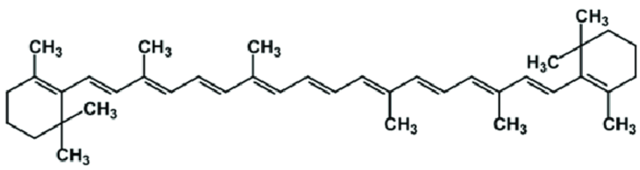

Figure 2: Structure of β-Carotene

3.1.2 Lycopene

Lycopene is most observed carotenoids found from tomato waste, these pigments are responsible for red colour in tomato. They are unsaturated compounds with $C_{40}H_{56}$ structure. Lycopene is used as red coloring agent in processed food industry since 1997; it comes under E160d colorant as per classification [15]. Lycopene determined by food processing industries can utilized as natural additives due to its antioxidant and anti-microbial properties [16]. For the processed tomatoes it was studied that tomato peels carries more lycopene than pulp [17] (Figure-3).

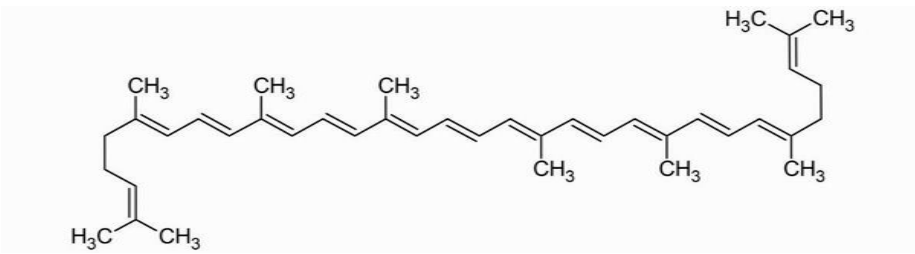

Figure 3: Structure of Lycopene

3.2 Protein

Industrial waste of tomato having high amount of protein content which can be utilized in manufacturing of high protein by products such as pasta from tomato and pepper waste [18]. They are 3D arrangement of amino acids molecule into chain which generally known as proteins. Tomato pomace carries high amount of protein than tomato seeds [19]. Due to protein rich resource tomato waste further utilized in bread quality with pepper seed waste [20] (Figure-4).

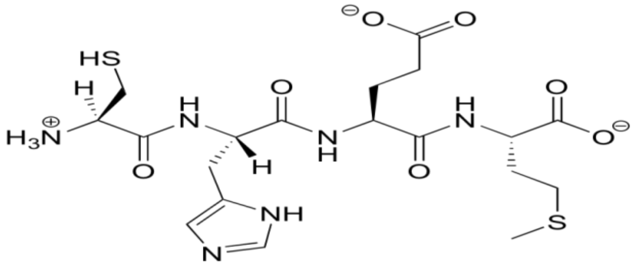

Figure 4: Structure of Protein

3.3 LIPIDS

Lipid content in tomato seeds is higher and lipids present in peels lower [21]. Fatty acids are rich in pomace. Unsaturated fatty acids that are more in observation whereas saturated fatty acids which can be detected in very lower amount. Common fatty acids such as palmitic acid, oleic acid and linoleic acids are discovered in tomato waste [22] (Figure-5).

