

Extraction of Pectin from Orange Peel's and Its Applications: Review

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ABSTRACT: Orange peels are a major commercial source of pectin. India is one of the large production country of orange is about 2.64 millions/year. In Maharashtra Nagpur region is well known in central Asia to produce and market hub for orange. It is also known as the California of India, producing excellent quality oranges in large number. This paper reviews the extraction process and its utilization in industry. In the past many researchers are working on the development of the part of the process technology needed for the extraction of value added products i.e. orange oil and pectin from orange peel, which is the waste of orange juice processing industry. Pectin and essential oil extracted by two methods steam distillation and leaching. The pectin yield from steam distillation is more than leaching process reported many researchers. The detail extraction processes were discussed in this paper. The pectin is majorly used in food processing industries, pharmaceutical and is traditional gelling agent for jam and jellies. The effect of various parameters on extraction of pectin and detail applications discussed after extraction processes.

KEYWORDS: Pectin, Orange peels, Extraction, Applications.

I. INTRODUCTION

Pectin has been recognised for at least 127 years back and was originally identified in 1790 in apples by the French chemist Nicholas Vauquelin. It was not until 1824 that further work on pectin was undertaken by Braconnot who named the acid, gelling substance pectic acid after the Greek word for gelling or congealing. Later, in the 1920s and 1930s, factories were built that commercially extracted pectin from dried apple pomace. In 1924 Smolenski identified the gelling substance as a polymer of galacturonic acid and later on in the 1937 Schneider and Bock established the basic formula of pectin[1-3]. Now a day pectin is recognised as a complex polymer that is present in many plants as a component of the middle lamella. Pectin is used extensively in the food industry as a gelling agent and is the key gelling agent in jam manufacture which is still one of the biggest markets for pectin. In the past Pectin sold as a liquid extract, but is now most often used as dried powder, which is easier than a liquid to store and handle. Pectin is a naturally occurring biopolymer that is finding increasing applications in the pharmaceutical and biotechnology industry [4-5]. It is also used in the food and beverage industry as a thickening agent, a gelling agent and a colloidal stabiliser. Pectin occurs commonly in most of the plant tissues, the number of sources that may be used for the commercial manufacture of pectin is limited. The various sources of pectin include citrus peels, sugar beets, residues of mango, guava, coffee, dried apple pomace, sunflower heads, papaya, and cocoa processing. Currently half of the commercial pectins used in the food industry are extracted from citrus peels. New application opportunities have emerged and pectin is no longer just a gelling agent but also used in wide applications [6].

II. HISTORICAL BACKGROUND

Pectin was first isolated and described in 1825 by Henry Braconnot, though the action of pectin to make jams and marmalades. In the 1908 the first liquid pectin extract and commercially produced in Germany. Later, in the 1920s and 1930s, factories were built that commercially extracted pectin from dried apple pomace. In 1924 Smolenski identified the gelling substance as a polymer of galacturonic acid and later on in the 1937 Schneider and Bock established the basic formula of pectin. Current years Pectin is mostly used in the form of dried powder, which is easier than a liquid to

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store and handle. Further changes of structure and location of the industry continue, but are constrained by the need for more capital investment to set up a plant of economic size, and the need for a large-scale source of raw material [8-9].

III. STRUCTURE AND SOURCES OF PECTIN

Pectin is a polysaccharide, long chains of a sugar derivative, galacturonic acid. It is present in the cell walls of plant tissues. The composition and structure of pectin are still not completely understood although pectin was discovered over 127 years ago. The structure of pectin is very difficult to determine because pectin can change during isolation from plants, storage, and processing of plant material (Novosel'skaya et al., 2000). Also some impurities which accompany the main components. Pectin for use in food is defined as a polymer containing galacturonic acid units (at least 65%). The acid groups may either be free, combined as a methyl ester, or as sodium, potassium, calcium or ammonium salts, and in some pectins amide groups may also be present. Pectin contains from a few hundred to about 1000 saccharide units in a chain-like configuration; this corresponds to average molecular weights from about 50 thousand to 150 thousand Daltons [10-11].

