International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Uses of Citrus Peels for Encouraging Food Nutrition: A Review

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Abstract:
Orange peel (*Citrus sinensis*) belong to the family *Rutaceae* and it is well known promising source of multiple beneficial nutrients for human being. Global orange production is about 51 million metric tons. In India, area under citrus is 9.23 lakh hector which produces 86.08 lakh tones of fruits. Maharashtra is second largest state after Andhra Pradesh in the country and contributes to about 18.9 per cent to the total production of citrus in country. Orange peel obtains new healthy fruit products because peel friction has interesting and not very well known nutritional components such as Phenolic compound, Flavonoids, Dietary fiber. Part of orange such as peel and rind are used in food preparations. The peel of orange is use to make herbal tea, candied fruits peel and marmalade. Peels are regarded as waste material and is usually dried and ground to make citrus meal, a substitute cattle feed. Orange peels are also used as flavoring liqueurs, orange peel flavors is most desirable natural flavors. They are used in beverage, confectionery, bakery, pharmaceutical, cosmetic and perfumery industries. The citrus fruit residues, which are generally discarded as waste in the environment, can act as potential nutraceutical resources. Due to their low cost and easy availability such wastes are capable of offering significant low-cost nutritional dietary supplements in the form of orange peel powder in cookies. the orange peel powder waste used in various proportion viz, 0, 5, 10, 15, 20 per cent levels for incorporation in cookies by replacing the Maida in the basis of overall sensory attributes, cookies prepared with 10 per cent orange peel powder were recorded higher acceptability as compared to other samples. It is calculated that orange peel powder and Maida can be substituted up to 10 per cent in Maida to prepared orange peel powder without adversely affecting attributes.

Keywords: Orange fruits, Orange peel powder, Nutritional value, Sensory evaluation and Quality attributes.

Introduction
Orange plant (*Citrus sinensis*) belonging to the family *Rutaceae* and it is well known promising source of multiple beneficial nutrients for human being (Shafiya *et al.,* 2016). As reported by the *United States Department of AgricultureForeign Agricultural Service* (2014) the global orange production is about 51 million metric tons. The global amount of transformed

orange is 20 million metric tons most of which is transformed in China, Brazil and Europe (*United States Department of Agriculture Foreign Agricultural Service, 2014*) In India, the area under citrus is 9.23 lakh hector which produces 86.08 lakh tons of fruits. The mandarin having largest area and maximum production constitutes about 26.54% of total area under citrus (Kumar, 2010). Maharashtra is second largest state after Andhra Pradesh in the country and contributes to about 18.9% of the total production of citrus in country. The state produces 1.41 million metric tons of citrus from the area of 0.28 million hector having productivity of 5.1 million tons /hector (Anonymous, 2011).

The orange juice industry uses approximately 50% of the fruit, while the other 50% is peels, seeds and albedo, which can reach 60% of the total byproducts (Fernandez-Lopez *et al*., 2009). Orange peel obtains new healthy fruit products because peel fraction has interesting and not very well-known nutritional components such as vitamin C, pectin, flavonoids, carotenoids or limonene (Mazza 1998; Braddock 1999). A 100 g raw orange peel contain 72.50 g water, 97 kcal energy, 1.50 g protein, 0.20 g total lipid (fat), 0.80 g ash, 25.0 g carbohydrate, 10.6 g total dietary fiber. Minerals like 161 mg calcium, 0.80 mg Iron, 22 mg magnesium, 21 mg phosphorus, 212 mg potassium, 3 mg sodium, 0.25 mg Zinc, 0.092 mg copper, 1.0 mg selenium. Vitamins like 136.0 mg vitamins C, 0.120 mg thiamin, 0.090 mg Riboflavin, 0.900 mg Niacin, 0.490 mg pantothenic acid, 0.176 mg vitamins B-6, 30 µg total folate, 21 µg vitamin A, 0.25 mg vitamins E, phytosterols 34 mg (Anonymous, 2016).

Pigmentation of fruit peel is highly diverse among the different species and cultivar of genus Citrus. Coloration of the peel is due to the presence of two main pigments: chlorophylls which provide green colour, and carotenoids, which are responsible for the characteristic coloration of mature fruits of most species and cultivar. Anthocyanin's are a third group of pigments, providing a red to purple tint, in a specific group, blood orange and mainly restricted to the flesh. (Rodrigo M. J *et al.,* 2013).

