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PECTIN FROM FRUIT PEELS AND ITS USES AS PHARMACEUTICAL AND FOOD GRADE: A DESCRIPTIVE REVIEW

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ABSTRACT
Pectin, a naturally occurring polysaccharide, It is commercially extracted from citrus peels and some other sources like banana, apple, grapes etc, under acidic condition. It is also used in confectionery, beverages and other fruit drinks. It can be used as pharmaceutical additives, and various food preparations. Pectin is completely soluble in pure water. Different pectin sources contain different amount of pectin, and different qualities. Pectin can be use as coloring agent, flavoring agent, thickening agent, pectin is also used for its therapeutic values in cholesterol regulation, as an anti-inflammatory agent, as an immunomodulator. But it is widely use according to its binding ability. It is also used in oral, nasal and vaginal preparations. It shows positive results in cholesterol regulation and in anti cancer preparations and many others.

KEYWORDS: citrus peel, pharmaceutical additive, binding ability.

INTRODUCTION
Pectin comes under the important plant cell wall components. Pectin is obtained by the aqueous extraction of the appropriate plant materials and basically from citrus fruit peel and apple pomace etc, followed by a decided precipitation using alcohol or salt. The raw materials used have a large amount of pectin with good quality and are available in sufficient quantities to make the manufacturing process more cost effective. The major functional feature of pectin is to make gel by using its gelling ability in aqueous solutions in the presence of a certain amount of sugar and acid or calcium ions. Pectin has very good aqueous solubility and gel forming ability, which makes it more important.

Pectins have the various advantages as additives in food and pharmaceutical preparations:

1. Pectins have the required stability under acidic conditions even at higher temperature it makes them suitable candidate to be used in drug delivery system.
2. Pectins have good gel forming ability in presence of divalent cations which makes them suitable carriers for delivering bioactive agents.
3. Pectins have a long standing reputation of being non-toxic and have high availability and low production cost.
4. Pectins can be used for delivering drugs via oral, nasal, and vaginal route and it has been well accepted by many patients.[1]

General properties of pectin: Pectins have good solubility in pure water. When Dry powdered pectin, added to water, become hydrate very rapidly, and form clumps. These clumps consist of semidry packets of pectin and contained in an envelope of highly hydrated outer coating. Clump formation can be prevented by dry mixing of pectin powder with water-soluble carrier material 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.[2]

Gel Formation Properties of Pectins

- The major use of pectin is based on its gel forming ability. The specific structure of pectin imposes some specific constraints.
- The gel forming ability of pectin is because of its hydrogen bonding between free carboxyl groups on the pectin molecules.
- When we add the acid, the carboxyl ions are converted to mostly unionized carboxylic acid groups.
- The decrease in the number of negative charges leads to lowers the attraction between pectin and water molecules, and also lowers the repulsive forces between pectin molecules. And Sugar further

decreases hydration of the pectin by competing for water.
- These conditions make the pectin to stay in a dispersed form.
- When cooled, the unstable dispersing of less hydrated pectin leads to form a gel.
- A continuous network of pectin leads to holding the aqueous solution. And the rate at which gel formation takes place is very important to understand the nature of pectin.
- Although sugar is not essential for gel formation but also the presence of small amounts (10-20%) of sugar tends to decrease syneresis and adds required firmness of these gels. When some sugar is present, the amount of calcium required to form gel is decreased. High concentrations of sugar (60% or higher) interfere with gel formation due to the dehydration of the sugar favoring hydrogen bonding.[3]

Effect of concentration on rheology

Pectin was used at various concentrations levels namely, 7.5, 10.0 and 12.5%. The solutions were prepared and then kept overnight for complete swelling. Their flow behavior was noted at different shear rates at 20°C. The viscosity was found from the down curve. Apparent viscosity at different shear rates was noted. The data obtained data was plotted as viscosity against shear rate, shear rate against shear stress, log shear rate against log shear stress and log viscosity against concentration.[4]

Nutritional and medicinal aspects of pectin

Nutritional Aspects of Pectins

- It is known to work as gelling agent in jellies and jams.
- It is used to prepare the dessert, sweets, medicines, and milk drinks and fruit juice.
- It works as an ingredient in jelling sugar.
- It is also known to stabilize yogurt and juices.

