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Extraction Of Pectin From Orange Peels : A Review

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Abstract : The aim of this study is to extract pectin from orange peels. In order to increase profits for citrus orange producers, farmers and processors, orange peels, a by-product of citrus orange processing, were studied as a source of pectin. Orange, specifically, the sweet orange is the most commonly grown orange tree. The present work is addressed to the development of the process required for the extraction of value added products like pectin from orange fruit peel, which is the waste of orange juice processing industry. The outcome of the present work highlighted that the sweet orange are good source of pectin and does have the potential to become important raw material for food processing industries. Extracted pectin from these orange fruit peel is majorly used in food processing industries, pharmaceutical and is traditional gelling agent for jam and jellies.

IndexTerms - Pectin,value added products,orange.

INTRODUCTION

The increasing rate of production and consumption of fruit, vegetables, and their products increased waste generation and landfills.This waste is biodegradable but more than required produce is also a major concern as it contributes to environmental pollution. These wastes are also composed of valuable and useful components which are having industrial applications. Therefore, the research is more towards the extraction and utilization of these valuable components[25]. Pectin one of the components majorly found in agro-industrial waste consists of fruits and vegetable waste [25]. Pectin is obtained by the aqueous extraction of the plant materials and basically from citrus fruit peel and apple pomace etc, followed by a decided precipitation using alcohol or salt.

Pectin (derived from Greek meaning –congealed and curdled‖) is a structural hetero-polysaccharide contained in the primary cell walls of plants. Orange trees are widely cultivated in tropical and subtropical climates for, which is peeled or cut (to avoid the bitter rind) and consumed whole, or processed to extract orange juice, and for the peel. Pectin are a class of complex polysaccharides found in the cell walls of plants, where they work as a hydrating agent and cementing material for the cellulosic network. Pectin also has several unique properties that have enabled it to be used as a matrix for the entrapment delivery of a variety of drugs,proteins and cells.[15]

Orange are citrus fruits which is composed of two parts namely the peels (rind). These two parts are easily separated from each other with the pulp serving as the edible parts of the orange fruit while the peels as a good source of pectin. Pectin is a natural biopolymer that is has increasing applications in the pharmaceutical and biotechnology industry.

The raw materials used have a large amount of pectin with good quality are available in sufficient quantities to make the manufacturing process more economical.[18] Commercially pectin is commonly extracted from apples and citrus fruits.Researches have been focused on the extraction of pectin from various industrial by-products, which presents itself as a green sustainable option for the valorization of agro-industrial residues, in line with the concept of circular bioeconomy.[20,21] Following FAO regulation, pectin must contain at least 65% galacturonic acid. It is usually found in the cell walls and middle lamella of the plants.

The main raw materials used to produce commercial pectin are apple pomace and citrus peel such as lemon and orange, sugar beet and sunflower heads. Pectins are extracted at a lower pH and higher temperature. Pectin forms gels with sugar and acid the structure of pectin is very difficult to determine because pectin can change during isolation from plants, storage, and processing of plant extract. [23] Pectin is used not only in food processing in jam, jellies, marmalades, ketchups, sauces, juices, concentrate, syrups, and yoghurt etc., but also in pharmaceutical industry such as medical formulations for stabilizing the suspensions. It has an important role in the cosmetic sector.Its tremendous potential has drawn the attention of food researchers for several years.Orange peel and pomace, guavas, jack fruit, papaya, Assam lemon,mango peel, and apple pomace have been studied for their pectin.[24]

HISTORY

The preparation of fruit jellies was carried out long time before the discovery of pectin.The first information on water soluble substances having a strong gelatinizing effect,was given by Vauquelin in 1790. He showed that the expressed juice of tamarinds and other fruits solidifies, when left t rest, to a transparent jelly, which may be purified by draining off the juice and after washing.

Pectin was first isolated and described in the year 1825 by Henri Braconnot. He defined pectin as the gelatinous substance in fruit that gave them the ability to form jellies on boiling with sugar. Braconnot recognized that sugar and the accurate pH were necessary for the reaction, and he mentioned that he had to add a small amount of acid “to break up the pectates” when making his jellies. Braconnot derived the term ‘pectin’ from the Greek word πηκτικός meaning “to congeal or solidify”.To obtain well-set jams from fruits that had little to poor quality pectin, pectin-rich fruits and their extracts were mixed into the recipe.

In the Industrial Revolution, manufactures of fruit preserves turned to producers of apple juice to obtain dried apple pomace that was cooked to extract the pectin.In the 1920s and 1930s, factories were built that commercially extracted pectin from dried apple pomace, and later from citrus peel, in regions that produced apple juice in both the USA and Europe.[8]

Pectin was first extracted from the waste remains of crushed apples (apple pomace) from making juice or cider. Today most pectin is extracted from citrus rinds. The long polymer of pectin binds the liquids with the dissolved and suspended solids forming a gel. Pectin allows a wider range of fruits to be made into jellies, jams, and preserves. Pectin gave momentum to the fruit-flavoured candy industry in Europe.Pectin was first sold as a liquid extract, but is now most often used as dried powder, which is easier than a liquid to store or handle.[8]

STRUCTURE

Pectin is a linear polysaccharide. Similar to manyplant polysaccharides, it is both polydisperse and polymolecular and the composition changes with the source and the conditions used through the isolation. In any sample of pectin, parameters like molecular weight or the content of subunits will change from molecule to molecule.Pectin compositions and structures are strongly dependent on the its’ source,developmental stages of plants, and extraction conditions. Pectin is composed of D-galacturonic acids (GalpA) α-(1,4) linked to form backbone interrupted by (1,2)-linked β-L-rhamnose (Rhap). There are a consensual classification of pectin based on three main structural domains: homogalacturonan (HGA), alternating with two types of highly branched rhamnogalacturonan regions designated as RG-I and RG-II.Structural classes of pectic polysaccharides also comprise xylogalacturonan, apiogalacturonan, arabinan, galactan, and arabinogalactan. The pectin structure largely governs its physicochemical properties and its applications for several purposes.[2,7]