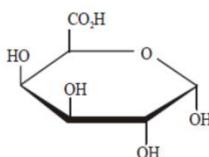


Fig. 1 Structure of Pectin

The commercial and traditional source of pectin is citrus peel and apple pomace. These are waste material from another industry such as apple pomace from a cider producer. Mostly Citrus peel has often been preferred material for pectin production due to its high pectin content and good colour properties. Generally lemon and lime peel are the preferred sources of citrus pectin. The peel must be unlimed and it cannot be enzyme treated. Lime treatment of the peel would hydrolyse all the pectin to pectic acid and peel that has been treated with enzyme to ease the peel removal will have the molecular weight of the pectin reduced. More recently other sources of pectin are beginning to find markets such as sugar beet pectin and sunflower pectin. Sugar beet pectin in particular is finding a niche market due to its unusual emulsification properties. The amounts of pectin from these different sources varies considerably as in Apple pomace (10-15%), Citrus peel (25-35%), Sugar beet (10-20%) and Sunflower (15-25%). Pectin contents of other fruits are also reported in the literature. Some of the common fruits and their pectin content are given in Table 1

Table 1: Sources of Pectin [10,11,12]

Sr. No	Pectin Source Name	% Pectic substance (by wet weight)
Low Percentage Sources [below 1%]		
1.	Pineapple [Ananascomosus L]	0.04-0.13
2.	Peaches [Prunus persica]	0.1-0.9
3.	Carrot [Daucus carota]	0.2-0.5
4.	Tomato fruit [Lycopersicon esculentum]	0.2-0.6
5.	Mango [Mangifera indica L.]	0.26-0.42
6.	Lychee [Litchi chinesis S.]	0.42
7.	Passion fruit [Passifloraedulis S.]	0.5
8.	Apple [Malus spp.]	0.5-1.6
9.	Strawberries [Fragaria ananassa]	0.6-0.7
10.	Carambola [Averrhoa carambola]	0.66
11.	Papaya [Carcia papaya]	0.66-1.0
12.	Banana [Musa acuminate L.]	0.7-1.2

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13.	Thimbleberry (Rubus rosalfolius)	0.72
14.	Guava [Psidium guajava L.]	0.77-0.99
High Percentage Sources [1% and above]		
15.	Beet pulp [Beta vulgaris]	1
16.	Apple pomace	1.5-2.5
17.	Tamarind [Tamarindus indica L.]	1.71
18.	Passion fruit rind	2.1-3.0
19.	Lemon pulp [Citrus limon]	2.5-4.0
20.	Orange peel [C. Sinesis]	3.5-5.5

IV. EXTRACTION OF PECTIN

Extraction is the most important process in the pectin production. Pectin extraction in a hot diluted strong mineral acid solution is the most commonly used method. Strong acids are corrosive and may be a potential threat to health. Moreover, the liquid waste generated from the industrial processes lead to burden the environment and a high cost might incur for treating the strong acidic waste. Pectin extracted from orange peels by mainly two ways such as fresh orange peels and from dried cake remains after steam distillation [6]. In the literature the yield of extraction of pectin from dried cake is high as compared to fresh orange peels i.e. remain after steam distillation. The Process flow chart for extraction of pectin from orange peels is given in fig 2.

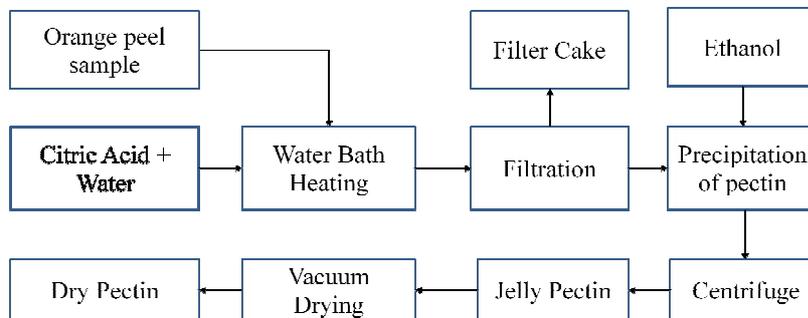


Fig. 2 Process flow chart for extraction of pectin from Orange Peel Sample

Total pectin is determined as gm/100 gm on fresh weight basis sample. Orange peels are separated from orange and dried for four days. After drying crush the dry peels and convert it in to powder form. For the extraction of pectin Orange powder is used for further experimentation. The 5 lit. distilled water and 50 ml HCL is added for blend and mixed well. After mixing kept it left for 24 hours, and then filtered in separation device. The one litre of filtrate is added to 1 litre ethanol (95%). This mixture is put into centrifugation apparatus. After that left for one hour and filtered through Buchner funnel. Add some known quantity of Acidified ethanol to residues. Wash the filtrate with 250 ml of acetone and the dried it at room temperature for one day. The dried product is grind into fine powder and sieved by 40-42 mesh sieve to separate pectin from fiber. The pectin powder is then collected, weighed. The percentage pectin yield is calculated by the ratio of dry pectin collected to initial weight of orange peels.

