



P-ISSN: 2349-8528

E-ISSN: 2321-4902

www.chemijournal.com

IJCS 2020; SP-8(4): 05-08

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Received: 04-05-2020

Accepted: 06-06-2020

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Utilization of orange peel waste in textile industry: A review

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DOI: <https://doi.org/10.22271/chemi.2020.v8.i4a.9808>

Abstract

Utilization of fruits and vegetable wastes are one of the important and challengeable works around the world. Orange peels are one of fruit waste generated mainly by the juicing industries that cause environmental problems due to its large volume of generation and physicochemical characteristics, such as soil and water pollution. Meanwhile, textile industry has been growing interest on utilization of bioresource waste derived from fruits as an important step toward sustainable development. Recently, researchers have developed various luxury materials using fruit waste from pineapple, apple, grape, and banana etc. Similarly, orange peel wastes are used as a source of natural dye, green absorber, mosquito repellent, perfume retention agent, and antimicrobial agent, and produced a luxury fiber in textile industry. This review describes the various application of orange peel waste as sustainable material in textile industry.

Keywords: Fruit waste, orange peel, natural dye, antimicrobial, luxury fiber

Introduction

The orange is a fruit belongs to the family Rutaceae, probably originated from regions comprising of Southern China, Northeast India and Myanmar (Nicolosi *et al*, 2000) ^[1]. Today, it is grown almost all over the world as a source of food for humans. The major Orange produced countries are Brazil, United States, China and Mexico. Orange is well known for most rich sources of vitamin C, it also contains considerable amounts of carotenoids, flavonoids, essentials oils and some minerals (Topuz *et al*, 2005) ^[2].

The world production of orange in 2017-18 was around 54.28 million metric tons; most are being used to make value added products such as jams, marmalades, juices, and squash, all of which result in around 3.8 million ton of orange peel waste per year. Italy alone produced about 700,000 tons of waste materials and by-products from citrus processing units every year [3]. Today, a huge quantity of fruit and vegetable wastes (FVW) and primary by-products from the fruit and vegetables processing industry are being thrown in landfills or a river, causing environmental pollution (Wadhwa *et al*, 2013) ^[4]. Utilization of waste from fruit and vegetable processing industries as local resource is one of the important and challengeable jobs around the world. The discarded fruits as well as its waste materials have been utilized as a low cost biosorbent, a substrate for the production of various enzyme and metabolites and further used for the extraction of bioactive components and functional ingredients, and livestock feed, etc. (Upadhya *et al*, 2010) ^[5]. Orange peels are one of fruit waste generated mainly by the juicing industries that cause environmental problems due to its large volume of generation and physicochemical characteristics, such as soil and water pollution. Orange peel contributes 50-65% of total weight of the fruits.

Textile industry is one of the industries, growing interest on utilization of bioresource waste derived from fruits as an important step toward sustainable development. Recently, researchers have developed various luxury materials out of fruit waste from pineapple, apple, grape, and banana, etc. in textile industry. Similarly, orange peel wastes have been used as an antimicrobial agent, mosquito repellent, natural dye, sustainable fiber, etc. in textile sector. Therefore, this review describes the various application of orange peel waste as sustainable material in textile industry.

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Application of orange peel waste in Textile industry

Use as a source of natural dye

The Carotenoids dye, orange peel waste is being used for coloring the textile fabrics. The dyes give a light orangish-yellow shade with sweet citrus smell to the fabric. Suitable mordant can be added to bind the dye on to the fibre. The color fastness to light, wash, rubbing and perspiration were good. A study done using orange and lemon peel waste as a potential natural dye and reported that the dye yield percentage improved by using 50 ml of ethanol as organic solvent for extraction (Kumar and Dhinakaran, 2017) ^[6]. There is another study reported that orange peel natural dye combined with copper sulphate mordant gave better results in terms color yield (K/S) and light fastness (Baaka *et al*, 2017) ^[7].