Medicinal Aspects of pectin

- It helps to treat diarrhea and constipation
- It helps to Prevent prostate, colon cancer
- It helps to treat gastro esophageal reflux disease, diabetes.
- It works to Prevent poisoning
- It is also useful for ulcerated mouth[5]

Sources of Pectin

- Pectin occurs commonly in the plant tissues as a cementing agent in the middle lamella and as a thickening agent on the cell wall, the numbers of sources that may be used for the commercial manufacture of Pectins are found to be very limited.
- Detection of a large quantity of pectin in a single fruit is not enough itself to qualify that fruit as a source of commercial pectin.
- At present, it is found that citrus peels are the main sources of commercially acceptable Pectins. Even they, produce slightly different Pectins, which make them more suitable for specific applications.
- Other sources of pectin that is found to be in considered are sugar beet and residues from the seed heads of sunflowers.
- The gel forming ability of Pectins depends on the molecular size and other factors; the pectin from different sources does not have the same gelling ability because of the variations in these parameters.
- Pectin contents of various fruits are reported in the literature. Pectin obtained from sugar beet has many disadvantages as a commercial source of pectin. In spite of its high pectin content, availability, and relatively low cost, sugar beet is not found to be good due to the poor gelling ability of its pectin compared with other from apple and citrus pectin.
- The main sources of pectin are given below.

Grapefruit, lemon, Oranges, Beans, Apricots, Bananas, Blackberries, Cherries Carrots, Apples, Dewberries, Grapes, Loganberries, Raspberries, Squash, Strawberry, Sweet Potatoes, Watermelon.[6]

EXTRACTION OF PECTINS

In the extraction procedure of pectin firstly we take, 5g of the peel powder was weighed and then put into a 250ml conical flask, and added 150 ml distilled water. Acid was added for maintaining different pH medium like reagents. For maintaining 1.5,2.0 and 2.5 pH medium, required 45g,14g and 10g citric acid(99.9% conc.) respectively. Extraction was carried out by hot water bath procedure. Thereafter, the mixture was heated for each different pH medium of extraction and stirred at 60,70 and 80°C for each different time 30,45 and 60min. The hot acid extract was filtered through muslin cloth and for each acid; three different pH medium of extraction at three different ranges of time and temperature, extraction was carried out and collected the extract separately for further experiments. The filtrate was cooled to room temperature.

Purification and Centrifugation Procedure

Pectin containing aqueous extract was made coagulated by using an equal volume (1:1) of 99.1% ethanol at 4°C and was left for 3 hour. The precipitate (ethanol-insoluble fraction) formed was recovered using centrifugation and filtration procedure, and then washed with 55% and then with 75% ethanol.[7]

STUDY DONE OVER PECTIN IN LAST FEW DECADES

Colin D. M.et al. (1990) Industrial Pectins are a specific group of carbohydrate polymers which are largely composed of galacturonic acid units, and it is a part of the wider class of plant pectic substances. The normal raw materials are apple pomace and citrus fruit peels, from which pectin is obtained by using acid extraction and precipitation using alcohols or aluminum salts.[8]

Sudhakar D.V. et al. (2000) the best method for manufacturing of pectin from Totapuri mango peels, was standardization by studying various factors that govern the recovery and quality of pectin . Among the different organic and inorganic acids, 0.05N HCL was found to be the best for recovery of pectin from mango peels.[9]

Suresh kumar R. et al. (2009) HPMC coated pellets Provides a greater degree of protection from premature drug release in the upper GI tract, than using pectin alone. The pectin is still available for enzymatic degradation, which allows more drug release under conditions that may be expected to pertain in the colon.[10]

Srinivasan B. et al. (2011) chemical modification is very essential, benefetial for the improvement of the binding property of the pectin. The acetylation of the free hydroxyl groups tends to the higher yield of pectin .and the acetylation can be done easily by using 20%, 40% and 60% v/v acetyl chloride in ethanol and it leads to the various Modified Pectins.[11]

