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*Review Article*

# Peels as an important natural source for different house hold and medicinal uses- A Short Review

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**Abstract:** Human being relies on many more plant species for their daily needs for food, clothing and shelter. These plants also provide crafts, medicines, cosmetics and also these plants are used for economic development. Plant derived traditional medicines effectively cure our primary health problems. Plants' waste source (peels) of some vegetable; fruits also have high medicinal value in comparison to the pulp of the corresponding vegetables/fruits. This was already reported and partly discussed by some researchers. But it is required to study well because in most parts of the world people do not know the actual use of peels and their medicinal property and are used these as cattle feed. A few peels show antimicrobial property against various types of bacteria like E. coli, Staphylococcus aureus, Pseudomonas etc. which has been reported earlier. Therefore, a detailed study of the benefits of peels is a need of the hour. In this review attempts have been made to highlight the benefits of fruit peel as a good source of antioxidant, anti-inflammatory due to the presence of various bioactive compounds.

**Keywords:** Fruit peel; vegetable peel; bioactive compounds; Medicinal uses; Household uses.

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## 1. Introduction

Natural products are like the God's gift to mankind (1). Vegetables, fruits and other plant products have been playing an important role in the health benefit of human being. Although, they are the chief source of minerals, vitamins, proteins and other nutritional components, the plants are also the source of different bioactive phytochemicals, the secondary metabolites having the medicinal value (2). All plant parts have shown some medicinal property and always give positive result, even the peel also shows the same. Moreover, in most parts of the world peel parts are either wasted or used only for the feed of the grazing animals. This happens due to the lack of proper knowledge among people. But it has been reported that peels also show efficacy against different diseases and contains bioactive molecules. For example, Sood et al., studied on Lemon peel and reported

the role of peel part in treatment of peptic ulcer. It also shows effectiveness in curing kidney stone disease (3). Cucumis melo and Citrullus lanatus peels showed great efficacy in related to dietary problems of animals and human beings (4).

Fruit peels also have highest mineral contents in comparison to the pulp and this was reported earlier (5). Wolfe et al., studied on apple peels and found high content of phenolic compounds, antioxidant anti proliferative property than the fresh pulp (6). Guo et al., also reported the same that in antioxidant activity level fruit peel fractions were more stronger than pulp fractions (7). The pomegranate peel contains highest phenol compounds, pro-athocyanidins, flavonoids, antioxidant activity in compare to the pulp (8).

India is a developing country with a 28% percent of population in middle income group. The people in general, are risk avert and are interested in saving money and investing in low-risk investments. Investment involves allocating capital in the expectation of a potential gain. In finance, the reward of an investment is called as return. Investors generally make investment decisions based on their risk bearing capacity. These investments are categorized into different levels of risk, which include low risk, medium risk and high risk.

**2. Current Status of research and development in subject (both International and National Status)**

Nowadays herbal medicines are in demand and their popularity is going to be high day by day. In ancient literature about 500 plants are mentioned as medicinal and in indigenous system of medicine around 800 plants are signified as medicine (9). As plants show their medicinal activity against curing for various diseases, some of the recent reports also indicate the beneficial effects of waste materials (peels) of various fruits and vegetables (10). Scientific investigations reveal the presence of large number of phytocompounds in all parts of a plant such as leaves, roots, stems and peels (wastes) also (11, 12, 13, 14). Most of the studies conducted on fruit peels and seeds revealed possess of antimicrobial, anticancer, antioxidant etc. (15). Plants' waste sources are now being used as organic matter for soil because it supports sustainability by recycling its elements. Nowadays, it seems to be growing interest in getting the phytoconstituents which are commonly used in pharmaceutical industry, cosmetic industry. On the basis of the importance of peels Santos et al., 2014 studied on papaya peel and seed flours, showed high contents of fiber and protein (16). Further, it was studied by many authors that peels can be added to various foods to add value. Jaishinghani et al., studied on the efficacy of antibacterial and flavonoid content present in the Punica granatum peel. From the study they concluded that pomegranate peel has antibacterial property and contain flavonoid compounds too (17).

