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Fruit wastes extract: a rich source of bioactive chemicals.

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ABSTRACT

Fruit trees are grown all over the world for their revitalizing juice and health benefits. Therapeutic application of bioactive chemicals extracted and purified from fruits' fresh tissues, residual parts and wastes have been reported as anticancer, antimicrobial, antiviral, anti-inflammatory apart from nutritional benefits. These phytochemicals having antioxidant potential are utilized in various industries. Utility of these extracts in various industries like food processing, cosmetics and pharmaceutical is due to high amounts of bioactive compounds such as polyphenols, flavonoids, carotenoids, vitamins, essential oils and minerals. Peels and seeds of various fruits are considered as waste product and constituent major portion of municipal solid wastes. Recently, with advance in extraction techniques and instrumentation facilities, proper treatment of these solid wastes is being utilized for extraction of useful phytochemicals. The present paper highlights the research on usage of fruits wastes in extraction of bioactive components which can be utilized as therapeutic agents, food and cosmetics products.

Keywords: Fruit wastes, phytochemicals, antioxidant, antimicrobial, toxicology

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INTRODUCTION

The fleshy seed-associated part of any plant having sweet or sour taste, and either edible in the raw or ripen state are generally considered as fruits [1]. Many types of cereal grain [corn, rice, wheat, etc] are another kind of fruit, called caryopsis. Here, the whole seed itself is edible since the fruit wall is very thin and is fused to the seed coat [2]. Fruit has been documented as a good source of nutrients, vitamins and minerals [e.g potassium] and folic acid. Fruits are considered as treasure house of important bioactive compounds which have many health benefits. Majority of bioactive phytochemicals of fruits are secondary metabolites including polyphenols, having a wide range of applications. Regular fruits intake helps in overall health improvement by aiding in efficient digestion, maintenance of blood pressure, and may decrease risk for stroke, cardiovascular disorders, type-2 diabetes and cancer [3]. There are five types of fruits belonging to viz., drupe, berry, pepo, hesperidium and pome (Figure 1).

Figure 1. Common fruits utilized at fruit juice centres.

Pericarp composition determines the fruits types. Generally, pericarp consists of three layers having hard, succulent and stony in nature. The pericarp of fruits contained a rich source of phytochemicals. The fruit skin bears oil glands, pigments, cellulosic material, essential oils, paraffin, waxes, steroids, triterpenoids, fatty acids, pigments, carotenoids, chlorophylls, flavanoids and enzymes [4].

Fruits residual/wastes products

Fruit residual and wastes are regarded as one of the major sources of municipal solid waste. In recent past, with improved lifestyle due to rise in economy in many countries across the world, different varieties of fruits are grown in many countries and there is rapid increase in consumptions. With high intake by people and industrial utilization, fruit wastes are generated in large quantities in town and cities. Fruit wastes and residues consist of fruit skin/peels, sugarcane bagasse, residual part and seeds. Presently, due to high consumption rate, fruit wastes production is increasing rapidly and termed as one of the main sources of municipal solid wastes. Landfilling, composting and incineration are the common processes of municipal solid waste disposal, but due to lacunae in the process [inappropriate management and generation of harmful gases like methane and carbon dioxide] alternative way out is the need of the hour [5, 6]. The best and profitable approach is the bioactive phytochemicals mining from these wastes through green technology. These bioactive compounds have immense requirement in various sectors, like cosmetics, pharmaceuticals and food industries.

Fruits bioactive chemicals

The isolated phytochemicals from fruit wastes are mainly rich in antioxidant compounds apart from dietary fibre, minerals, etc [7]. Plant derived antioxidants have gained significant interest in recent years for their function in inhibiting reactive oxygen species [ROS] and microbial growth and preventing auto oxidation of fats, oils in food products.

Dietary Fibre:

It is accepted as indigestible material in foods made up of non-starchpolysaccharides, mainly cellulose, hemi-cellulose, lignins, gums and mucins. In human dietary fibre help in prevent of few diseases such as atherosclerosis, diabetes and cancer [8]. Presence of dietary fibres in fruit depends on fruit types. The common biological activities includes facilitate proper nutrient absorption, water holding capacity and holding toxins and bile acids. Fruits rich in fibre include apple, pear, banana, cherry, pomegranate, strawberry and peach.

Polyphenol compounds and antioxidant property

Plants produce a diverse type of secondary metabolites. Majority of edible fruits contain flavonoid and polyphenols compounds besides beta-carotene, ascorbic acid and vitamin E. On analysis of fruits wastes for the present of the phytochemical content, it revealed that the total polyphenol and flavonoid contents are higher in the fruit wastes from mango seeds and peels. Reported literatures have shown that the bioactive phytochemicals content is much higher in peel and seeds as compared to the edible part of fruit of mangoes, lemons, oranges, and grapes [9-12]. Citrus fruit contains ascorbic acid which imparts good health to people [13, 14]. Apart from antioxidant rich compounds, essential oils are unique to citrus fruit. Antioxidant contents of fruits could be subjective to important factors, like solvent used, extraction methods, and test system.