Rajendra a. Et al. (2011) The objective of this study was to evaluate and understand rheological properties of pectin solutions to determine the influence of polymer concentration, pH, preservatives and heating duration on viscosity, using Brookfield R/S Plus Rheometer. The result finally shows that, the dilute pectin solutions are showing Newtonian, but at a moderate concentration they show the nonNewtonian behavior, and the psudoplastic nature was found to increase with the concentration.[12]

Shailendra P. et al. (2012) Binders are the agents which employed to impart cohesiveness to the granules. This confirms the tablet remains intact after compression. The development of some new excipients for potential use as binding agent in tablet formulations continues to be of interest. There are a wide range of natural polymers have been used in pharmaceutical preparations. Natural substances.

Like starches, mucilage's, gums and also dried fruits can be used as binding agents according to their capability.[13]

Ghanshyam Y. et al. (2013) nowadays many countries are looking for the use of herbal drugs due to their very less side effects and other qualities too. As herbal drugs have different pharmacological activities and a wide range of qualities, they can be also used in different cosmetic preparations. Natural polysaccharides are used in a large number of different preparations and they are non toxic also, they are used in different pharmaceutical preparations as well as in cosmetic preparations.[14]

Sujitha B. et al. (2013) all pharmaceutical dosage forms contain many additives besides the active ingredients to assist manufacturing and they show their own qualities also. And hence they obtain the desired effect to the pharmaceutically active ingredients. The advances in drug delivery have simultaneously urged the discovery of novel excipients which are safe and fulfill specific functions, and after that they directly or indirectly influence the rate and extent of release and or absorption.[15]

Hamid N. et al. (2014) Nutraceuticals are products, which other than nutrition are also used as medicine. They work as medicinal as well as nutritional agent. A nutraceutical product may be defined as a substance, which has physiological benefit or provides protection against chronic disease. Nutraceuticals help to improve health and, delay the aging process, and prevent chronic diseases, increase life expectancy, or support the structure or function of the body also.[16]

Pranati S. et al. (2011) A no. of different plant and their different plant products are very useful as the excipients and as the drug also in different cases. It is naturally available as polysaccharide and used in different pharmaceutical preparations as binder and some time for different applications. Different binders are available according to their demand and uses nowadays pectin is widely applying in many fields.[17]

Jackcina S. C. E. et al. (2014) The study was aimed at utilization of the fruit wastes collected from Uzhavar Santhai, Chokkikulam, Madurai, and others. Different fruit wastes were collected to get pectin of different types and binding capacity in separate baskets before they were dumped to the bin and were utilized for the extraction of useful by products viz., pectin and ethanol. Pectin was extracted from the peels and ethanol was extracted from the pulp. The ethanol extracted from the fruit pulp was used to extract pectin from the fruit peel. A considerable amount of pectin could be extracted per day from the collected fruit wastes. The uses of pectin have a wide range from inder to disintegrator.[18]

Suman R. Y. et al. (2015) Pectin is a naturally occurring biopolymer that is finding increasing applications in the pharmaceutical field as well as it is also applied in food industries and biotechnology industry. In present study pectin was extracted from the peels of three different fruits viz. Orange, Sweet lime & Papaya and comparative study of characterization done. Pectin was extracted by two different acids, such as Hydrochloric acid & Citric acid.[19]

Kiranmoy K. et al. (2016) there are a number of natural substances have been used in pharmaceutical preparations. Natural substances like gums, mucilage's, pectin, and also dried fruits can be used as binding agent; pectin is very important polymer due to their qualities. They have been shown good potential as binding agent as well as they hold some other properties like fillers, disintegrating agent, sustain releasing agent. Natural gums and mucilage's exposed good binding property in

wet granulation for the manufacturing of different types of tablets; granules are stable and less friable in contrast with other binders. Pectin shows good binding as well as disintegrating properties also.[20]

Kanmani P. et al. (2014) Pectin is a structural hetero polysaccharide, and it is biocompatible in nature also, commonly obtained from the peels of citrus fruits and finds prime commercial use as a gelling agent and stabilizer in food industries and it shows a no. of properties like filler, disintegrate. In the present study, pectin was extracted using alcohol precipitation method from the peels of orange (Citrus sinensis), sweet lime (Citrus limetta) and lemon (Citrus Limon).[21]