For growth and development of crop people use fertilizers that make crops to be healthier. Use of chemical fertilizers gets plenty of water out of the soil which contaminate and pollutes water (18). Chemical fertilizers are inert one which may damage the soil by reducing fertility degrade soil health and finally lower the productivity of crops. Therefore, maintaining the adequate levels of nutrient in soil is meant for a healthy plant (18). Numerous plant materials have been tested as nematicidal agent. Mercy S and his coworkers studied on a number of fruit peels to exploit for the growth and production of plants (18).

In 2017, Ramya et al., studied on anti-inflammatory activity of different variety of peel of Musa sapientum sp. From the study it was reported that Rasthali peel exhibited best result on anti-inflammatory activity (19). Hawthorn fruit peel (traditional medicine in China) was studied by Wu et al., 2017 (20). They evaluated inhibitory activity, cytotoxic activity, antioxidant activity of peel of Hawthorn fruit. Jaime et al., 2002 studied the entire onion and found the highest dietary fibers in the skin compared to the inner part which indicates the importance of onion peel (21, 22).

Asmaa et al., 2015 conjointly studied the growth inhibitory cause of pomegranate peel extract on chronic myeloid leukemia. They reported that pomegranate peels have growth inhibitory effect on CML cells (23). Even though pomegranate peels may be a potential supply of polyphenolic compounds having antioxidant and antimicrobial property. Bhardwaj et al., 2017 studied on pomegranate peel to show their preservative effect on the keeping quality of cream primarily based fat spread. Their results showed positive because the pomegranate peel has potential to function as a preservative enhancing the shelf-life of food merchandise (24).

In 2017 Bahramsoltani et al., also studied on peel of Cucurbita moschata. From their study it was reported that C. moschata has wonderful wound healing property (25). Some peels show antimicrobial property against various types of bacteria like E. coli, Staphylococcus aureus, Pseudomonas etc. which was reported earlier. Citrus aurantifolia display promising antibacterial activity against some important cariogenic bacteria like Streptococcus mutans (26). Peel of Punica granatum also shows fungal activity on some specific fungus such as Candida albicans and showed excellent anticandidal activity (27).

Cucurbita maxima (Pumpkin) and Lagenaria siceraria (Bottle Gourd) are two most important vegetables for human being. Pumpkin has been used by people not only as vegetable but also as a medicine (28). Fruit pulp of pumpkin contains β-carotene which helps in preventing various skin diseases, eye disorders and cancer (29). The seeds are highly rich in macro-elements as well as micro elements. It has a potentiality to prevent chronic diseases as it contains zinc, poly-unsaturated fatty acids and phytosterols (28). Bottle gourd has also some medicinal value. It contains vitamin B-complex and ascorbic acid. It was reported that it also contains pectin, saponins, fatty oils and alcohols (30). Its consumption controls diabetes mellitus, hyper tension, liver diseases, and weight loss. It also helps to cure insomnia, urinary disorder, premature hair growth etc. (31). All parts of these two vegetables are consumable but some people consume only the pulp parts because of limited knowledge about the benefits of the peel parts. But Pumpkin peels have substantial amount of proteins and fibers in comparison to the pulp (25). Also, it has been reported that bottle gourd peel possesses antimicrobial potential against different microbes (32).

Citrus, commonly known fruit is highly consumed all over the world as fresh and juice. But most often the peel is discarded as waste but it contains wide variety of secondary metabolites in comparison to other parts of the fruit (33). Most of the people consider peels as primary waste, but it was reported by researchers that citrus peels are the sources of pectin, molasses and limonene and is usually used as cattle feed by drying the peels (34). Therefore, identification and isolation of bioactive compounds from by-products can result in value addition (35). Based on these Shafiya et al., 2016 reviewed the potential components present in citrus peels. Their study showed that due to its bioactive compounds these unwanted cast-offs of manufacturing could be re-cycled as food supplements that provide dietary fibers and polyphenols (36).

Citrus aurantifolia, Citrus maxima and Citrus limon are three commonly traditionally used fruit which are highly valued for nutritional qualities and numerous health related problems. Citrus aurantifolia has antihelmintic and mosquito repellent power. It is also used as antiseptic and to cure many other chronic diseases (37). Citrus maxima fruit contains high quantity of polyphenolic compound, β-sitosterol, acridone alkaloid. It is usually used eaten as fruit. From the medicinal point of view, it is used to treat hemorrhagic diseases and epilepsy (38).