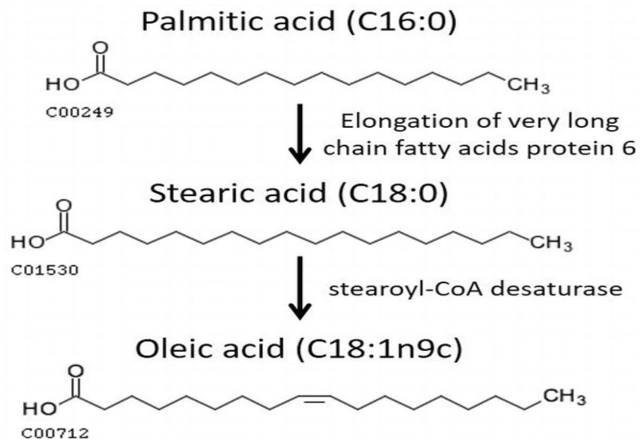

Figure 5: Structure of Lipids

3.4 Dietary Fibers

Major dietary fibers found in processed waste are polymers of ten or more than that carbohydrates like oligosaccharides, polysaccharides, lignin which are rebellious to digestive enzymes [23]. These dietary fibers absorbs glucose while enhancing cholesterol reduction which can lowers the cardiovascular disorders risk, obesity and colon cancer [24]. Plant based fibers like some soluble and few of insoluble dietary fibers such as pectin, β-glucan, cellulose, lignin and hemicellulose extracted by ultrasound assisted extraction or microwave assisted extraction metho [25] (Figure-6).

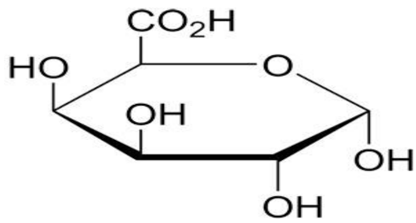

Figure 6: Structure of Fibers

3.5 Carbohydrates

Tomato pomace are the richest source of carbohydrates which can be recovered. From industrial waste these carbohydrates are further processed and converted into biocomposits and biopolymers. [26] (Figure-7).

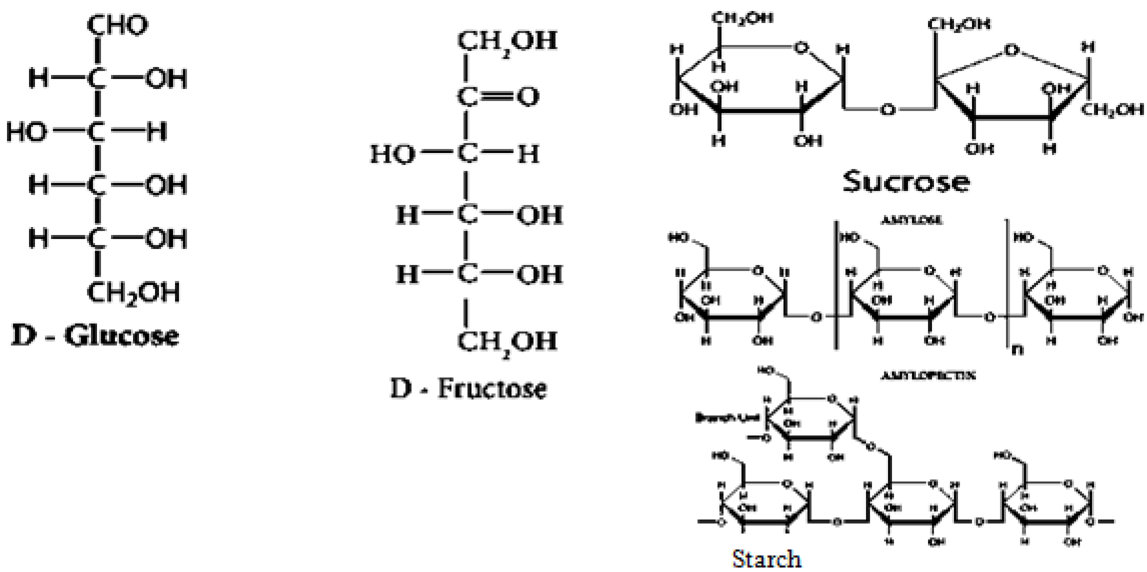

Figure 7: Structure of Carbohydrates

4. Steps for Bio Active Compounds Recovery

To extract different type of bio active compounds from food waste are always a challenge in terms of environmental waste management. Bio active compounds recovered by four essential steps (1) Pre-treatment, (2) Extraction, (3) Purification and (4) Preservation by drying.