The pectin yield can be calculated by following way,

$$\%Yield = \frac{W_{Pec}}{W_{op}} \times 100$$

Where, W_{pec} is weight of dry pectin and W_{op} is weight of initial amount of orange peels.

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V. FACTORS AFFECTING PECTIN PRODUCTION

In extraction of pectin from orange peels affect the following parameters such as PH, temperature, solvent used for extraction, time of extraction. The detail parameters are discussed below.

1. **pH:** pH is considered as one of the more crucial parameters affecting the amount and properties of extracted pectin. In literature shows that the pectin yield decreased with increasing the pH value and vice-versa.
2. **Temperature:** At the lower temperature the yield of pectin is low while at high temperature it Combustible. As compared to low and high temperature range the pectin yield is high at moderate temperature. In literature same trend is observed in pectin yield.
3. **Solvent used for extraction:** In the literature many solvents are used for the extraction of pectin such as Citric Acid ($C_6H_8O_7$), Hydrochloric Acid (HCL), Sulphuric Acid (H_2SO_4), Nitric Acid (HNO_3), EDTA, Ammonium Oxalate ($C_2H_8N_2O_4$) and oxalic acid ($C_2H_2O_4$). The high yield is obtained by using Citric Acid as a solvent. The yield of pectin extraction is reported in literature up to 55-60% by using Citric Acid as a solvent.
4. **Time of extraction:** As the time range of extraction increased the pectin yield increases but up to a limit. The time of extraction increased to a extreme there is less effect on yield of pectin reported and also decreased from the maximum level due to the thermal degradation of the extracted pectin.
5. **Agitation Rate:** The yield of pectin keeps on increase with increase of agitation rate. This situation is due to the fact that increase stirring rate may reduce the thickness of the diffusion layer which can enhanced the extraction process.
6. **Liquid Solid Ratio (LSR):** The yield of pectin is increased firstly and gradually decline with increasing LSR is reported in literature. This is due to increasing of dissolving capacity when LSR is increased but reduced the separation ability of pectin from the solution. As for the other reason, when the LSR increase from certain values the degradation of pectin increase with the decrease of pectin concentration in the solution. This was due to the low content of raw material that provided less protection for the dissolved pectin and facilitated to the degradation of pectin.

VI. APPLICATIONS OF PECTIN

Due to the exploration and utilization of the natural properties of pectin their applications tend to become more and more varied and sophisticated. Pectin is one of the most versatile stabilizers available. It's thickening, gelling, and stabilizing attributes makes is an essential additive in the production of many food products. Pectin is traditionally used as a gelling agent in a wide range of fruit-based products, such as jams, marmalades, jellies, fruit preparations for yogurts and desserts and fruit filling for bakery products. Besides these applications pectin is also used in chocolates, delicate fruit rolls, tasty dessert toppings, tender filling for chocolates and caramel candies and foamed confectionary products. In soft drinks due to its cloud-stabilizing and viscosity properties it is used widely. Product and application development by the major pectin producers has over the years resulted in a large expansion of the opportunities and applicability of pectin. It is widely used in the food industry, medical applications, Dairy applications, pharmaceutical, Nutritional, Health, and cosmetic products. Some of the specific applications are given below.

1. Pectin and pectin derivatives are used in diarrheal disorder and constipation
2. Pectin lowers the blood cholesterol level by increasing the fecal cholesterol, fecal fat, sterols and bile acid.
3. In medicine, pectin increases viscosity and volume of stool so that it is used against constipation and diarrhea.
4. In cosmetic products, pectin acts as stabilizer
5. Pectin is used in confectionery jellies to give a good gel structure and a clean bite.
6. Pectin can be used to improve the mouth-feel and the pulp stability in juice based drinks and as a stabilizer in acidic protein beverages.
7. Pectin also reduces syneresis in jams and marmalades and increases the gel strength of low-calorie jams.
8. Pectin reduces rate of digestion by immobilising food components in the intestine.
9. It is used in the hair tonics, body lotions and shampoos.
10. It is also used in the deodorants and tooth pastes
11. Pectin is also used in wound healing preparations and specialty medical adhesives, such as colostomy devices.