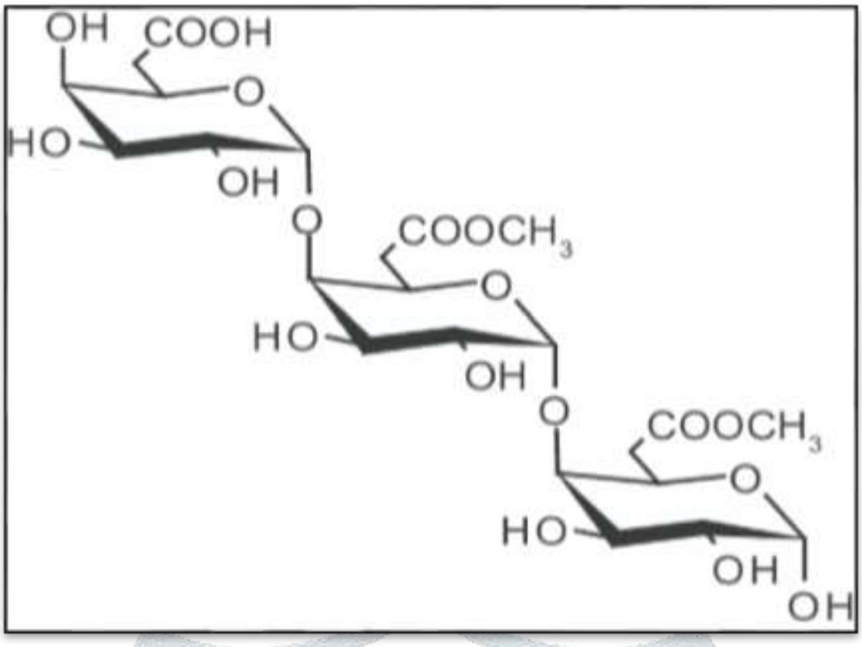

Fig No.1: Structure of pectin

However, not only these chemical variables are important but also the composition of neutral sugars, degree of branching, and degree of polymerization (molar weight), which can modify the structure of this complex polysaccharide. The pectin gelation process is strongly affected by the pectin degree of esterification(DM).

Depending on the DM of pectin (defined as percentage of carboxyl groups esterified), two different procedures of pectin gelation can be distinguished. High-methoxylated pectins (DM > 50%) are pectin formed in the presence of cosolutes as sucrose, at a concentration > 55%, and under pH < 3.5. Low-methoxylated pectins (DM < 50%) are gels created with the presence of divalent cations, mainly Ca2+.High and low methoxyl pectins have diverse physicochemical properties and therefore have varied applications. High methoxyl pectin can be used as a gelling agent, emulsifier, stabilizer, and thickener in the food industry for the production of jams and jellies. Low methoxyl pectin can be used as a fat replacer, ice cream, yoghurt, bakery glazing, emulsified meat products, and for low calorie products. The diversity of pectin structures influences the physicochemical properties and also different technological applications, biological activities, biofunctionality, and therapeutic properties.

SOURCES OF PECTIN

The commercial and the traditional sources of pectin are citrus fruit peels and apple pomace. These are waste materials from industries such as apple pomace from cider producer.Usually citrus peel has often been preferred material for pectin production due to its high pectin content and good colouring properties. Mostly orange,lemon and lime peel are the sources preferred of citrus pectin. The peel must be unlimed and it cannot be treated by enzyme. Lime treatment of the peel would hydrolyse all the pectin to pectic acid and peel is treated with enzyme to ease the peel removal will have the molecular weight of the pectin reduced.Recently other sources of pectin are beginning are finding markets such as sugar beet pectin and sunflower pectin. Sugar beet pectin in particular is finding a niche market due to its unusual emulsifiaction 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 .[8]

Table No1: Source of pectin[8]

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

High Percentage Sources [1% and above]	
Beet pulp [Beta vulgaris)	1
Apple pomace	1.5-2.5
Tamarind [Tamarindus indica L.]	1.71
Passion fruit rind	2.1-3.0
Lemon pulp [Citrus limon]	2.5-4.0
Orange peel [C. Sinesis]	3.5-5.5

GENERAL PROPERTIES OF PECTIN

Pectin have good solubility in pure water. When dry powdered pectin is added to water it hydrates very rapidly, and form clumps. These clumps consist of semidry clumps of pectin and contained in an envelope of highly hydrated outer coating. Clump formation can be avoided by dry mixing of the pectin powder with water-soluble carrier substance or by the use of pectin having enhanced dispersibility through special treatment during manufacturing. Pectin solutions have viscosity, solubility, and gelation like many qualities. For example, factors that improve gel strength will improve the tendency to gel, decrease solubility, and increase viscosity, and vice versa.[26].

Gel Formation Properties of Pectin[18]

- The major application of pectin is based on its gel forming ability. The specific structure of pectin is responsible for some specific constraints.
- The gel forming ability of pectin is because of hydrogen bonding between free carboxyl groups on the pectin molecules.
- When the acid is added, the carboxyl ions are converted to unionized carboxylic acid groups.
- The decrease in number of negative charge leads to decrease in attraction between pectin and water molecules, and also decreases the repulsive forces between pectin molecules.Sugar further decreases hydration of the pectin by competing for water.
- These conditions make pectin to stay in a dispersed form.
- On cooling, the unstable dispersing of less hydrated pectin leads to formation a gel.