In food product, apart from the pulp, parts of the orange such as the peel and the rind are used in other food preparations. The peel of the orange is used to make herbal tea (Anderson *et al*., 1990), candied fruit peel and marmalade. However, in the orange juice manufacturing industry, the peel is regarded as waste material and is usually dried and ground to make citrus meal, a substitute cattle feed (Braddock *et al*., 1990). Orange peel, fresh or dried, sliced, grated or ground, is an important flavoring material in many European and Asian cuisine. The dried orange peel is a common ingredient in many Chinese based sauces for chicken and beef that requires long simmering or stir-frying. The rind of orange is an essential ingredient in Japanese spice mixture, *shichimitogarashi*. The rind and peel are used in Southeast Asian and Mediterranean cooking and for flavoring of many European liqueurs (Uhl*et al*., 2000). In France, it is added to bouquet garnish, fish and meat dishes. It adds a fruity, bitter flavor to the many hot, sweet and sour Szechwan dishes of China (Knights, 2002). Citrus flavors are among the most desirable natural flavors. They are used in beverage, confectionery, bakery, pharmaceutical, cosmetic and perfumery industries (Morton, 1987). The major source of citrus flavor is peel oils. Peel oil comes from the oil glands that are found on the fruit surface (Belitz*et al*., 1999). The orange oil are typical volatiles or essential oil consisting of mixture of terpenes, sesquiterpenes, higher alcohols, aldehydes, ketones, acid esters and camphor or waxes (Kew, T.J. *et al*., 1970)

Fruits and vegetables are a suitable source of phytochemicals such as flavonoids, vitamins, polyphenols, and pigments (Jayaprakasha and Patil 2007) that has been associated with enhanced human health (Ochoa-Velasco and Guerrero-Beltrán 2014). It is well known that people who consume high amount of fruits and vegetables show a low incidence of cardiovascular, cancer, obesity and other diseases (Delia-Gabriela et al. 2012). However, higher demands of these products increase the amount of residues such as peel, bagasse and seeds. A higher amount of by-product that could be used as a good source of bioactive compounds (Sáenz*et al*., 2007; Kong *et al*., 2010). Moreover, orange peel could reach about 50–65% of total weight (Ghasemi *et al*., 2009). Food industry uses citrus peel as a source of molasses ,pectin, oil and limonene (Braddock 1995), and has been studied because it contains several bioactive compounds, such as flavanones, polyethoxylated flavones, flavonols and phenolic acids; these compounds have a lot of uses as a natural antioxidants for pharmaceutical, biotechnological and food industries (Bocco *et al*., 1998).

Components of citrus peel having functional properties.

Phenolic components

Major bioactive components known for health benefits are phytochemicals, especially phenolics in fruits and vegetables. Plant phenolics are not only present in edible parts of plants but their presences with multiple biological effects have also been reported in non edible parts of the plants. The mechanisms behind the contribution of phytophenolics in health promotion and

diseases prevention related to cell differentiation, pro-carcinogens deactivation, DNA repair maintenance, suppression of N-nitrosamine formation and change of estrogen metabolism, amongst other (Shahidi, 1997) citrus contain a host of active phytochemicals that can protect health. In addition to this, it provides an ample supply of vitamin C, folic acid, potassium and pectin. Citrus species of various origin have been evaluated for their phytochemical composition and its contribution in health promotion (Proteggente *et al*., 2003; Gorinstein *et al*., 2004; Anagnostopoulou *et al*., 2006; Guimaracs *et al*; 2009) and it has been recognized that citrus species exhibit promising biological properties including antiatherogenic, anti-inflammatory, antitumor activity, anti-clotting and strong antioxidation activity (Middleton and Kandaswami, 1994; Montanary *et al*., 1998; Samman *et al*., 1996). Kinnow or Tangerine (Ctriusrecticulata) is process into juices by the industrial and fruit vendor and 30-35% of kinnow peel is obtained as a major processing by-product. This kinnow peel is found to be a rich source of health beneficial compounds including vitamin C, carotenoids and polyphenolic antioxidants (Anwar *et al*., 2008). The major cause of food deterioration especially meat products are lipid oxidation and auto-oxidation. Synthetic antioxidants have been used from year to prevent this lipid oxidation which may produce changes in meat quality parameters such as colour, flavor, odor, texture and even nutritional value (Fernandez *et al*., 1997). To overcome disadvantage of using synthetic anti-oxidant in meat products, (Davatkal *et al*., 2010) replaced them with kinnow rind powder extract successfully and the result revealed that extracts are rich source of phenolic compound having free radical scavenging activity and concluded that the extracts of citrus powders have potential to be used as safer alternative to synthetic ones.