Ermias G. et al, (2016) Pectin can be used as an agent which can perform a no. of task according to demand. In this study pectin as a food and pharmaceutical additive investigate the effect of temperature, time and pH of the yield and physicochemical characteristics of pectin extracted from banana and mango peels. Pectin was extracted using acid extraction method by using citric acid or HCL acid.[22]

Pectin is a natural polymer having a wide range of pharmaceutical applications as mentioned in Table 1. Various sources are available for the extraction of pectin but we need to know that which type and what amount of pectin is required for the further work. Different fruits and vegetables provide the pectin with different colour, taste and thickness of pectin as given in Table 1. Pectin has the quality that it can be use for both medicinal and food grade product.[23-92]

Table 1: Review for the study conducted for medicinal and food grade use of pectin.

S.no.	Source of pectin	Name of Scientist	Year	Medicinal use	Food grade uses
1.	Different type of poly saccharides occurs Naturally on plant cell wall	Ghanshyam yadav et al.	2013	Used in the formulation of conventional dosage form.	In the formulation of jams and jellies.
2.	Anionic polysaccharides extracted from cell wall of most plants	Rathod hetangi et al.	2010	Formulation of Conventional liquid dosage form and in the treatment of peptic ulcer	Good stability and biocompatibility of gel can be achieved.
3.	It is produced by chemical synthesis or directly extracted from the animal biomass	https://www.dietaryfiberfood.com/dietary-fiber/pectins.php	s2015	In treatment of constipation, wound healing, diarrhea.	It is used as thickening and gelling agent and colloidal stabilizer, texturizer, emulsifier.
4.	Naturally occurring polymers produced by all living organisms.	Ansari Afaque Raza Mehboob et al.	2015	It show potential as colon-specific drug carrier systems.	It can act as good coating agents, which can sustain the drug release, or can protect the drug from degradation in stomach.
5.	Cellulose, Celluloses is use widely.	R. Sharada et al.	2014	It is known to improve the digestive system.	It improves the feed value and performance of animals
6.	Apple pomace and Orange peel are the main sources.	Beli R. Thakur et al.	2014	It favorably influences the blood cholesterol level.	It is use to prepare the everages and fruit juices.
7.	Olive, Pomegranate, grape, Banana, Fig are the main sources	Hamid Farhangi et al.	2014	It helps to control the lead and mercury poisoning.	It has high iron content and is very useful in treating anemia.
8.	From Burmese grape	Md. Farid Hossain et al.	2017	It has Anti-inflammatory and anti-oxidant properties.	It is use to prepare jam jelly and wine.
9.	From Papaya peel	Boshra V et al.	2013	It is low in calories and rich in minerals and vitamins like vitamin A and vitamin C.	Its root shows diuretic and Anti- fungal activity.
10.	pectin is obtained from two variety of quince	Alev Akpinar Borazan et al.	2017	It helps in gastrointestinal problems.	It is use to prepare jams, jellies and marmalade.
11.	Animal origin is preferred	Bhavisha Rabadiya et al.	2013	Well control degree of viscosity and gel strength	It is used for the preparation of confectioneries.
12.	Pectin from Berberis lyceum fruit	Purvika sood et al.	2012	prevent liver disorders, abdominal disorders, skin diseases, cough, ophthalmic etc.	preparation of juices, jams, preserve etc. by the local inhabitants
13.	Pectin from various possible	Savita Dhir et al.	2016	Conventional liquid formulation for	Jam, jellies and soft drinks.