❖ A network of pectin leads to holding the aqueous solution.The rate at which gel formation takes place is very vital to understand the nature of pectin.

❖ Sugar is not essential for gel formation but the presence of small amounts (10-20%) of sugar tends to decrease syneresis and adds required firmness of these gels. When sugar is present,the amount of calcium required to form gel is decreased.[26]

DESCRIPTION

Most commonly used methods are -

1. Microwave-assisted extraction (MAE)
2. Ultrasonic-assisted Extraction
3. Dielectric Barrier Discharge Plasma Extraction (DBD)
4. Thermo Mechanical Extraction Method
5. Enzymatic Extraction

VARIOUS PROCESSES OF EXTRACTION OF PECTIN

1.MICROWAVE-ASSISTED EXTRACTION [7]

❖ Microwave-assisted extraction (MAE) is an emerging technique where, polar solvent absorbs microwave energy and includes two oscillating perpendicular fields i.e. Electric & Magnetic fields.

❖ MAE is rapid extraction technique which includes the use of electro-Magnetic radiation in the microwave frequency range in the sample to produce thermal energy in solvent. The solvent used here is EDTA and naoh. Microwave energy starts an electrophoretic transfer of ions as well as electrons that generates an electric field which is responsible for particle movements, while dipole Rotation is occurred due to alternate displacement of polar molecules. Microwave energy increases efficiency of the extraction process as compared to the conventional heating techniques. The heat generated is an important factor in the extraction process as the higher temperatures causes an increase in diffusion rate and hence, enhance extraction Yields. Also , the dielectric properties of the sample and solvent and solubility of the interesting compounds in the solvent also affect the extraction rate and quality of extracted Compounds.

❖ When dried orange peels are kept in microwave radiation, there is inactivation of pectin esterase enzyme and destruction of orange skin Cells due to rapid heat generation in microwave environment Since the pectin esterase interfers with pectic substances in an Orange peels and reduces their solubility, their inactivation improves The pectin extraction. Moreover, due to breaking of Parenchyma cells,there is an increase in specific surface area, which enables the water absorption capacity of plant cell. It is Used to reduce extraction time and energy.

❖ There is no any significant difference in yield and quality Characteristics extracted from both conventional extraction & MAE except moisture and ash content Increase in microwave power did not affect yield.

2 .ULTRASONIC-ASSISTED EXTRACTION [7]

❖ Ultrasounds (Us) are widely employed in the food sector. There are many potential applications of this in the food industry such as extraction, emulsification, filtration,cutting, or food preservation, etc.Ultrasonic waves ranges from 20 to100 khz, are many times used in U-assisted extraction.Ultrasonic-assisted extraction is used to reduce extraction time and increase yield than conventional methods (hydrolysis in an acid medium).

❖ In this method, sound waves allows to pass through a liquid medium, which creates compression & expansion. This process leads to cavitation i.e. production, growth, & collapse of the bubbles . This reslus the formation of unstable microscopic bubbles which have high temperatures and pressures. Cavitation occurs near the surface of the target material. Due to which it affects the plant matrix and allows better penetration of the extractor solvents , thus extraction efficiency is better.The Significant benefits of U-assisted extraction are reduction in extraction time, equipment size, and energy consumption, and improved extraction yield, and it is more environmentally friendly than the conventional method.

3.DIELECTRIC BARRIER DISCHARGE PLASMA EXTRACTION (DBD) [7]

❖ Plasma includes partly ionized gases containing species like negative and positive ions, electrons, gas atoms, etc. The Dielectric barrier discharge (DBD), radiofrequency, gliding arc discharge, etc. are methods that generate atmospheric cold plasma. DBD can change the biomacromolecule's side chains by an action of the chemically active species constituting the plasma or break down specific bonds for the destruction of the secondary structure

❖ It could be used to degrade biopolymers, including proteins and polysaccharides. The hydroxyl free radicals produced by high-energy electrons from the DBD process attack the pectin chains & degrade them into molecules of smaller sizes.The pectin extraction by DBD plasma has not attracted much attention and there is limited research on this topic. DBD may also be used to modify pectin structure in the future.

4. THERMO MECHANICAL EXTRACTION METHOD: [7]

❖ This method has been used in Locations where drying facilities and/or solvent extraction Units cannot be installed. However these processes have poor Yields and frequently require the use of chemical aids. Thermo mechanical extraction method also use high pressure Boiler so it needs high steam consumption.

5. ENZYMATIC EXTRACTION [7]

❖ Enzymes are used to improve the extraction process by hydrolysing the matrix of the plant cell wall. These reactions break cell wall & increase cell permeability. Enzymatic extraction depends on concentration of enzyme, reaction temperature,time,the particle size of the plant material,and type of an enzyme. The enzymatic extraction of pectin is carried out by pectinases which are enzymes mainly extracted from fungi.

❖ Pectinase is a generic term designating several enzymes species, including esterase's (pectin methyl esterases), hydrolases (endo- and exopolygalacturonases), and lyase (pectine lyases).The enzymatic treatment interferes with the glycosidic bonds of the pectin and ensures their breakagePectinase is a generic term designating several enzymes species, including esterases (pectin methyl esterases), hydrolases (endo- and exopolygalacturonases), and lyase (pectine lyases).

❖ The enzymatic treatment defermetss with glycosidic bonds of pectin and ensures their breakage.This action decreases the viscosity of the solutionn, facilitating filtration and centrifugation.This extraction method has the advantage of being less polluting as compared to others. Also, pectinases have specific reactivity to pectin.but ,enzymatic production remains expensive and the reaction is difficult to control. Finally, this method can lead to a degradation of the pectin and a loss of its properties.