Flavonoids

Flavonoids are polyphenolic compounds having a phenyl benzopyrone structure, representing as two benzene rings (C6) joined by a linear three-carbon chain (C3), with carbonyl group at the C position. Although flavonoids are generally regarded as non-nutritive agents, their potential role in the prevention of major chronic diseases. The citrus flavonoids found to be have health-related property, which included anticancer, antiviral, anti-inflammatory activities, reduce capillary fragility, and restricts human platelets aggregation (Huet, 1982; Benavente-Garcia *et al*., 1997). Some glycosylate flavanones can be easily converted into the corresponding dihydrochalcones, which are potent natural sweeteners (Bor *et al*., 1990). The wide biochemical functions of flavonoids in orange peel have been studied recently. They increase serum antioxidant capacity against lipid peroxidation (Assini *et al*., 2013 and reduced elderly oxidative stress. These compounds possess the beneficial effects of anti-inflammation, antitumor (Romagnolo and

Selimin, 2012; Park and Pezzuto, 2012), and anti atheroserosclerosis (Mulvihill and Huff, 2012. In addition to this, these also serve as supplementary of drug chemotherapy (Meiyanto and Hermawan, 2012), diabetes health food (Aruoma *et al*., 2012), and neuro protective drug (Hwang *et al*., 2012). Ramful *et al*., (2010) examined flavedo extracts of different varieties of citrus fruits grown in maturities for their total phenolic; flavonoid and vitamin C contents and antioxidant activities. Dried tangerine peel (Citrus reticulate is used as traditional Chinese medicine, pericardium called chen-pi to cure a wide array of ailments, including bronchial asthma, dyspepsia, and cardia circulation, (China Pharmacopoeia Committee, 2010). A number of scientific studies report it as rich source of flavonoids, especially flavanone glycosides and polymethyl flavones, which play a great contribution in protection against life threatening diseases such as cancer, atherogenesis, (Tripol *et al*., 2007; Benavente-Garcia and Castillo, 2008) and neurodegeneration disorders (Youdim *et al*., 2004 Hwang *et al*., 2012). Inhabiting microglia activation-mediated neuro inflammation has become a convincing target for development of functional food to treat neurodegenerative diseases. Tangerine peel has potent inflammatory capacity and corresponding active components remain unclear. Hesperidin has been found as the most predominant flavonoid in tangerine peel, followed by tangerine and nobiletin. It has been reported that hesperidin's, nobiletin, and tangerine individually possess mild inhibitory activity against neuroinflammation but their collective effect found to be significant (Su-Chen and Chum-Ting, 2014).

Dietary fiber

Dietary fiber which is often classified as soluble dietary fiber and insoluble dietary fiber consist of a mixture of plant carbohydrate polymer, both oligosaccharides and polysaccharides e.g., cellulose, hemicelluloses, pectin substances, gums, resistant starch, insulin and in association with some no carbohydrates moiety (Fuentes-Zaragoza *et al*., 2010). Health conscious people prefer natural supplements fearing that synthetic ingredients may be the source of toxicity, fiber-rich by-product, rich in dietary fiber and bioactive compound act as a prize to food processors. Supplementation with dietary fiber can result in safer and economical foods with multiple health benefits. The average daily requirement of dietary fiber is 21 -25g per day for women and 30-38g per day for men (Food and Nutrition Board, Institute of Medici, 200l). Most nutritionist and diet expert suggest that 20-30 % of our daily fiber intake should come from soluble fiber. One typical example is the residue obtained from industrial processing of citrus peel (Braddock, 1999). Garcia *et al*., (2002) reported that the addition of cereal or fruit fiber, specifically 1.5% orange fiber, can be used as a fat replacer in dry fermented sausages. Citrus fiber, which possesses bioactive functions due to presence of polyphenol-like components, can be used as effective inhibitors of lipid oxidation in meat products, thereby improving their oxidation stability and prolonging their shelf life levels (Fernandez-Gines *et al*., 2003). Citrus peel could be considered to be a potential source of pectin which is composed of white, spongy and cellulosic tissue (Terpestra *et al*., 2002). Frequent consumption of dietary fiber is associated with low risk of life threatening chronic diseases such as bowel, gastrointestinal disorders, obesity, diabetes, cardio vascular diseases, cancer and also promoting physiological functions including reduction in blood cholesterol level and glucose attenuation (Figuerola *et al*., 2005). The effectiveness in citrus peel in lowering the plasma liver cholesterol, serum triglycerides level, serum total cholesterol, liver total lipid and liver cholesterol (Terpstra *et al*., 2004) is proven by many epidemiological studies. The peel fiber derived from orange fruit is involved n the improvement in intestinal functional and health.