	sources			drug delivery	
14.	Pectin from Quince crop	Alev Akpinar Borazan et al.	2017	Use in skin diseases	used in jellies, jams and marmalade,
15.	Apple pomace and citrus peels are rich in pectin.	Colin D.M. et al.	1990	Reducing the blood cholesterol level	Jam, jellies and soft drinks.
16.	Sugar beet pectin.	Mehdi Rejaii et al.	2016	It reduces the microbial infection of squeeze juice.	Jam, jelly and marmalade
17.	Pectin obtained from Lemon and orange peel	Abdel Moneim E. Sulieman et al.	2013	Help to regulate cholesterol level in lood	The main use for pectin is as a gelling agent, thickening agent and stabilizer in food.
18.	Pectin from plant cell wall.	K. Mehraj Pasha et al.	2013	Shows Anti-microbial activity	Strawberry, Raspbberry and blackberry juices
19.	Pectin from Apple pomace	P C Sharma et al.	2014	It uses juice from apple pomace in the treatment of various diseases	It is used as gelling agent, thickener and emulsifier in food products.
20.	Pectin from mango peels waste and apple pomace.	P.B. Jadhav et al.	2010	It reduces the microbial infection of squeeze juice.	Extraction of citrus fruit and apple pomace pulp is used as by- product to save energy. and provide more option,
21.	Pectin from Hibiscus sabdariffa plant	H. Padmaja et al.	2014	The research during 1990-2014 presented a lot of medicinal, industrial uses of this plant.	*Hibiscus sabdariffa* L. is a well known shrub for various food products, beverages
22.	Pectin from emulsions	Praveen Kumar G. et al.	2008	It reduces the microbial infection of squeeze juice.	Use in beverages
23.	Pectin from carrot cell wall.	Albert Ribas et al.	2014	Congo red cell wall staining and Cell wall polysaccharide immunolabelling	Carotenoids and other micronutrients in plant-based food products.
24.	Pectin from citrus peel and apple pomace.	A. Allwyn Sundar Raj et al.	2012	Reduce blood cholesterol in a wide variety	Gel and conserves formation
25.	Pectin from star-fruit juice.	Narmataa Muthu et al.	2016	Anti-microbial, anti-inflammatory and anti-ulcer property	Minerals and vitamins
26.	Pectin from the strawberry jam	Korlepara Raja Gopal et al.	2017	Anti-inflammatory activity is found	Juice, jam and purees
27.	Pectin from Guava peels and	MDJC Sandarani et al.	2017	Enzymatic extraction of pectin is	Jam, fruit juice and

	Citrus peels			environmentally safe and more effective in terms of pectin yield.	marmalade.
28.	Pectin from Apple pomace	http://digitalcommons.unl.edu/foodscidiss/40	2014	Prevent the blood clotting	pectin is as a gelling agent in jams and jellies
29.	Pectin in cell wall of carrot.	Albert Ribas et al.	2014	Improve immunity	Used in confectionaries
30.	Pectin from Burmese grape fruit	Md. Farid Hossain. Et al.	2017	Anti-inflammatory and anti-oxidant	Jam, jelly and wine
31.	Pectin is available as natural polymer	Nidhi	2016	It helps to control the lead and mercury poisoning.	preparation of juices, jams, preserve etc. by the local inhabitants
32.	It is a natural polysaccharide	http://www.grainprocessing.com/personal-care/body-powders.html	2013	It has Anti-inflammatory and anti-oxidant properties.	Jam, jellies and soft drinks.
33.	Pectin is obtained from mango peel	Ermias Girma et al.	2016	It is low in calories and rich in minerals and vitamins like vitamin A and vitamin C.	used in jellies, jams and marmalade,
34.	Pectin is obtained from tropical fruits.	S. Neidhart et al.	2002	It helps in gastrointestinal problems.	Jam, jellies and soft drinks.
35.	Orange peels are collected from the orange trees in the tropical climate.	https://www.sciencedirect.com/topics/medicine-and-dentistry/pectin	2012	Well control degree of viscosity and gel strength	Jam, jelly and marmalade
36.	Pectin is obtained from the primary cell wall of plant	Patel VI et al.	2012	prevent liver disorders, abdominal disorders, skin diseases, cough, ophthalmic etc.	The main use for pectin is as a gelling agent, thickening agent and stabilizer in food.
37.	Pectin is present in the middle lamella of the plant.	https://www.sciencedirect.com/topics/medicine-and-dentistry/pectin	2014	Conventional liquid formulation for drug delivery	Strawberry, Raspbberry and blackberry juices
38.	polysaccharide found in middle lamella of plant cell membrane	K.G. Praveen et al.	2017	Use in skin diseases	It is used as gelling agent, thickener and emulsifier in food products.
39.	pectin is obtained from the lemon pomace at the maturity stages	LIVESTRONG. COM	2017	Reduces the blood cholesterol level	Extraction of citrus fruit and apple pomace pulp is used as by- product to save energy. and provide more option,
40.	Pectin is obtained from the Apple Pomace	ML Fishman et al.	2005	It reduces the microbial infection. s	Sometimes it is use for sugar free beverages
41.	Pectin was acid extracted	RAJENDRAAWASTHI et al.	2011	As a binder in tablet formulation	Used as a flavoring agent