EXPERIMENTAL METHOD

MATERIALS AND METHOD

Material: HCL, Acetone, Ethanol, Lemon and orange peel, Distilled water. [15]

Sample preparation:

Fresh Orange fruits were purchased from market. The fruits were physically examined to ascertain their wholesomeness. All the oranges were split/cut into four parts and the peel removed (a soft white substance inside the skin of citrus fruits), then the peels were further cut into smaller pieces for easy drying and washed with large quantity of water to remove the Glycosides the bitter taste of the peels and then weighed with a digital weighing balance and air dried. [15]

Procedures in Heating Pretreatments:

The following procedures were used to conduct heating pretreatments.

1] 5g of orange peel powder was added in to 1000 ml conical flasks. Then 300ml of distilled water was added to beaker.
2] The conical flasks was capped with the help of rubber plugs, shaker substrate primarily after checking for PH using a digital PH meter.
3] The PH then was adjusted to 1.96-2.1. Hydrochloric acid solution was added dropwise to the other flask with constant stirring until the pH reached to a range of 1.96-2.1.
4] Water bath was heated at a temperature of 80°C for (1-2) hours.
5] After finishing the given pretreatment time and temperature the sample in water was allowed to cool and separate soluble pectin from the insoluble by filtrate.
6] The soluble pectin was precipitation of pectin in the next steps & the soluble solution in another 1000ml of beaker. [13]

Pectin extraction from prepared sample:

1] The dried peels were separately transferred into a beaker containing of water 2.5 mL hydrochloric acid was added to give a pH of 2.2.
2] This mixture was then boiled separately
3] Thereafter, the peels were removed from the extracts by filtering through a filter paper filter study.
4] The cake was washed with boiled water and the combined filter allowed to cool to 25°C to minimize heat degradation of the pectin.
5] The extracted pectin was precipitated by adding 95% ethanol to the extracted pectin with thorough stirring, left for 30 min to allow the pectin float on the surface.
6] The gelatinous pectin flocculants was then skimmed off.
7] The extracted pectin was purified by washing in ethanol and then pressed on a nylon cloth to remove the residual HCl and universal salt.
8] The resulting pectin was weighed and shredded into small pieces and was air dried. Finally, the dried pectin was further reduced into smaller pieces using a pestle and mortar and weighed using a digital weighing balance.
9] Percentage yield of pectin from initial wet peels was then determined on both wet and dry weight basis. [15]

Filtration

The cake was removed from the extracts by using filter cheese cloth. After that the extracted pectin was precipitated by adding equal ratio of ethanol to the extracted of pectin with thorough stirring, left for some time to allow the pectin float on the surface.[13].

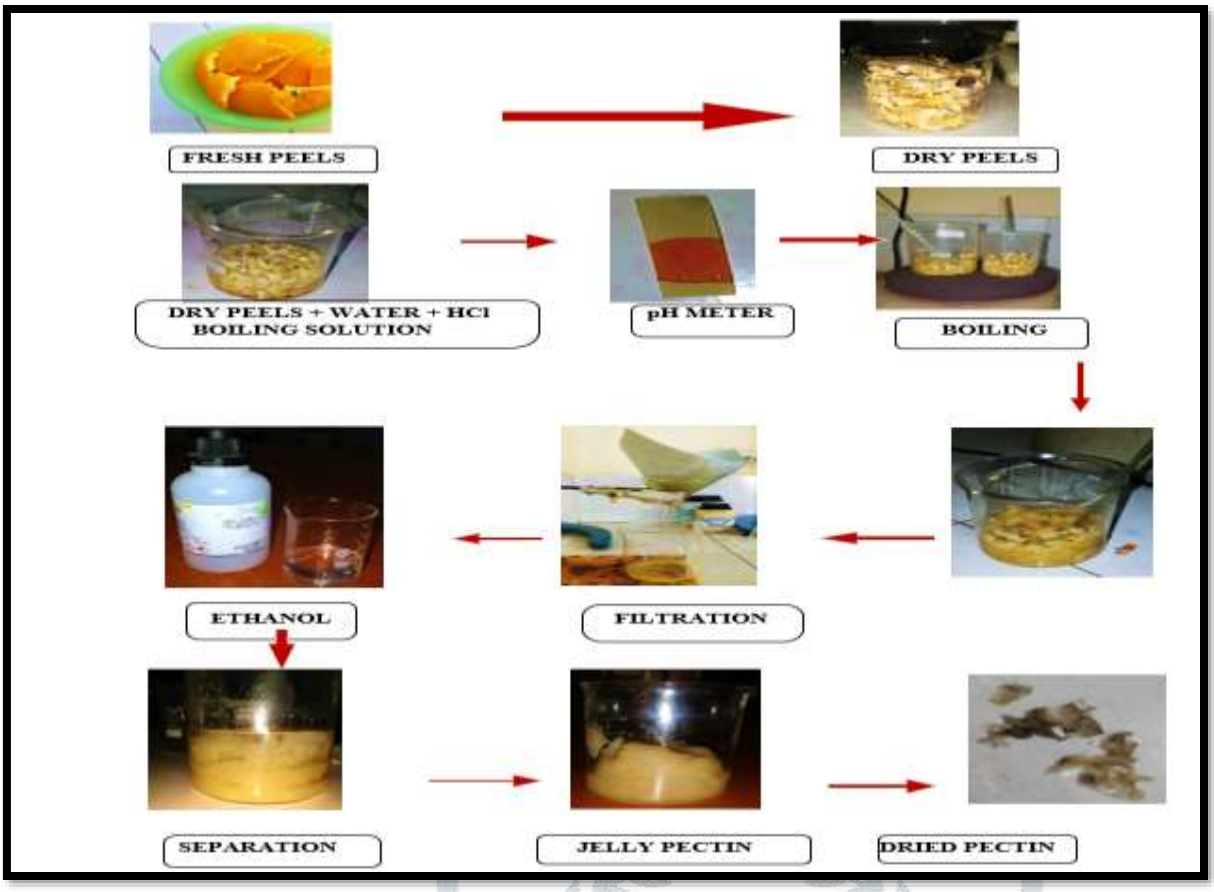

FIG No.2: Process flow diagram of extraction of pectin from orange peels

CHARACTERISATION OF PECTIN

1. QUALITATIVE ANALYSIS

1.Pectin colour:

Dried pectin samples were observed visually and the colours of samples were noted down. [15]

2.Solubility in hot and cold water (dry pectin):

Initially, 0.03g of the pectin samples were taken in different conical flasks with 10 ml of 95% ethanol added followed by 50 ml distilled water. The mixture obtained was shaken vigorously and a suspension was formed which was then heated at 85-95°C for 15 min using magnetic stirrer [15]

3.Solubility in hot and cold alkali (NaOH):

Initially, 10 ml of 0.1N NaOH taken in a conical flask, 0.1g of dry pectin was added and was heated at 85-90 °C for 10- 15 minutes using magnetic stirrer. [15]

4.Precipitation:

The alcohol insolubility of pectin has been developed into a test for traces of pectin in fruit Juices. A positive reaction is indicated by the development of a stringy, gelatinous deposit. [6]

5.Chromophore Formation:

In histological testing, pectin may be distinguished from surrounding non pectin material by staining with ruthenium red (ammoniated ruthenium oxychloride). A positive test is evidenced by the typical pink color (pectin) on a gray background (lignin and cellulose).[6]

6.Decarboxylation:

A vigorous evolution of CO_2 and appearance of a pentose derivative, notably furfural, resulting from the action of strong mineral acids and heat on pectin, is claimed to be a good indication of the presence of pectin. [6]

7.Differential staining (in leaf sections) was accomplished with alkaline NH_2OH FeCl3. The reaction converts pectin carboxyl groups to hydroxamic acids, resulting in water-insoluble, red complexes in excess Fe(UI)The test is specific for pectin.[6]

Table No.2 : Result of The Qualitative Test for Samples

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S. No	Parameter	Orange
1	Colour	Yellow
2	Solubility in cold water	Dissolved slightly and form suspension after vigorous shaking
3	Solubility at 85 - 90^0 C for 15 min	The mixture dissolve
4	Solubility at pectin suspension in cold alkali	The pectin suspension forms yellow precipitate
5	Solubility of pectin suspension in hot alkali	The pectin suspension dissolved and turned milky

2.QUANTITATIVE ANALYSIS [10]

1. Equivalent Weight:

- Equivalent weight is used for the calculating *anhydrouronic acid content* and *degree of esterification*.
- It is determined by the titration with the sodium hydroxide to pH 7.5 using phenol red
- 0.5 g sample was taken in the 250 ml conical flask and 5 ml ethanol was added. 1 g of the sodium chloride to sharpen end point and the 100 ml of the distilled water added. Finally 6 drops of the phenol red were added and titrated against 0.1 N NaOH, Titration point was indicated by the purple color. This is neutralized solution was stored for the determination of the methoxyl content.
- Equivalent weight calculated using equation:

$$\textbf{Equivalent Weight} = \frac{\textit{Weight Of Pectine Sample} \times 100}{\textit{ml of Alkali} \times \textit{Normality of Alkali}}$$

Equivalent weight = $\frac{0.5 \times 1000}{0.9 \times 0.1}$ = **5555.55 gm**

2. Methoxyl Content (MeO)

- Important factor in the *controlling setting time of pectin and sensitivity to polyvalent cations, and their usefulness in preparation of low solid gels, fibres and film is methoxyl content*
- It is determined by the saponification of pectin and the titration of liberated carboxyl groups.
- The neutral solution was collected from the determination of equivalent weight, and 25 ml of the sodium hydroxide (0.25 N) was added. The mixed solution was stirred thoroughly and kept at room temperature for the 30 min. After 30 min 25 ml of 0.25 N hydrochloric acid was added and the titrated against the 0.1 N of NaOH to same end point

$$\textbf{Methoxyl Content (\%)} = \frac{\textit{ml of alkali} \times \textit{Normality of alkali} \times 3.1}{\textit{Weight of sample}}$$

Methoxyl Content = $\frac{5.9 \times 0.1 \times 3.1}{0.5}$ = **3.658 %**

3. Total Anhydrouronic Acid Content (AUA)

- Estimation of anhydrouronic acid content is essential to determined the *purity and degree of esterification, and to evaluate the physical properties.*
- Pectin, which is a partly esterified polygalacturonide, contains 10% or more of organic material composed of arabinose, galactose and perhaps sugars. Making used of the equivalent weight and methoxyl content value of titre used.