C. maxima peels also have several chemical compounds such as Vitamin C, flavonoids and carotenoid, which are sturdily associated with some biological activities such as antioxidant, antiatherogenic, antimicrobial, anti-inflammatory, anticancer, appetizer, stomach tonic, cardiac stimulant, antiepileptic as well as anticough (39, 40). Earlier most of the researchers studied and reported that Pomelo (Citrus maxima) peel contained higher amount of antioxidant content compared to its pulp (41). Also, Zead et al., 2019 studied on Pomelo peel extract and concluded the presence of

phytochemical composition and possible antioxidant activities (42). They accomplished from their study that Pomelo peel is potentially rich sources of natural antioxidants and possesses high antioxidant property. Due to its essential oils, Pomelo peels extractions are considered to be used in aromatherapy and also have a variety of health benefits (43). Lan- Phi 2010 studied and quantified some essential oils from the Phuc Trach, Van Giang and Nam Roi pomelos of Vietnam and separated 91 volatile components. The compounds available in these peels are $\alpha$-pinene, sabinene, $\beta$-pinene, myrcene, $\alpha$-terpinene, limonene, terpinolene, $\gamma$-terpinene and linalool (44). Therefore, Lan-Phi et al., 2015 investigated the chemical composition, antioxidant properties and antimicrobial activities of pomelo peels grown in south regions of Vietnam. Vitamin C accessibility Citrus limon are highly valuable in medical and industrial purposes. Citrus peel consumption helps in improving various metabolic activities as well as it treats inflammatory disorders (3).

Based on several evidences of Citrus peel Md. Maniruzzaman et al., 2019 studied on antimicrobial effects of different species of lemon peel against five different strains of bacteria. Although they reported that the study showed good efficacy of lemon peels against the selected bacteria. These studies give a concept that these peels might be beneficial for human health (45).

EI Zawawy, 2015, studied the antioxidant, antitumour, antimicrobial activity and phytochemicals of peels of orange, kiwi, lemon, tangerine, watermelon, carrot, banana, goldenberry. This study showed all the peels contain pharmacologically active compounds which provide scientific knowledge in the traditional use of bacterial and fungal infections (46).

Citrus sinensis, the plant is called sweet orange. Most of the people peel off the Citrus sinensis, only eat the pulp one, but Citrus sinensis peel is used medicinally (47) as it contains calcium, potassium, phosphorus, ascorbic acid, vitamin A, as well as volatile oil and hesperidin (48). In Africa, these peels are used to treat colic, whereas, in India these are used to treat upset stomach (47). Furthermore, due to the presence of biflavonoid compounds these peels are included in treating phlebitis (48). Previously it was reported as both the fruits and vegetables peels showed better antifungal activity than antibacterial activity (48). The peel extract of C. sinensis exhibited antibacterial activity against S. aureus and E. coli (49).

In most of the countries of the Americas, Dengue is the most endemic disease over the past 20 years (50). No effective vaccines are released, only vector control is the way to reduce the transmission of the virus. For this, some kind of plant products have been used against vectors like Croton zehntneri, Lippia spp., etc. Based on this, Aguiar et al., 2010 studied on peels of ripe and unripe fruit of Hymanaea courbaril peel against Aedes aegypti. The study showed good efficacy (51).

Among various medicinal plants, Hawthorn fruit is well known traditional medicine in China because of the effects of improving digestion, regulating qi-flowing for removal of blood stasis. Wu et al., 2017 also studied the phytochemical composition of Hawthorn fruit peel which was analyzed using Liquid Chromatography, Tandem Mass Spectrometry and High-Performance Liquid Chromatography (20).

Hylocereus undatus (red Pitaya) and Hylocereus megalanthus (yellow pitaya) are two fruits which have sturdy antioxidant property and are trendy in many countries all over the world (52). It is also called as 'Dragon fruit'. Luo et al., 2014 studied on the composition of the pitaya peel, analyzed by GC-MS. This study provides proof for studying the chemical composition of these pitaya peels and also their biological activity.