Main pigments in citrus fruit peel

Carotenoids

Citrus fruits are one of most complex sources of carotenoids, with the large diversity of carotenoids among the different species and cultivars in terms of types and amounts (Gross *et al*., 1972; Kato *et al*., 2004; Fanciullion *et al*., 2006; Xi *et al*., 2006; Matsurnoto *et al*., 2007; Agocs *et al*., 2007) Ripen orange fruit is characterized by the orange colour of the flavedo (outer coloured portion of peel) and the intensity of the colouration is mainly determined by genetic factor (Saunt, 2000) As envisaged from Table 1, these differences in colour are not always directly correlated to carotenoid content in the peel, which ranges from ≈40 to ≈120 μgg-1 FW, but also the particular proportion of each carotenoid. Most carotenoids correspond to ββ - xanthophylls, which can account for up to 90% of total carotenoids in some cultivars (Kato *et al*., 2004; Rodrigo *et al*., 2004). In ripen orange most abundant carotenoid is the xanthophylls 9-Z-violaxanthin, according up to 80% of total peel carotenoids (**Table 1**). As violaxanthintypical provides a yellowish colour (Britton, 1998), it is unlikely that this carotenoid is the only responsible for the characteristic orange colour. The main orange-colour carotenoids in the peel of sweet orange fruits are β-cryptoxanthin and the C30 apocarotenoid β-citraurin, both reddish orange colored (Stewart and Wheaton, 1972; Gross, 1987). For example, the higher intense pigmentation of Navel in relation to Valencia orange has been suggested to be due to a higher ratio violaxanthine/ β-citraurin in the last cultivar (Oberholster *et al*., 2001)

Table 1 Total carotenoid content (μgg^{-1} FW) and composition in the peel of mature fruit from selected cultivars of sweet orange

Cultivar	Total carotenoids	Percentage of main carotenoids	Reference
Sweet orange Bonanza Cara Cara	 43.3 62.3	 31% Auroxanthine; 23% β-Citraurin 36-57% Phytoene; 31% Violaxanthin	 Xu et al.(2006) Xu et al.(2006), Alquezar et al. (2008)
Washington Navel Navel	123.4 60.0-75.0	73% Violaxanthin; 18% Phytoene 26%-58% Violaxanthin; 12%- 33% Phytoene	Marsumoto et al. (2007) Curl and Bayley(1961).
Navelate Navelina Anliu	59.0 94.2 56.0	80% Violaxanthin; 31% Violaxanthin; 18% Phytoene 31% Violaxanthin; 20% β-Cryptoxanthin; 20% Lutein	Rodrigoet al.,(2004) Carmona et al. (2012) Liu et al. (2007)
Hong Anliu Trovita Valencia	37.5 122.2 90.0-120.0	27% Violaxanthin; 20% Lutein 73% Violaxanthin; 18% Phytoene 44-55% Violaxanthin;	Liu et al. (2007) Marsumoto et al. (2007) Gross (1987). Kato et al. (2004)

Chlorophylls

Chlorophylls (chl) are the main pigments in the peel of immature and mature-green Citrus fruit and tend to decrease during ripening being, in general, absent in the peel of ripe fruits (Eilati *et al*., 1969; Gross,

1987; Alos *et al*., 2006) Hence, Chl concentration reach the highest values (around 300-250 µgg-1 FW) in the peel of immature green fruits and at the colour breaker stage the concentrations start to decrease progressively to virtually disappear in the peel of fully colour fruit in most species and cultivars (Yamauchi *et al*., 1997; Rodrigo *et al*., 2004; Alos *et al*., 2006, 2008; Alquezar *et al*., 2008, 2013).
Chl a is , in terms of abundance, the major component of Chl in Citrus peel, followed by Chl b (Yamauchi *et al*., 1997; Alos *et al*., 2008; Srilaong *et al*., 2011). In addition, some other Chl derivatives that greatly decrease during natural degreening have been detected in the peel of Wase Satsuma mandarin, such as OH-chlorophyll a, chlorophyll a pheophytin a have been detected at mature green stage, and eventually these pigments decreased and disappeared, respectively (Alos *et al*., 2008).