4.1 Step-1: Pretreatments

Tomato waste collected from the processing industry must be dried at 60ºC in hot air dryer before use. Slurry type collected waste start to deteriorate if not properly air dried and stored in air tight bags. After air drying the bags are stored in deep freeze at-20ºC to preserve pomace in its original state. Traditional solvent extraction methods use solvents like chloroform, methyl chloride, benzene which are toxic in nature. Thus, development of ecofriendly method for extraction is highly demanded in food processing sector. Tomato pomace is perishable in nature as it is extremely moisturized waste. Soli-liquid extraction is widely used to recover dietary fibers and carotenoids without disturbing original properties of pomace. Ohmic heating prior to extraction can recover lycopene, fatty acids, phenolic compounds and proteins. It is environmental friendly method which uses low energy and high temperature without losing colour, flavor and nutrient content of tomato waste [27].

4.2 Step-2: Extraction

Tomato food waste mainly consists of carotenoids, fibers, protein, lipids and flavonoids in significant amount. Carotenoids such as lycopene, pectinβ-carotene is majorly present. Extraction of lycopene is possible by using Solvent Extraction method using different type of solvents such as acetone, ethanol, methanol, and hexane in particular ratio. Recently lycopene recovery is possible with solvent extraction method with pretreatments. Pretreatment based on enzyme assisted [28], ultrasound assisted [29] or microwave assisted [30] are useful for lycopene recovery.

Super critical fluid extraction is also one of the common methods for carotenoids and polyphenols recovery. Instead of toxic solvents it uses solvent free extraction by high temperature. Due to this it is nonflammable and nontoxic recovery method. Apart from this degradation of carotenoids also occurs by sub critical carbon dioxide [31].

Fatty Acid composition of seed oil was identified by using Gas Chromatography-mass spectroscopy which resulted in high content of linoleic acid, stearic acid and palmitoleic acid, arachidic acid, meristic acid and margaric acid. Approximately 13.3 to 19.3% range of oil content was identified from the tomato waste seeds by following Karl Fischer titration method which also helps in determination of the water content with chemical reactions [32]

CPE -known as cold press extraction method and enzyme assisted extraction method (EAEM) to determine oil content from the seed waste from which around 12.80% and 9.66% seed oil was recovered respectively [33].

4.3 Step-3: Purification

After extraction process any impurities can found in the extracted waste. Hence elimination of major impurities and obtain a stable final compound is main requirement by food sector. Once extraction process is over purification process achieved by isolating such bio active compounds in the its précised form rather than a complex mixture. To achieve this some techniques such as high pressure liquid chromatography, gas chromatography-mass spectroscopy, membrane filtration process and final step is crystallization techniques are used.

4.4 Step-4: Preservation by Drying

Drying of purified bio active compound reduce the chance of further reactive process such as oxidation. Mainly freeze drying, rotary vacuum drying, spray drying and sprinkling techniques are used.

5. Conclusions

Increase in Food demand has increased food processing industrial growth at global level. Tomato processing industries mostly produce jams, juice, puree, powder, chutney, sauces and soup from the raw tomatoes. From the above review it was investigated that by preferring green technologies for extraction of bio active compound can produce less environmental burden for its disposal treatment. Rather than following conventional solvent extraction method, ecofriendly methods such as ohmic heating, supercritical fluid extraction etc can be used. As tomato peels and seeds have many neutracutical values many bio active compounds present in the waste pomace which mainly carries carbohydrates, protein, lipds, dietary fibers, fatty acids and carotenoids. This review concludes that tomato waste is enriched with above mentioned nutrients and many health benefits to society due to its anti-microbial, anticancer, antioxidant properties. Extracted carotenoids, dietary fibers are used as raw material for other industries like cattle feed manufacturers, lycopene as food coloring agent and pharmaceutical, pesticide and cosmetics manufacturing processes which are also cost effective solution to any industry. Hence, bioactive compound derived from tomato waste can be reutilized and reduce the adverse effect in environment rather than landfill mode of disposal. Bio active compound are natural and value-added solution to food processing sectors which enhance by product production and sales.