On the demand for the production of fruits and vegetables, huge amount of lignocellulosic biomass is needed during processing, cultivation and harvesting (53). Therefore, in food processing and agricultural industries fruit peels

are produced in a large scale, becoming a serious environmental concern. Halpatrao et al., 2019 studied on different fruit peels (apple, pineapple, sweet lime and banana) to check for the effective growth of plant. Their result showed that fruit peels have a high potential to enhance plant growth.

Untreated agro wastes can produce bad odor, pollute soil, harborage for insects and can give rise to serious environmental pollution (54). By utilizing these waste materials, scientists were tried and able to develop high value-added products such as medicines, cosmetics (55). It seems that application of fruit peels strongly depends upon availability of chemical composition (56). Feumba and his coworkers investigated the chemical composition that present in fruit peels of some selected fruits like orange, watermelon, apple, pawpaw, pomegranate, banana, pineapple, and mango and they come to know that all the fruits have important proportions of peels and also are the sources of lipids, proteins, minerals. Phenolic compounds are act as anti-nutrients and for the presence of these anti-nutrients these fruits can be used as good ingredients in formulation of health benefits food products.

Garcinia mangostana (common name Mangosteen), it belongs to the family Guttiferae, mainly cultivated in Southeast Asian countries such as Sri Lanka, Indonesia, Malaysia, Philippines, Thailand. Traditionally it has been used as medicine to treat dysentery, abdominal pain, diarrhoea, infected wound, etc. It has already been reported that Garcinia fruit peels contain high level of phenolic compounds such as xanthone (57). This phenolic compound possesses antioxidant, antitumour, antiallergic and antiviral properties. On the basis of these knowledge Lee et al., 2016 demonstrated the biosynthesis and characterization of Au-NPs of Garcinia fruit peels. They demonstrated the properties of both reducing and stabilizing agent which is only due to the presence of different phytocompounds. The synthesized Au-NPs are potential in biomedical application (58).

Lycopersicon esculentum (Tomato) is one of the world's major edible vegetable which is widely consumed by people either raw or after processing which provide total antioxidants in the diet (59). When tomatoes are processed into products, 10-20% of their weight becomes waste (60) and it usually represents some environment related problems for the industry which may cause ecosystem imbalance. Nowadays, most of the studies have been carried out by potential utilizing of by-products which could provide correct solution for the pollution problem connected with food processing and reducing industrial costs (61). Among various researchers, Al-Wandawi and his coworkers in 1985 studied on tomato peel and concluded that peels contain high levels of lycopene compound as compared to the seeds and pulp (62). Stewart et al., 2000 reported the presence of highest amount of flavonol compound in peels. Also, Sharma and Le Maguer studied the presence of Lycopene in tomato peels and observed that most of the lycopene was associated with the skin (63). George et al., 2004 studied and reported that on average tomato skin had 2.5 times higher lycopene levels compared to the pulp one (64). But it seems there is a lack of information on antioxidant levels in the peel fraction of tomatoes, so, Elbadrawy et al., studied the nutritional value of tomato peels by determining of its content of phenol, total lipids, total carbohydrates, minerals, fatty acids, amino acids, phenolic acids and also the property of antioxidant. From their study it comes to know that tomato peel contains nutrients and have antioxidant property that can be used as a food supplement (65).

New environment-friendly technologies could help to convert tomato waste to new food ingredients or alternative products (66). Di Donato et al., 2011 investigated the potentiality in enzyme production and thermophilic and halophilic microbial strains production of tomato waste (67). Moayedi, Hashemi and Safari (2016) studied on tomato waste showed that this protein containing waste can be valorized to produce antioxidant and antibacterial hydrolysates in fermentative system (68). Zuorro et al., 2014 studied the capability in the production of tomato oleoresin by pre-treating the fraction of tomato peel with some enzymes (69). Benakmoum Abbeddou, Ammouche, Kefalas and Gerasopoulos (2008) studied the presence of chemical compounds on tomato peels and reported that they are highly rich of edible oils with

carotenoids and lycopene which is followed by direct integration (70). For proposing an alternative approach to elaborate new functional foods Nour, Ionica and Trandafir (2015) reported the effects of the addition of tomato peel on the physicochemical, baking and sensory qualities of wheat bread (71). Alternatively, Violeta et al., 2017 determine various contents of nutrients and bioactive compounds like carotenoids, polyphenols, amino and fatty acids present in the waste coming from the tomato processing industries (66).