❖ Total AUA of pectin was obtained by the following formula,

$$\textbf{\% of AUA} = \frac{176 \times 0.1z \times 100}{w \times 1000} + \frac{176 \times 0.1y \times 100}{w \times 1000}$$

$$\% \text{ of AUA} = \frac{176 \times 0.1 \times 0.9\ 100}{0.5 \times 1000} + \frac{176 \times 0.1 \times 5.9 \times 100}{0.5 \times 1000} = \mathbf{23.936\ \%}$$

Where ,
molecular unit of AUA (1 unit) = 176 g
Z = ml (titre) of NaOH from equivalent weight determination.
Y = ml (titre) of NaOH from methoxyl content determination.
W = weight of sample

4. Determination of Degree of Esterification (DE)

The Degree of Esterification of pectin was measured on the basis methoxyl and Anhydrouronic acid content and calculated by following formula.

$$\textbf{\% DE} = \frac{176 \times \%MeO}{31 \times \%AUA} \times 100$$

$$\textbf{\% DE} = \frac{176 \times 3.658}{31 \times 23.936} \times 100 = \mathbf{86.764\ \%}$$

Where ,
MeO = Methoxyl content,
% AUA = Anhydrouronic Acid Content

5. Moisture content:

1g of sample was weighed in the desiccators and then dried in the oven for 4 hour at 100°C.Then cooled over silica gel. Percent moisture observed is added (1%) to obtained the agreement with the Fischer method

$$\textbf{\% Moisture content} = \frac{R}{W} * 100$$

$$\% \text{ Moisture content} = \frac{0.8}{1} * 100 = \mathbf{80\%}$$

Where, R=Weight of the residue
W=Weight of the sample

6. Percentage yield of pectin:

The pectin yield was calculated by equation

$$\textbf{Y pec(\%)} = \frac{P}{Bi} \times 100$$

$$\text{Ypec(\%)} = \frac{1.594}{25.29} * 100 = \mathbf{6.3\%}$$

Where, Y pec (%) is the extracted pectin yield in percent(%),
P is the amount of extracted pectin in g and Bi is the initial amount of orange or lime peel

Table No.3 : Result of The Quantitative Test for Two Samples.

S. No	(%)	Orange
1	Equivalent weight	5555.55 gram
2	Methoxyl content	3.658 %
3	Total Anhydrouronic Acid content	23.936 %
4	Degree of esterification	86.764 %
5	pH	2.2 -2.5
6	Percentage yield of pectin on dry basis	6.3 %
7	Moisture Content	80 %

FACTORS AFFECTING PECTIN PRODUCTION [8]

The extraction of the pectin from orange peels were affect the parameters like PH, temperature, solvent used for extraction, time of extraction. [8]

❖ **pH**: pH is considered as the one of the more crucial parameters affecting the amount and the properties of extracted yield of the pectin. In the literature shows that pectin yield were decreased with increasing in the pH value and the vice-versa. [8]

❖ **Temperature**: At the lower temperature the yield of the pectin is low while at the high temperature it is Combustible. As compared to the low and high temperature range the pectin yield is high at the moderate temperature. [8]

❖ **Solvent used for extraction**: In literature many solvents are used for extraction of the pectin such as Citric Acid Hydrochloric Acid , Sulphuric Acid, Nitric Acid, EDTA, Ammonium Oxalate) and oxalic acid. The high yield is obtained by using Citric Acid as a solvent. [8]

❖ **Time of extraction**: As the time range of the extraction increased the yield of the pectin increases but up to a limit. The time of the extraction is increased to a extreme there is less effect on the yield of pectin reported and also decreased from maximum level due to thermal degradation of extracted pectin.

❖ **Agitation Rate**: The yield of the pectin keeps on the increase with the increase in the agitation rate. This situation is due to fact that the increase stirring rate may reduce thickness of the diffusion layer which can be enhanced the extraction process. [8]

❖ **Liquid Solid Ratio (LSR)**: The yield of the pectin is increased first and then gradually decline with the increasing LSR is reported in the literature. This is due to the increasing of dissolving capacity when LSR is increased but reduced the separation ability of the pectin from solution. When the LSR increase from the certain values the degradation of pectin increase with decrease of the pectin concentration in solution. This is due to the low content of the raw material that provided less protection for dissolved pectin and the facilitated to degradation of the pectin. [8]

EFFECT OF PARAMETERS ON PECTIN YIELD

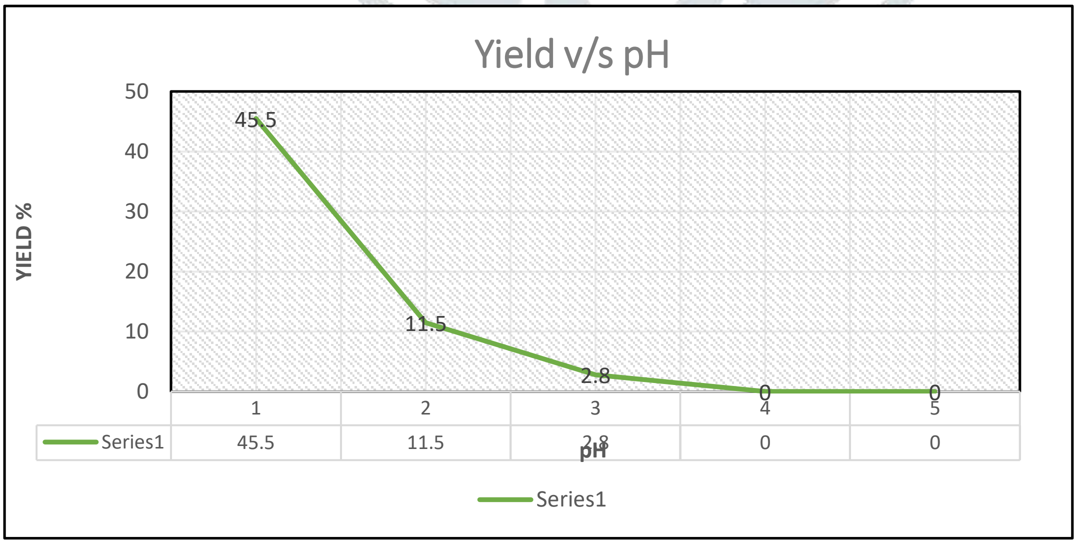
1. EFFECT OF pH

- It shows that % yield of the pectin increased as the pH value increased in fresh peel Extract. [6]
- In other words, the more acidic solvent is, the more the yield of the pectin [6]
- The maximum yield of the pectin obtained at extraction medium pH of 1.