Anthocyanins

A third group of pigments relevant in the coloration of a particular group of Citrus fruit are anthocyanins, providing red, blue and purple colors. The presence of anthocyanins is restricted to a specific group of sweet oranges denominated blood oranges and their hybrids, and accumulates mainly in the flesh but also provide an intense dark-red coloration to the peel (Rapisarda *et al*., 1999). These pigments may also accumulate in young shoots and fruits, and in some floral tissues of lemon (C. limon), and citron (C. medica). Moreover, the content of anthocyanins is determined by the genotype but also.is highly influence by environmental condition and storage temperature (Cultrone *et al*., 2010). In particular, colour development in blood orange fruits, is strongly dependent on the climatic conditions during fruit ripening, and low night temperatures are essential for intense colour formation. Therefore prolonged post-harvest storage at low temperature enhances the development of fruit coloration due to the stimulation of anthocyanins accumulation (Rapisarda *et al*., 1999; Crifo *et al*., 2011). These environment requirements, and the presence of seeds, have limited the large-scale commercial production to the Sicilian region of Italy, from where most modern varieties of blood orange, such as Tarocco and Moro, have been mainly devoted to juice production. Anthocyanins are a class of flavonoids derived ultimately from phenylalanine, being the major anthocyanins in citrus cyanidin 3-glocoside and the acylatedcyanidin 3-(acetyl)-glucoside, constituting about 50 and 18% , respectively, of the total anthocyanins of blood oranges Mazza and Miniati, 1993).
The anthocyanins biosynthetic pathway Is relatively well characterized and the expansion pattern of structural genes has been investigated in citrus fruits (Lo Piero *et al*., 2005; Licciardello *et al*., 2008 Cultrone *et al*., 2010). However, most of the works are related to pulp tissue, where anthocyanin accumulation preferentially occurs (Cotroneo *et al*., 2006). As in other fruits, studies in citrus led to the conclusion that anthocyanins accumulation take place when two sets of genes are expressed: structural genes, encoding enzymes catalyzing reactions of the metabolic pathway, and regulatory genes, encoding transcription factors (MYB and bHLH types) regulating their expression. (Cultrone *et al*., 2010; Licciardello *et al*., 2008). Some of these genes have been characterized from Citrus.

Production and composition of citrus by-product

Citrus fruits are principally consumed by humans as fresh fruit or processed or concentrated. After juice is extracted from the fruit, there remains a residue (**table 3)** comprised of peel (flavedo and albedo),pulp (juice sac residue), rag (membranes and cores) and seeds. These components, either individually or various combinations, are the source materials from which citrus by-product feed stuffs (BPF) are produces (Sinclair 1984; Ensminger et al.1990). The main citrus BPF citrus processing (**Fig. 1)** are fresh citrus pulp which is the whole residue after extraction of juice, representing between 492 and 692 g/kg of fresh citrus fruit with600-650 g dry matter (DM) / kg peel, 300to 350 g/kg pulp and 0-100g/kg seeds (Martinez-Pascual and Fernandez-Carmona 1980), and dried citrus pulp (DCP) which is formed by shedding , liming, pressing and drying the peel, pulp and seeds residues to about 80g/kg moisture, and citrus meal and fines which is formed and separated during drying process. Atypical processing plant produces these BPF in a ratio of about 850g/kg DCP, 140g/kg citrus meals and 10 g/kg citrus fines. Other citrus BPF include citrus molasses, made by concentrating the press liquor from the citrus peel residue, which has a bitter taste and contains about 100-150 g/kg soluble of which 500-700 g/kg consist of sugar (Ensminger et al. 1990), citrus peel liquor, which is similar to citrus molasses, but not concentrated, and citrus activated sludge which is produced from liquid wastes from citrus processing plants.