Pectin, one kind of polysaccharide, widely used in food industry which is used as gelling, thickening and stabilizing agent in various food items such as jams, jellies etc., and normally it can be extracted from fruit peels (72). Passion fruit peels contain this type of polysaccharide along with some other bioactive compounds. According to some authors and researchers, passion fruit peels contain the pectin content ranges from 15-20g/100g dry mass (73, 74). Therefore, de Oliveira et al., 2016 also studied the presence of pectin compound of Passion fruit peel by evaluating the potentiality of extraction through ultrasound method and their results showed that using of this method pectin is extracted better as compared to the conventional method (75).

Like other fruits, plum and grapes are distinguished for their high content in bioactive compounds in peels and seeds. (76). Among various fruits, grapes are the second world's largest fruit crops that are used for the production of wine. Also, grape peels represent one of the most important food by-products (FAO 2012). Grape peel extract has also the anti-hyperglycemic property in diet induced obese rats (77).

Potato, popularly known as "the king of vegetables" which grows more than 100 countries (78) of which potato chips are one of the most popular processed foods but during this processing large amount of potato peels are produce as by- products (79). It was identified that most of the common environmental pollution is associated with organic wastes decomposition. To avoid such kind of problems, we can use potato peels as they contain high phenolic compound which act as an antioxidant in food system (80). This phenolic compound of potato peel has the capability to protect from bacteria, fungi, viruses and insects (81). Due to its multiple advantages, potato peel can serve as best response for eco-friendly industrial products. Now-a-days it seems potato peels are re used as an animal feed and also used for the production of bio-fuels by most of the people (82). Royashed et al., 2015 studied for the utilization of potato peels and its effectiveness in the stability of fat in biscuits. Their results showed that potato peel extracts gave an excellent effect on biscuits (83).

Beetroot peel extracts possess strong antioxidant activity in comparison to other vegetable peels thereby indicating its use in food and nutraceutical industries. As compared to the flesh, peel of beetroot contains greater amount of betanin and isobetanin compounds. Considering the biological activities of beetroot, John et al., 2017 screened the presence of various secondary plant metabolites and also determined the antioxidant and antimicrobial activity of beetroot peel (84). Beetroot peel exhibits nutraceutical potential which has the ability to scavage free radicals and inhibiting the growth of microorganisms. Kujala et al., 2001 also studied the effect of extraction method of beetroot peel (85).

Onion is one of the most popular and valuable crops grown for its various purposes such as pharmaceutical, nutritional, industrial etc (86). In food processing industries, huge amount of onion waste (peel) has been generated (87). Red onion peel has been demonstrated to contain high constituent of quercetin (88). Quercetins are effective antioxidants against the lethal effects of oxidative stress (89, 90). The outer layer of onion is famous as food colouring agent among the Javanese tribes (91). Considering that Chiew et al., studied the phyochemical composition of onion peel and also evaluated the antifungal, antibacterial, preliminary cytotoxic activities. From the available information of Onion peel, Singh et al., 2009 optimized the procedure of antioxidant based on their contents of total phenolics, total flavonoids, antioxidant activity, free radical scavenging activity and reducing power (92).

### 3. Results & Discussion

It is no doubt or no arguing that fruits or vegetables are beneficial for our health. But removing peel is somehow due to habit, preference or to reduce exposure to pesticides. However, removing peels mean removing one of the nutrient rich sources. They are packed with nutrients. The amounts of nutrients are varying base on the type of fruits or vegetables. In general, non-peeled fruits or vegetables contain higher amount of minerals, vitamins and other beneficial compounds. Due to higher fiber contains these peels can reduce hunger and helps to feel fuller for longer (Table 1).