References

[1] Quinet, M., Angosto, T., Yuste-Lisbona, F. J., Blanchard-Gros, R., Bigot, S., Martinez, J. P., & Lutts, S. (2019). Tomato fruit development and metabolism. Frontiers in plant science, 10, 1554. https://www.frontiersin.org/articles/10.3389/fpls.2019.01554/full

[2] Chikkeri, S. C., Kumar, S., Samnotra, R. K., Loona, D., &Noopur, K. (2023). Evaluation of tomato (Solanum lycopersicum L.) genotypes for growth, yield attributes and yield under subtropical region of Jammu. The Pharma Innovation J, 12(6), 3036-3038. https://www.thepharmajournal.com/archives/2023/vol12issue6/PartAI/12-6-417-375.pdf

[3] Tsang, Y. F., Kumar, V., Samadar, P., Yang, Y., Lee, J., Ok, Y. S. & Jeon, Y. J. (2019). Production of bioplastic through food waste valorization. Environment international, 127, 625-644. https://doi.org/10.1016/j.envint.2019.03.076

[4] Coelho, M. C., Rodrigues, A. S., Teixeira, J. A., & Pintado, M. E. (2023). Integral valorisation of tomato by-products towards bioactive compounds recovery: Human health benefits. Food Chemistry, 410, 135319. https://doi.org/10.1016/j.foodchem.2022.135319

[5] Oliveira, T. C., Caleja, C., Oliveira, M. B. P., Pereira, E., & Barros, L. (2023). Reuse of fruits and vegetables biowaste for sustainable development of natural ingredients. Food Bioscience, 102711 https://doi.org/10.1016/j.fbio.2023.102711

[6] Shah, K. K., Modi, B., Lamsal, B., Shrestha, J., & Aryal, S. P. (2021). Bioactive compounds in tomato and their roles in disease prevention. Fundamental and AppliedAgriculture, 6(2), 210-224. https://doi.org/10.5455/faa.136276

[7] Robles-Ramírez, M. D. C., Monterrubio-López, R., Mora-Escobedo, R., & Beltrán-Orozco, M. D. C. (2016). Evaluation of extracts from potato and tomato wastes as natural antioxidant additives. Archivos latinoamericanos de nutrición, 66, 066-073. https://foodresearch.tabrizu.ac.ir/article_15957.html?lang=en

[8] Shaho, D., Venkitasamy, C., Li, X., Pan, Z., Shi, J., Wang, B. & McHugh, T. H. (2015). Thermal and storage characteristics of tomato seed oil. LWT-Food Science and Technology, 63(1), 191-197. https://www.sciencedirect.com/science/article/abs/pii/S0023643815001504

[9] Van Dijk, Michiel, et al. "A meta-analysis of projected global food demand and population at risk of hunger for the period 2010–2050." Nature Food 2.7 (2021): 494-501. https://www.nature.com/articles/s43016-021-00322-9

[10] Scherhaufer, S., Moates, G., Hartikainen, H., Waldron, K., &Obersteiner, G. (2018). Environmental impacts of food waste in Europe. Waste management, 77, 98-113.Pandya, D., Akbari, S., Bhatt, H., Joshi, D. C., & Darji, V. (2017). Standardization of solvent extraction process for Lycopene extraction from tomato pomace. J. Appl. Biotechnol. Bioeng, 2(1), 12-16. https://www.sciencedirect.com/science/article/abs/pii/S0956053X18302617

[11] Coelho, M. C., Pereira, R. N., Rodrigues, A. S., Teixeira, J. A., & Pintado, M. E. (2020). The use of emergent technologies to extract added value compounds from grape by-products. Trends in Food Science & Technology, 106, 182-197. https://www.sciencedirect.com/science/article/abs/pii/S092422442030618X