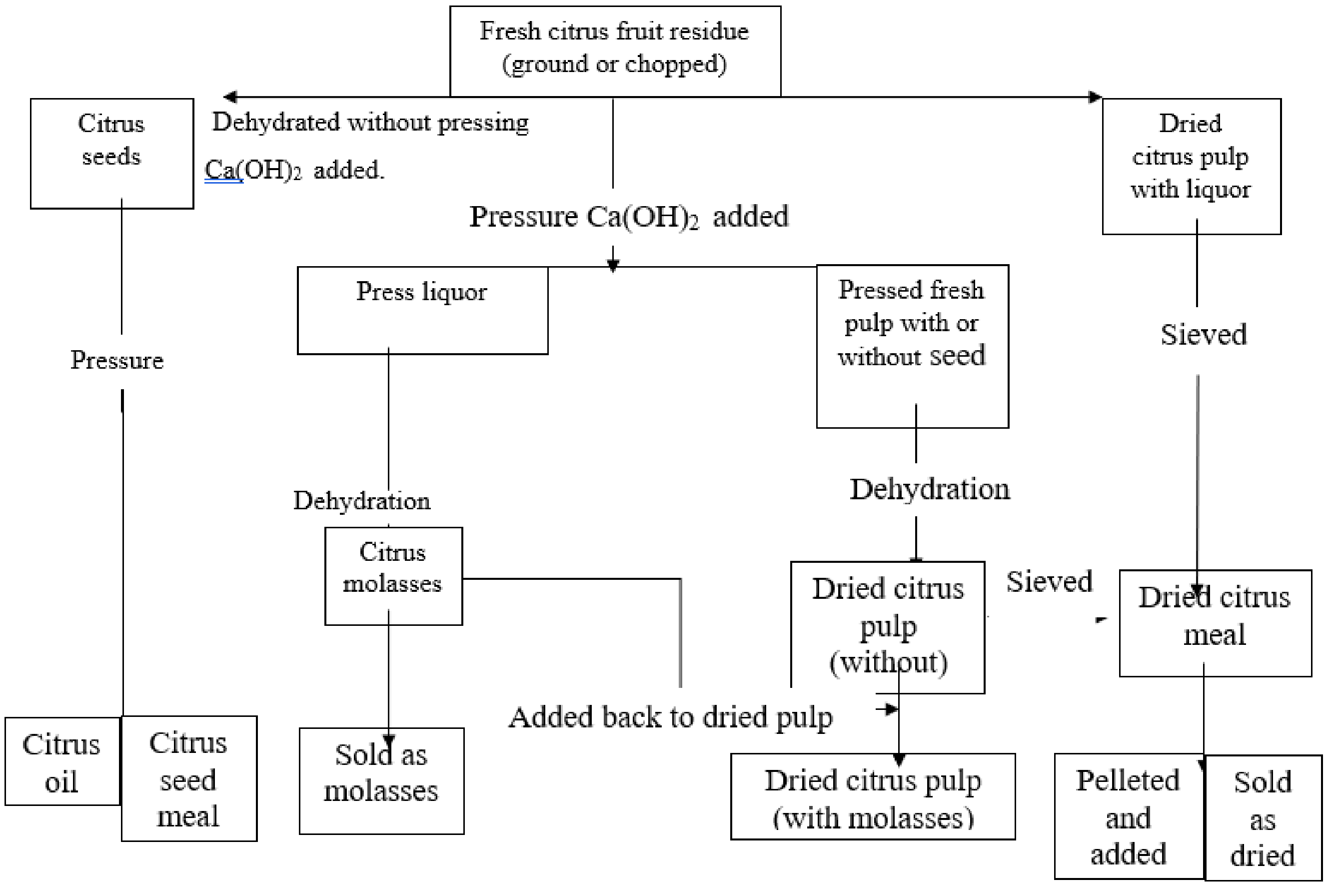

Fig. 1 Schematic presentation of citrus by-product production. (Adapted from Bapedi's and Robinson (2006)).

Table 3 Productsand by-products of various tissues of citrus fruits (Sinclair *et al*. 1984; Bambini's and Robinson 2006.)