However negligible yield is obtained at pH of 4 and 5 seen from Graph plotted between the pectin yield % obtained for the Various values of the pH of medium as shown in fig, [5]

Table No.4 : Experimental observations of yield of pectin at different pH[5]

Solution of pH	pH 1	pH 2	pH 3	pH 4	pH 5
Volume taken for extraction (ml)	100	100	100	100	100
Amount of peel sample (g)	10	10	10	10	10
Extraction temperature	80	80	80	80	80
Extraction time (minute)	5	5	5	5	5
% yield of pectin obtained	45.5	11.5	2.8	-	-



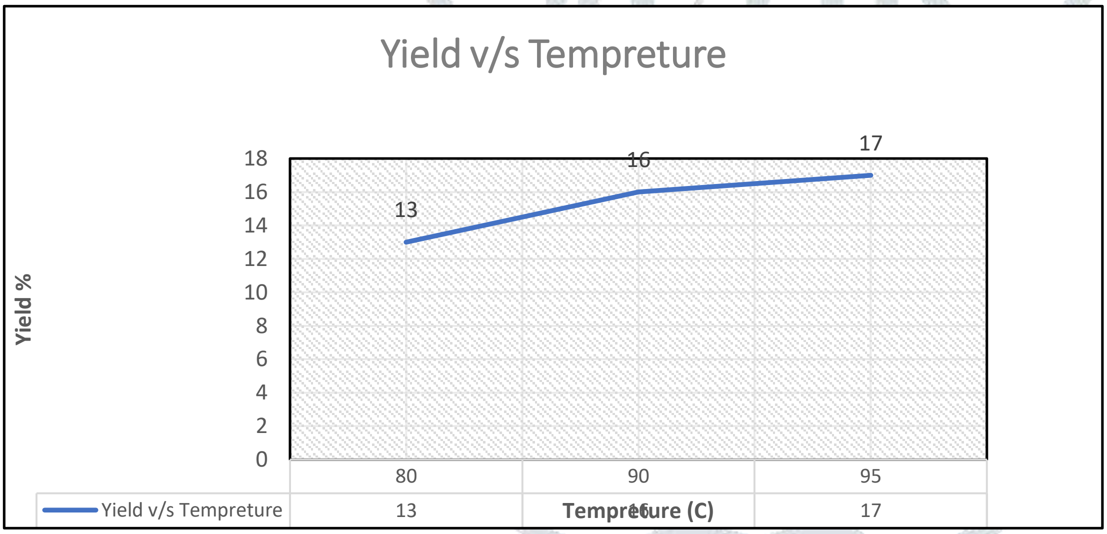
Graph No.1 : Effect of pH on yield of pectin from dried peels

2. EEFECT OF TEMPERATURE

- ❖ The yield increases with increasing the temperature for Orange peels at the constant pH Concentrations. Because increasing extraction temperature would increase solubility of extracted pectin, giving higher rate of extraction.
- ❖ However, further increase in temperature Beyond 80℃ shows a decreasing tendency of the pectin yield.
- ❖ However, high temperature encourages the energy loss through vaporization and increases the cost of extraction process from industrial point of view. On the other hand, Yield decreases with the increasing temperature for the Orange peels at the increasing pH concentrations. [17]

Table No.5 : % yield is plotted against the highest values of temperature

Temperature(C)	% yield
80	13
90	16
95	17



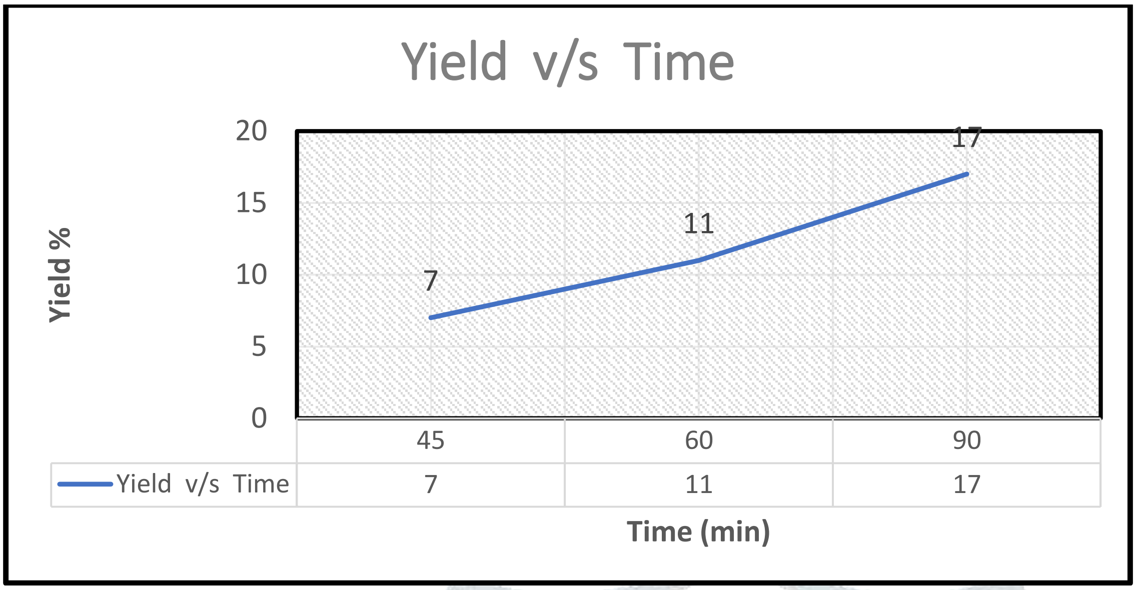
Graph No.2 : Effect of temperature on yield of pectin from dried peels