[12] Khongthaw, B., Dulta, K., Chauhan, P. K., Kumar, V., &Ighalo, J. O. (2022). Lycopene: a therapeutic strategy against coronavirus disease 19 (COVID-19). Inflammopharmacology, 30(6), 1955-1976. https://link.springer.com/article/10.1007/s10787-022-01061-4

[13] Nabi, B. G., Mukhtar, K., Ahmed, W., Manzoor, M. F., Ranjha, M. .M. A. N., Kieliszek, M., ... & Aadil, R. M. (2023). Natural pigments: Anthocyanins, carotenoids, chlorophylls, and betalains as food colorants in food products. Food Bioscience, 102403. https://doi.org/10.1016/j.fbio.2023.102403

[14] Kalogeropoulos, N., Chiou, A., Pyriochou, V., Peristeraki, A., &Karathanos, V. T. (2012). Bioactive phytochemicals in industrial tomatoes and their processing byproducts. LWT-Food Science and Technology, 49(2), 213-216 https://doi.org/10.1016/j.lwt.2011.12.036

[15] Faustino, M., Veiga, M., Sousa, P., Costa, E. M., Silva, S., & Pintado, M. (2019). Agro-food byproducts as a new source of natural food additives. Molecules, 24(6), 1056. https://doi.org/10.3390/molecules24061056

[16] Szabo, K., Diaconeasa, Z., Cătoi, A. F., &Vodnar, D. C. (2019). Screening of ten tomato varieties processing waste for bioactive components and their related antioxidant and antimicrobial activities. Antioxidants, 8(8), 292. https://doi.org/10.3390/antiox8080292

[17] Nour, V., Panaite, T. D., Ropota, M., Turcu, R., Trandafir, I., & Corbu, A. R. (2018). Nutritional and bioactive compounds in dried tomato processing waste. CyTA-Journal of Food, 16(1), 222-229. https://www.tandfonline.com/doi/full/10.1080/19476337.2017.1383514

[18] Teterycz, D., & Sobota, A. (2023). Use of High Protein and High Dietary Fibre Vegetable Processing Waste for Pasta Fortification. https://doi.org/10.3390/foods12132567

[19] Szabo, K., Cătoi, A. F., &Vodnar, D. C. (2018). Bioactive compounds extracted from tomato processing by-products as a source of valuable nutrients. Plant foods for human nutrition, 73, 268-277 https://link.springer.com/article/10.1007/s11130-018-0691-0

[20] Wirkijowska, A., Zarzycki, P., Teterycz, D., Nawrocka, A., Blicharz-Kania, A., &Łysakowska, P. (2023). The Influence of Tomato and Pepper Processing Waste on Bread Quality. Applied Sciences, 13(16), 9312. https://doi.org/10.3390/app13169312

[21] Rossini, G., Toscano, G., Duca, D., Corinaldesi, F., Pedretti, E. F., & Riva, G. (2013). Analysis of the characteristics of the tomato manufacturing residues finalized to the energy recovery. Biomass and Bioenergy, 51, 177-182. https://www.sciencedirect.com/science/article/abs/pii/S0961953413000330

[22] Namir, M., Siliha, H., &Ramadan, M. F. (2015). Fiber pectin from tomato pomace: characteristics, functional properties and application in low-fat beef burger. Journal of food measurement and Characterization, 9, 305-312. https://link.springer.com/article/10.1007/s11694-015-9236-5

[23] Coelho, M. C., Ribeiro, T. B., Oliveira, C., Batista, P., Castro, P., Monforte, A. R., ... & Pintado, M. (2021). In vitro gastrointestinal digestion impact on the bioaccessibility and antioxidant capacity of bioactive compounds from tomato flours obtained after conventional and ohmic heating extraction. Foods, 10(3), 554. https://doi.org/10.3390/foods10030554