Whole peel or rind (pericarp)	Consist of flavedo (exterior yellow peel, epicarp) and albedo (interior white spongy peel, mesocarp) .Albedo rich in pectin. The whole peel combined with the pulp residue (rag) and/or molasses can become feed for animal. It is also used for production of human foods and food supplements.
Pulp (principal edible portion, endocarp)	Used mainly to produce raw juice for human nutrition, after mechanical extraction and screening. The material screened from the raw juice is also

	called pulp and is usually combined with other residue to produce by-products used in animal nutrition.
Pulp residue(called rag in industry)	Consist of the fraction screened from the pulp, being cores, segment wall of membranes, juice vesicles and seeds. The pulp residue usually combined with peels residue to manufacture by-product feeds. From the lime treated mass peel and pulp residues, citrus processers produce such by-products, as press liquor, citrus molasses, citrus pulp, citrus meal and feed yeast. It is also used for production of human foods and food supplements.
Seeds	Sometimes separated from the rag to produce seed oil, seed meals and dried seed pressed cake.
Waste waters (aqueous effluent emulsions from processing plant)	Have potential uses for production of such products as activated sludge and yeasts. It is also used for production of human foods and food supplements.

Human Disorders and Health

Any condition that interferes with the normal functioning of the body is called a disease. In other words, disease may be defined as a disorder in the physical, physiological, psychology or social state of a person caused due to nutritional deficiency, physiological disorder, genetic disorder, pathogen, or any other reason Citrus peels has antioxidant properties that plays vital role to cure the following human disorder and improving health.

Digestion and flatulence:

Bitter orange peel is used for stomach aches and higher blood pressure. The Basque people in Europe use the leaves for stomach aches, insomnia, and palpitation and bitter orange peel as an anti-spasmodic. In traditional Chinese medicine, the peel of a immature fruit is used for indigestion, abdominal pain, constipation, and dysenteric diarrhea. Where the patient is weak, the milder, mature fruit used similarly. However, bitter orange used for insomnia and indigestion in many parts of the world

Cardiovascular health:

Orange peels contain hesperidin, a compound known for its antioxidant properties. It is also found in orange pulp but in much lower amount. Hesperidin helps in lowering the cholesterol level of the body and maintain the blood pressure. The fiber in orange is another major contributor to the heart health. Citrus fruit (especially tangerines) are one of the richest sources of pectin – a type of dietary fiber. Pectin is the major component of kind of fiber that is known to lower cholesterol pectin is also use to stabilizing blood sugar. A single orange provides 3 gm of fiber, and dietary fiber is associated with wield range of health benefit.

Cancer:

In the oil of the peel of the citrus fruits is a phytonutrient known as limonene Oranges, mandarins, lemons and limes contain significant amounts of limonene in the peel and smaller quantity in the pulp. Limonene stimulates our antioxidant detoxification enzyme system, thus helping to stop cancer (Satoh et al., 1996) before it can even begin. Limonene also reduces the activity of portions that can trigger abnormal cell growth. Limonene has blocking and suppressing action that, at least in animals, actually causes regression of tumor. Mediterranean people suffer lower rates of certain cancers than others, and researchers now believe this can partly be describing their regular consumption of citrus peel.

Weight Loss:
Tea prepared from the orange peel is an excellent remedy for weight loss. It increases metabolism, removes fat from the body and increases the body energy and stamina.

Cosmetic use:
Bitter orange extract can have antioxidant properties when eaten; however use topically its methanol content makes it potentially irritating for skin. C. aurantium Amara (bitter orange) peel extract is an extract of a peel of the bitter orange, C. aurantium Amara, as a raw material, it has reported used in cosmetic related products such like sunless tanning, conditioner, bar soap, shampoo, makeup remover, exfoliate/scrub, blush, mask, facial cleanser.
Citrus aurantium can be used to prevent skin fragility and perks up skin tone, and metabolism boosting. C aurantium peel extract is classed as a biological product and is used as a miscellaneous skin-conditioning agent as well as fragrance ingredient.

Value added products from citrus peel:
Kinnow citrus peel has assumed special economic importance and export demand being acknowledged for its higher juice contents, special flavor, delicious taste and being rich source of vitamin C. It is widely used for juices, squashes, jam, jellies and marmalade. It also provides some micronutrients such as calcium, phosphorus and iron. Essential oils are volatile oils obtained from citrus fruits peels sacks. They are used by food industry to give flavor to drinks and food. Some limonoids compounds, called limonoids glycosides, are stable at high temperatures; new products incorporating these compounds could include juices, cakes, bread and cookies. Citrus pulp and pellets are the result of the conversion of peels and pulps that have been left behind once the juice have been extracted. They are used for animal feeding.

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