Use as a natural waste absorbent

The textile industries release many harmful textile effluents and discharge directly to the water bodies. These wastes disturbed the aquatic ecosystem and polluted the water. Synthetic dyes such as benzidine based dyes are well known for its carcinogenic and mutagenic nature. It is quite difficult to treat the hot and color textile dyeing wastewater because of presence of high COD (Chemical Oxygen Demand), large suspended solids and acidic pH. Hence, there is need to remove color from waste effluents before it discharge to the water bodies. There are numerous techniques to remove the dye from wastewater systems. Some of mostly widely used methods are flocculation, coagulation, precipitation, membrane filtration, adsorptions, electrochemical techniques, etc. (Naik *et al*, 2018) ^[8]. Amongst these techniques adsorption is an effective and useful process. Additionally, it is easy to operate, biodegradable, high efficiency, low cost, consume less time and can treat the dyes in more concentrated forms. Concerning the environmental point of view, scientific researchers looking for low cost and ecofriendly adsorbents to replace the expensive methods for removing the dye from wastewater. Orange peel was used as a low cost green adsorbent for the removal of dyes from textile effluents. Orange peel contains cellulose, pectin, hemicellulose, lignin and chlorophyll pigments. These components contain various functional groups such as carboxyl and hydroxyl groups, because of presence of these functional groups, therefore, the orange peel has the potential to remove metal ion from aqueous solutions (Liang *et al*, 2010) ^[9]. Another reasons is due to the presence of considerable amounts of pores in the structure of orange peel, these pores trapped and adsorbed the dyes from the waste effluents (El-Said *et al*, 2012) ^[10]. A study reported that use of discarded orange peel as an absorbent remove the reactive dye from the wastewater (AbdurRahman *et al*, 2013) ^[11].

Use for the synthesis of silver nanoparticles

Nanotechnology is one of recent technology used in textile industry. Nanoparticles are being used to improve the functionalities of the textiles. They are used mostly in functional finishes like abrasion resistance, antimicrobial, flame retardant, self-cleaning, abrasion resistance, water repellent, antistatic finishes, etc. (Hassan *et al*, 2019) ^[12]. Silver nano particles are one of nanosized metallic particles used in textile processing. The traditional methods for the synthetic of nanosized metallic silver particles are chemical reduction, electrochemical, photochemical, microwave-assisted, hydrothermal, laser ablation, and sol-gel methods (Zhang *et al*, 2014; Gudikandula and Maringanti *et al*, 2016)

^[13-14]. All these methods use very hazardous chemicals and require high energy, and moreover many issues are arises regarding the stabilization and aggregation of nanoparticles. Concerning the environment point of view, a new method was developed for the synthesis of silver nanoparticles. Additionally, this new method use nontoxic and ecofriendly renewable resources such as phytochemicals extracted from plants. A study reported that orange peel waste as a natural, renewable and ecofriendly reducing agent for the synthetic of silver nanoparticles. Nano sized silver nanoparticles extracted orange peel shows an excellent photocatalytic activity against dye molecules and further can be used for the purification of water and treatment for dye effluent (Skiba and Vorobyova, 2019) ^[15]. Another study successfully synthesized TiO₂ nanoparticles by using Orange peel (Rao *et al*, 2015) ^[16].

Use as an antimicrobial agent

Antimicrobial finishes are considered as one of most important functional finishes given to medical textiles, but also in daily wear. The detrimental effects caused by microbial growth are unpleasant odour, loss of mechanical strength, stains and discolouration of textile fibres. The application of antimicrobial finishes to textiles avoids the growth of microbes. Many antimicrobial agents such as Triclosan, quaternary ammonium compounds, metal salts based on silver, copper, zinc or cobalt, and silver nano particles, etc. are used in order to avoid the deterioration of textile fibres (Shahidi and Wiener, 2012) ^[17]. All these synthetic agents are toxic that cause many environment related issues. Considering this issue, the natural antimicrobial agents with effective antimicrobial activity are being used, and replace the synthetic agents. The application of different natural antimicrobial agents such as aloe vera, eucalyptus, turmeric, neem, and basil has been already reported in textile processing (Reshma *et al*, 2018) ^[18]. The fruits rind of citrus fruits shows an efficient anti-microbial agent, hence can be used for the preparation of anti-microbial finish of medical cloths (Tariq *et al*, 2017) ^[19]. Due to the rich of flavonoids, the orange peel has antimicrobial properties. A study reported that orange peel and papaya skin with silver nanoparticles combined induce anti-microbial properties to the fabric (Rani *et al*, 2020) ^[20].