[24] Ribeiro, T. B., Campos, D., Oliveira, A., Nunes, J., Vicente, A. A., & Pintado, M. (2021). Study of olive pomace antioxidant dietary fibre powder throughout gastrointestinal tract as multisource of phenolics, fatty acids and dietary fibre. Food Research International, 142, 110032. https://www.sciencedirect.com/science/article/abs/pii/S0963996920310577

[25] Buljeta, I., Šubarić, D., Babić, J., Pichler, A., Šimunović, J., &Kopjar, M. (2023). Extraction of Dietary Fibers from Plant-Based Industry Waste: A Comprehensive Review. Applied Sciences, 13(16), 9309. https://doi.org/10.3390/app13169309

[26] Panja, A., Paul, S., Jha, P., Ghosh, S., &Prasad, R. (2023). Waste and their polysaccharides: Are they worth bioprocessing?. Bioresource Technology Reports, 101594. https://www.sciencedirect.com/science/article/abs/pii/S2589014X23002657

[27] Coelho, M. C., Ghalamara, S., Campos, D., Ribeiro, T. B., Pereira, R., Rodrigues, A. S., ... & Pintado, M. (2023). Tomato processing by-products valorisation through ohmic heating approach. Foods, 12(4), 818. https://doi.org/10.3390/foods12040818

[28] Zuorro, A.; Fidaleo, M.; Lavecchia, R. Enzyme-assisted extraction of lycopene from tomato processing waste. Enzym. Microb. Technol. 2011, 49, 567–573 https://www.sciencedirect.com/science/article/abs/pii/S0141022911000913

[29] Kumcuoglu, S., Yilmaz, T., &Tavman, S. (2014). Ultrasound assisted extraction of lycopene from tomato processing wastes. Journal of food science and technology, 51, 4102-4107. https://link.springer.com/article/10.1007/s13197-013-0926-x

[30] Ho, K. K., Ferruzzi, M. G., Liceaga, A. M., & San Martín-González, M. F. (2015). Microwave-assisted extraction of lycopene in tomato peels: Effect of extraction conditions on all-trans and cis-isomer yields. LWT-Food Science and Technology, 62(1), 160-168 https://doi.org/10.1016/j.lwt.2014.12.061 .

[31] Arab, M., Bahramian, B., Schindeler, A., Valtchev, P., Dehghani, F., & McConchie, R. (2019). Extraction of phytochemicals from tomato leaf waste using subcritical carbon dioxide. Innovative Food Science & Emerging Technologies, 57, 102204. https://www.sciencedirect.com/science/article/abs/pii/S1466856419305673

[32] Botineştean, C., Gruia, A. T., & Jianu, I. (2015). Utilization of seeds from tomato processing wastes as raw material for oil production. Journal of Material Cycles and Waste Management, 17, 118-124. https://link.springer.com/article/10.1007/s10163-014-0231-4

[33] Ozyurt, V. H., Çakaloğlu, B., &Otles, S. (2021). Optimization of cold press and enzymatic-assisted aqueous oil extraction from tomato seed by response surface methodology: Effect on quality characteristics. Journal of Food Processing and Preservation, 45(5), e15471. https://doi.org/10.1111/jfpp.15471

[34] De Menna, F., Dietershagen, J., Loubiere, M., &Vittuari, M. (2018). Life cycle costing of food waste: A review of methodological approaches. Waste Management, 73, 1-13. https://www.sciencedirect.com/science/article/pii/S0956053X17309984

[35] Urbonavičienė, D., Bobinaitė, R., Trumbeckaitė, S., Raudonė, L., Janulis, V., Bobinas, Č., &Viškelis, P. (2018). Agro-industrial tomato by-products and extraction of functional food ingredients. Zemdirbyste-Agriculture, 105(1).

[36] http://www.zemdirbyste-agriculture.lt/wpcontent/uploads/2018/02/105_1_str9.pdf