Reactive Oxygen Species [ROS] like singlet molecular oxygen [O_2^-], superoxide, [O_2], hydroxyl [$OH^\cdot$] and peroxide [O-O-H] radicals are causative agent for tissue damage by reactive with important biomolecules [DNA, protein/enzymes and lipid]. These chemical species are mostly oxidant and are generated during respiration process. External sources of free radical species are environmental toxic pollutants [chemical, physical and biological]. However, our body system has protective mechanisms against these oxygen radicals. When our body system could not able to sustain fully, intake of dietary supplements help in maintaining detoxifying excess reactive species. Phytochemicals present in fruits helps in eradication of oxidants. Phytochemicals having antioxidant properties are vitamin C, vitamin E, and beta-carotene. Among fruits, apple contains many important bioactive phytochemicals having antioxidant property are polyphenols, carotenoids, and vitamins. Polyphenols compounds exhibit diverse groups and include antioxidant and antimicrobial activities. Flavonoid is another group of chemical compound having polyphenol nature. The citrus fruit peels contained a rich source of flavanones and flavones. Flavonoids if consumed regularly may reduce the coronary heart disease in elderly men. Grape skin contains catechin, picatechin, epicatechin gallate and epigallocatechin [15, 16].

Antimicrobials

Burt had reported detail study on antimicrobial activities of naturally occurring phenolic components from plant [17]. Many reports are available which demonstrated recent research usefulness of fruit peels and seeds in antimicrobial therapy. Among many fruits reported, seeds and peels of grape, pomegranate and mango have potentially good antimicrobial property [18]. In papaya a phytochemical called sulphydroxyl protease is present which can inhibit viralsor microbial infection [19]. Antimicrobial activity towards pathogenic bacteria and fungus by citrus juices is reported by many authors [20, 21]. The bioactive phytochemical of the citrus contains alkaloids, flavonoids, terpenoids, steroids, cardiac glycosides, saponins, and reducing sugars [22-24]. These phytochemcials which have mostly antioxidant property help in inhibiting microbial growth. Apple ranked fourth most important fruit crop worldwide. The phytochemicals of apple peels phenols and flavonoids impart significance antimicrobial property compared to its fresh tissue [25]. Similarly, banana peels is most useful by-product from food industries. It is highly rich in antioxidant capacities and has good antimicrobial activity [26]. Fruit peel wastes of five common fruits [pineapple, jackfruit, papaya, custard apple, jackfruit and pomegranate] were extracted in different solvents systems and were evaluated for antimicrobial activity. Acetone extract of fruit peels exhibited significant result against pathogenic isolates [27].

Usage of Bioactive phyto-conpounds of fruit peels/seeds

In the previous sections, the phytochemicals contents and their roles in safe guarding human health is mentioned. Looking into the importance of these chemicals having least environmental hazards, mining of large amount of these chemicals are the outmost needs. Current extraction procedures are being utilized to

extract these chemicals in their native form so that they can be directly used by different industries. Several phenols and flavonoids are currently used in cosmetic, pharmaceutical and food processing industries [28-32]. Fruit pigments, Anthocyanins are mostly used in food and beverage industry aminly as coloring agent. These chemicals are also employed as food preservatives. Being antimicrobial, antiradical and anticancerous agents, these compounds are suitable for application in pharmaceutical industry for development of therapeutic drugs and food supplements. Ferulic acid demonstrates large scale application in pharmaceutical industries as antiallergic, hepatoprptective, anticarcinogenic, anti-inflammatory and antimicrobial and antiviral agent. Ferulic acid also acts as a vasodilator and as antithrombotic agents [33]. Antioxidant rich phytochemicals also exhibits photoprotective property and used in preparation of sunscreen and various facial lotions. Saponin is used as hyperglycaemia, antioxidant, anticancer agent. Tannin is a phenolic compound reported to have pharmacological property and thus used as antiviral, antibacterial, anti-tumour agent. Plant derived steroids are used as cardio tonic and antimicrobial agents.

Toxicology study of phytochemicals

Phytochemicals have immense role in personal care products [cosmetics and pharmaceuticals], and food processing, but present of toxic elements cannot be ignored [34]. Since, most of the antioxidants when used in high amount can revert to prooxidant. These prooxidant instead of scavenging free radicals, start generating free radicals species. Toxicological studies for evaluating biocompatibility, safe dose and formulation of plant derived products are necessary requirement for human usage of phytochemicals. Instead of single method, multiple methodologies should be recommended to study the bioactivity of photochemical. The test method should be as simple, specific, and quick. Firstly, in-vitro assessment models of bioactive components are adviced rather than a bioassay with small animals system. Animal models includes mice, guinea pigs or rabbits. An in-vitro model includes interaction of phytochemicals with DNA, proteins/enzymes and fats. Cell lines of animal including human, plant and microbes are used to assay toxicity of phytochemicals.