**Table 1:** Various types of fruit peels and their uses

| Sl. No. | Name of Peels | Source | Use |
|---|---|---|---|
| 1 | Lemon (Citrus limon) | Native to Asia, primarily Northeast India (Assam) | Pectic ulcer, Kidney stone |
| 2 | Muskmelon (Cucumis melo) | Native to Persia, | Dietary problems |
| 3 | Apple (Malus domestica) | Worldwide, | Protect brain cells from damage, prevent memory loss |
| 4 | Pomegranate (Punica granatum) | Mediterranean region, cultivated throughout, north and tropical Africa, middle east | Chronic Myeloid leukemia |
| 5 | Papaya (Carica papaya) | Tropical countries, native to northern South America and Mexico | Treat dandruff, rebuild damaged skin, skin lightening agent |
| 6 | Banana (Musa sapientum) | Native to wet, tropical areas | Astringent in foot care |
| 7 | Hawthorn (Crataegus) | Temperate region, Europe, North America, Asia | Inhibit cancer cells |
| 8 | Onion (Allium cepa) | Originated in Iran, western Pakistan, Central Asia | Boosting immunity, promote heart health, maintain blood sugar level |
| 9 | Pumpkin (Cucurbita moschata) | Central America, Northern South America | Wound healing property |
| 10 | Key lime (Citrus aurantifolia) | Tropical Southeast Asia, South Asia | Antithelmintic mosquito repellent power |

| | | | |
|---|---|---|---|
| 11 | Giant pumpkin (Cucurbita maxima) | South America | Control acne, boost collagen production |
| 12 | Bottle gourd (Lagenaria siceraria) | Africa, Asia, Europe, America | Digestion, control diabetes |
| 13 | Pummelo (Citrus maxima) | Native to Southeast Asia | Hemorrhagic disease, epilepsy |
| 14 | Citrus fruits (Citrus) | Native to Australia, New Guinea, Southeast Asia | Inflammatory disorders |
| 15 | Orange (Citrus sinensis) | Southern China, Northeast India, Myanmar | Type 2 diabetes, obesity, Alzheimer's disease |
| 16 | Kiwi (Actinidia deliciosa) | Eastern China, New Zealand | Reduce the risk of several kinds of cancer and heart disease |
| 17 | Tangerine (Citrus tangerine) | Native to Southeast Asia, America | Treats acne, slow down aging, lower cholesterol level |
| 18 | Watermelon (Citrullus lanatus) | Worldwide, Northeastern Africa, grow in tropical to temperate regions | Maintain regular bowel movement, reduce risk of colon develop |
| 19 | Carrot (Daucus carota) | Native to Europe, Southwestern Asia | Keep heart health, nervous system, digestive system and skin healthy |
| 20 | Goldenberry (Physalis peruviana) | Native to Columbia, Ecuador, Peru, England, South Africa | Treat hepatotoxicity, prevent diabetes |
| 21 | Red pitaya (Selenicereus undatus) | Mexico, Southeast Asia, Australia, tropical and subtropical world region | Prevent hyperlipidemia, reduce cholesterol level, maintain good health |
| 22 | Mangosteen (Garcinia mangostana) | Southeast Asia, America, Australia, Southern Africa | Antiobesity, anti-inflammatory |
| 23 | Garden tomato (Lycopersicon esculentum) | Western South America, Central America | Preventing cancer, cardiovascular diseases |
| 24 | Passion (Passiflora edulis) | Tropical and subtropical areas, native to southern Brazil | Protects from the risk of colon cancer, prevent constipation |

| | | | |
|---|---|---|---|
| 25 | Grape (Vitis vinifera) | North America | Reduce blood pressure, improve blood flow, reduce oxidative damage |
| 26 | Potato (Solanum tuberosum) | Native to America | Lower the risk of colon cancer, heart disease, type 2 diabetes |
| 27 | Beetroot (Beta vulgaris) | North America | Protects from sign of aging, prevent wrinkles |

Nowadays people are getting smarter and healthier, it is possible because of changing of world and people opting for eco-friendly alternatives. Fruit peels are remarkably healthier and quite useful. By this way it helps not only to reduce peel waste but also it makes life easier as well. In this review it comes to know that peels contain more nutrients and beneficial for human being.

**4. Conclusion**

This review highlights the beneficial effects of fruits by products and considered as a rich source for production of variety of co products which make a value-added product. On the basis of recent reports, it is clear that fruit residues have potential neutraceutic resources, capable of offering nutritional dietary supplements. For this it becomes strategy to minimize wastage of peels and utilize it as neutraceuticals which would become a pathway to add income to the farmers.

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