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12. Pectin hydrogels have been used in tablet formulations as a binding agent and have been used in controlled-release matrix tablet formulations
13. It has been used in gentle heavy metal removal from biological systems.
14. Pectin is also used in throat lozenges as a demulcent.
15. Pectin acts as a natural prophylactic substance against poisoning with toxic cations.
16. Pectin is used to maintain the viscosity of syrups.
17. Pectin in combination with kaolin is used to prevent ulcerated mouth and throat sores.
18. A complex of degraded pectin iron is reported to be useful for the treatment of iron deficiency anemia.
19. It is also use for diabetes and gastroesophageal reflux disease.
20. It is used to make artificial cherries.
21. Pectin blocks angiogenesis in cancer cells which results in death of the cancer cell.
22. Pectin is used in dietary products due to its nutritional physiological properties
23. Pectin alone or in combination with gelatin is used as an encapsulating agent for the sustained release of medicine

VII. GLOBAL MARKET PATTERN OF PECTIN

The global market for pectin has been increasing significantly due to rising demand for food products from developed as well as developing economies. Asia Pacific is a potential market owing to the presences of emerging countries such as China and India. These country rapidly change in lifestyle of the individuals as well as changing consumer preferences for convenience foods. The industry has been mature in developed regions such Europe, followed by North America. . The demand in the region is high owing to the presence and growth of end-use application for the product. The region accounted for over 32% of the global market in 2015. Brazil is one of the largest producers of pectin, followed by Denmark and Mexico. Argentina is also a key country for growth of citrus fruits. The global market has gone from 30,000 to 60,000 tonnes per year, and day by day increasing. New players, such as Jin Feng Pectin in China now producing 1,000 tonnes, have entered the market. The overall result is that in the last decade (2005-2015), despite increases in the raw material prices and shortages of raw material supply (especially of dried citrus peel), there has been a constant growth of the pectin market, leading to significant production capacity expansion. By Focusing in R&D activities leading to product innovation is expected to provide new opportunities for the growth of the market. In addition, emerging regions such as Asia Pacific hold immense potential for the overall hydrocolloid market on account of rising consumption of convenience foods.

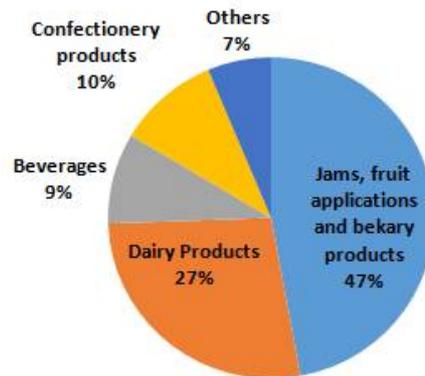
Growing health awareness among consumers for functional foods is expected to be one of the major factors driving the demand for pectin over the forecast period. Moreover, multi-functionality of pectin in various dairy and functional foods is expected to broaden their application scope in the food industry, further leading to the growth of the market. In addition, the industry has been witnessing demand for low-calorie and low-fat food products from consumers resulting in more demand for pectin from food manufacturers. Dairy & frozen product accounted for largest application segment in the overall pectin market owing to their wide consumption as stabilizers in ice-creams, yogurts etc. Leading large-scale companies such as Yantai Andre Pectin Co. Ltd. are implementing various strategies such as new product launches and expansions in order to increase their productivity and widen their global reach. B&V srl, Cargill Inc., Ceamsa, CP Kelko, Danisco A/S, and Yantai Andre Pectin Co. Ltd. are some of the leading manufacturers of pectin present in the industry. According to the latest market study released by Technavio, the global pectin market size is projected to grow to USD 1,286.2 million by 2021, at a CAGR of nearly 8% over the forecast period. The global market by application is shown in fig.3. The major pectin consumption is 47% for Jam, fruit, and bakery products.

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Global Pectin Market by Applications

Fig. 3 Global Pectin market by application

VIII. CONCLUSION

The review gives the idea about extraction of pectin from orange peels. The detail extraction process is described in the extraction of pectin section. The pectin has wide applications in the pharmaceutical, food industry, medical, Dairy, Nutritional, Health, and cosmetic products. Pectin is known for being the traditional gelling agent in jams and jellies. World over, industrial waste of both apple and citrus processing industries is used as an input for pectin. Despite abundant resources, India doesn't produce sufficient pectin to cater to the domestic demand. Nowday India has better opportunity in the field of pectin production. As research and development (R&D) recently increasing to find more yield of pectin, in future we expect many innovative and exciting applications in the field of extraction of pectin. Its opportunity for young researchers those who want to enter the business with serious long-term commitment.

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