CONCLUSION

Large scale generation of food wastes leads to handling problem in proper disposal of municipal solid wastes. With advancement in extraction system, important phytochemicals are being isolated and purified from fruits peels and seeds. Thus, the waste discarded fruit materials can be converted into useful products. These antioxidant products can be potentially utilized in personal care and food industries.

REFERENCES

[1] Schlegel RHJ. Encyclopaedic dictionary of plant breeding and related subjects. Haworth Press, New York. 2003; pp. 177.
[2] Lewis RA. CRC Dictionary of Agricultural Sciences. CRC Press. 2002; pp. 238.
[3] Benzie IF, Choi SW. Adv Food Nutr Res 2014; 71: 1-53.
[4] Putta S, Kilari EK. IJPPR 2015; 7(5): 960-966.
[5] Qdais H, Abdulla F, Qrenawi L. Jordan J. Mech. Ind. Eng 2010; 4: 69–74.
[6] Buekens A. Huang H. J. Hazard Mater 1998; 62:1–33.
[7] Balasundram N, Sundaram K, Samman S. Food Chem 2006; 99: 191-203.
[8] Narasinga Rao, BS. NFl Bulletin 1998; Vol 9, [4]: 1-5
[9] Gorinstein, Martin-Belloso O, Park YS, Haruenkit R, Lojek A, Ciz M, Caspi A, Libman I, Trakhtenberg S. Food Chem 2001; 74: 309–315.
[10] Soong YY, Barlow PJ. Food Chem 2004; 88: 411–417.
[11] Wolfe KL, Liu RH. J Agric Food Chem 2003; 51:1676–83.
[12] Joshi VK, Kumar A, Kumar V. Intl J Food Ferment Technol 2012; 2(2): 123-136.
[13] Boudries H, Madani K, Touati N, Souagui S, Medouni S, Chibane M. Afr J Biotechnol 2012; 11: 4258–4267.
[14] Rekha C, Poornima G, Manasa M, Abhipsa V, Pavithra Devi J, Vijay KHT, Prashith K. Chem. Sci. Trans 2012; 1: 303–310.
[15] Yilmaz Y, Toledo RT. J Agri Fd Chemi 2004; 52: 255-260.
[16] Lau DW, King AJ. Agri F Chemi 2003; 51: 1602-1607.
[17] Burt S. Int J Food Microbiol 2004; 94: 223–53.
[18] Kabuki T, Nakajima H, Arai M, Ueda S, Kuwabara Y, Dosako S. Food Chem 2007; 71: 61–6.

[19] Rajashekhara E, Tippannavar CM, Sreenivasa MN, and Sharma JS. Zentralblatt Fuer Microbiologie 1990; 145: 455-456.
[20] Aruoma OI, Landes B, Ramful-Baboolall D, Bourdond E, Neergheen-Bhujune V, Wagnerf KH, Bahorun T. Prev. Med 2012; 54: S12–S16.
[21] Karimi E, Oskoueian E, Hendra R, Oskoueian A, Jaafar HZE. Molecules 2012; 17: 1203–1218.
[22] Ehigbai IO, Ehimwenma SO, Faith EO, Kelly O. Food Sci Nutr 2016; 4(1): 103–109.
[23] Rauf A, Uddin G, Ali J. Org Med Chem Lett 2014; 4: 5.
[24] Owoseni AA, Ajayi A. J Med App. Biosci 2010; 2: 64–73.
[25] Wolfe K, Wu X, Liu RH. J Agri Food Chem 2003; 51: 609-614.
[26] González-Montelongo R, Lobo MG, González M. Food Chem 2010; 119:1030-1039.
[27] Roy S, Lingampeta P. IJRET 2014; 03(07): 273-279.
[28] Aviram M, Fuhrman B. Ann NY Acad Sci 2002; 957: 146-161.
[29] Doll R. Proc Nutr Soc 1990; 49: 119-131.
[30] Mena P, García-Viguera C, Navarro-Rico J, Moreno DA, Bartual J, Saura D, Martí N. J Sci Food Agric 2011; 91(10): 1893-906.
[31] Liu S, Yang F, Zhang C, Ji H, Hong P, Deng C. J Supercrit Fluids 2009; 48: 9-14.
[32] Drotleff AM, Bohnsack C, Schneider I, Hahn A, Ternes W. J Funct Foods 2014; 7: 150-160.
[33] Naresh K, Purthi V Biotechnol Reports 2014; 4: 86–93.
[34] Qinghua Y, Yongtao L, Yang L. Trop J Pharm Res 2014; 13(4): 607-611.