Use as a mosquito repellent

The orange peel wastes are used as mosquito repellent, help in reducing deadliest bug on planet, mosquito bite. Interestingly, repellents of plant origin are biodegradable and do not harm to human and animals. There are two ways of coating the mosquito repellent agent on fabric surface, i.e by using paddle mangle and microencapsulation. In padding mangle technique, the orange peel dried, powdered and coated on the fabric surface using padding mangle. Whereas, in microencapsulation process, the limonene presence in orange peel were extracted using ultrasonic waves and converted into capsules form and further coated on the textile fabric. Additionally, the coated fabrics have UV protection and antimicrobial properties also (Gupta and Singh, 2017) ^[21].

Use as a sustainable fibre

The two young Italian girls, Adriana Santanocito specialized in design and innovative textile and Enrica Arena, expert in communication and marketing invented orange fiber. They collected orange peel waste from the city, washed, cleaned and processed them. The orange peel waste is processed with their patented technology known as 'Pastazzo' that extracts

the cellulose from the entire orange peel waste. International brand "H&M" purchased their patented idea, became the first brand in the world to launch the textiles made from orange peel waste. The fabric made from orange fibre gave soft touch, smooth, silky and shiny and lustrous appearance. It can weave with other existing yarn like cotton, silk and polyester; have good blending ability with other fibres. Fabric has vitamin A, C and E with natural oils therefore; wearing the textiles made out of orange fiber is like wearing a vitamin cream; it nourishes the skin of the wearer (Aishwariya, 2020) [22].

Use as a perfume retention agents

Perfume textiles are becoming popular in the markets. Earlier, perfume retention agents such as cyclodextrins, elastomer latex/synthetic resin emulsions, polyurethane urea and thermoplastic microcapsules were used to release the fragrance from textiles for longer periods of time (Ibrahim *et al.*, 2013) [23]. Now many essential oils were extracted from herbal plants and applied onto the fabric with the help of microencapsulation to achieve aromatherapy textiles. Many companies applied the fragrance to the jacket, sweater, T-shirts, socks and lingerie. Several works were reported on the application of diverse encapsulated essential oils such as migrin, lemon, mint, rosemary, limonene, lavender and rose on the textile substrates. A study reported that cotton fabric was treated with microcapsules containing lemon essential oil through padding and coating, and found that the durability of the fragrance last long when gelatin and Arabic gum use as a wall materials for microencapsulation (Specos *et al.*, 2010) [24]. Orange peel is one of source of fragrance used in perfume textiles. The fabric coated with limonene oils extracted from orange peel gave fruity orange like smells and moreover it gives the feeling of freshness to the wearer (Ghayempour and Montazer, 2016) [25].

Conclusion

Utilization of waste from fruits and vegetable processing industries is one of the important and challengeable jobs around the world. Orange peel is one of fruit waste discarded mainly by the juicing industries. After consuming or processing of fruits, peel were discarded to the landfills causing environmental pollution. Textile is one of the sectors, growing interest on utilization of bioresource waste derived from fruits as an important step toward sustainable development. Orange peel wastes are used as a source of natural dye, green absorber, antimicrobial agent, mosquito repellent, perfume textiles and produced a luxury fiber in textile industry. Hence, the orange peel waste from industry transform into sustainable and biodegradable materials in textile industry.

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