3.EFFECT OF TIME

- ❖ The effect of the time on pectin yield was determine by if the increasing in the extraction time would be increase the yield of the pectin.
- ❖ There was an increase in yield as extraction time was increased.[6]

Table No.6 : Effect of time on the dry peel

Time (min)	% yield
45	7
60	11
90	17



Graph No.3 : Yield of pectin(%) with time

APPLICATIONS OF PECTIN

Due to the exploration and utilization of the natural properties of pectin and their applications become more varied and sophisticated. Pectin is the versatile stabilizers. It is gelling, thickening, and stabilizing attributes makes an essential additive in the production of many food products. Pectin is the traditionally used as gelling agent in 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 , tasty dessert toppings chocolates, delicate fruit rolls, 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 major pectin producers has over the years resulted in a large expansion of the opportunities and applicability of the pectin. It is widely used in food industry, medical applications, pharmaceutical, Nutritional, Health, and cosmetic products, , Dairy applications. Some of the specific applications are given below. [8]

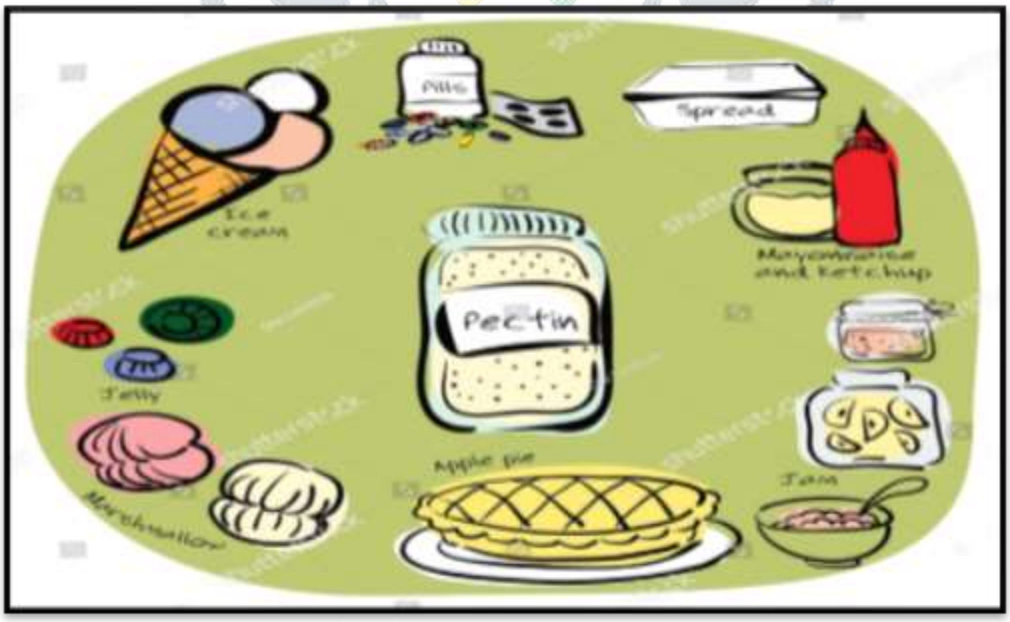


Fig No.6 : Applications of pectin

1. Pectin derivatives are used in diarrheal disorder , constipation. [8]
2. Pectin lowers blood cholesterol level by increasing the fecal cholesterol, fecal fat, sterols and bile acid.[8]

3. In medicine, pectin increases viscosity and volume of stool so that it used against constipation.[8]
4. In cosmetic products, pectin acts as stabilizer [8]
5. Pectin is used in the confectionery jellies to give good gel structure and clean bite.[8]
6. Pectin can be used to improve mouth-feel and pulp stability in juice based drinks and as stabilizer in the acidic protein beverages.[8]
7. Pectin also reduces the syneresis in the jams and the marmalades and to increases gel strength of the low-calorie jams.[8]
8. Pectin reduces the rate of digestion by immobilising food components in intestine. [8]
9. It is used in the hair tonics and shampoos and the body lotions.[8]
10. It is also used in the tooth pastes and deodorants [8]
11. Pectin is also used in the wound healing preparations and specialty medical adhesives, such as colostomy devices. suitable for the fillings and pastries.
12.In contrast, citrus pectin is the lighter and more suited as a texturing agent for the jam and confectionery jellies.
13. HM pectin can be used as a gelling agent, stabilizer, emulsifier, and thickener in the food industry for the production of jams and jellies, while LM pectin can be used as a fat replacer in spreads, ice cream, fruit preparations for yoghurt, heat-reversible bakery glazing, emulsified meat, or low-calorie products such as diet carbonated beverages.
14. The texture and the stability of the milk-based products can be modified by the addition of pectin. The gelling and thickening properties of pectin stabilize beverages containing the acidified
15, HM pectin can be specifically stabilize acid casein particles, through HM pectin–casein interactions, in acidified dairy beverages.

CONCLUSIONS :

1.The overall results showed that the pectin from these sources are suitable for industrial use.
2.The chemistry and gel-forming characteristics of pectin enabled this naturally occurring biopolymer to be used in pharmaceutical health promotion and treatment.
3.These results demonstrate that the successful extraction of the pectin, providing potential benefits for the industrial extraction of pectin from an economic and environmental point of view.
4.The functional properties of the pectin are influenced by source, methods, and conditions of extraction, mainly extraction time, pH, solid/liquid, temperature, power and frequency of waves, type of enzymes used, and combinations of these factors.
5.Novel extraction methods can be used to reduce the extraction time and solvent consumption and increase the process efficiency and the yield of pectin

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