	from orange albedo by steam injection heating under pressure				
42.	Pectin is obtained from citrus fruit waste	Veronika Batori et al.	2017	Have good gelling strength	Shows their aromatic property
43.	Pectin is obtained from inner leaf gel of Aloe Vera Plant	Mulay S. et al.	2014	It work as good immunomodulator	It is used in chronic drug therapy
44.	Pectin is obtained from plants, used for specific drug delivery systems.	Praveen kumar G. et al.	2017	Helps in target selectivity	Have a amount of vitamins and minerals
45.	Pectin is a polysaccharide obtained from various plant sources	Sang -Ho Yoo et al.	2006	As a binder in tablet formulation	Forms gel easily
46.	Pectin is collected from steam explosion of plant	http://digitalcommons.unl.edu/usdaarsfacpub/1771	2017	Helps to maintain good viscosity of the preparations	Modify rheological properties
47.	Pectin is obtained from primary cell wall of plant	S.H. Christensen et al.	2009	Used for cough, and ophthalmic preparations etc.	Have good gelling property
48.	Pectin was acid extracted from orange albedo by steam injection heating under pressure.	Pranati Srivastava et al.	2011	Have good gelling strength	Aggression of pectin molecule occur
49.	Pectin is obtained from Apple pomace and Orange peel	Thakur BR et al.	1997	It is used in the preparation of various gel formulation	Act as flavouring agent
50.	Pectin is obtained from citrus fruit waste	B. Veronika et al.	2017		It may work as thickening agent
51.	Plants are the main source of pectin	http://ijpsr.com/articles/	2018	It helps to maintain the cholesterol regulation	It is used in the preparation of conserves
52.	Pectin is obtained from plant origin	Swarupa A et al.	2015	Used in anti-microbial preparations	Provide stability to gelling agents
53.	Pectin is obtained from plant cell wall.	Simon Bechard et al.	1986	Shows anti-inflammatory activity	Used in confectionaries
54.	Pectin is obtained from citrus fruit peel.	http://www.epharmacognosy.com/2012/03/pectin.html	2016	Also used in gastric problems	Used as stabilizing agent for jam and jellies
55.	Pectin is obtained from Bio-refinery of Orange Peels waste	Boukroufa M et al.	2015	It helps in gastrointestinal problems.	Shows their aromatic property
56.	Pectin is obtained by atomic	Fishman ML et al.	2004	Reduces the blood cholesterol level	_

	force microscopy				
57.	Apple pomace and orange peel are the major source of pectin	Thakur BR et al	2009	Helpful in case of Cardiotoxicity	Also used as coloring agent
58.	Pectin is obtained from plant and animal sources.	Pornsak sriamornsak et al.	2011	It shows anti-cancer activity	It provides required consistency to the various preparations.
59.	Pectin is obtained from Moroccan orange peels	Mohamed Yassine Sayah at al.	2018	Widely used for its anti-bacterial activity	It provides good flavoring activity
60.	Pectin is obtained from animal sources	Taylor & Francis Group	2006	_	It may work as thickening agent
61.	Pectin is obtained from orange peels	Mohamed Yassine Sayah et al.	2014	Used for the preparation of conventional dosage form	It is widely used in the preparation of Jams and jellies
62.	Pectin is obtained from the primary cell wall of Plants	Gordon. A. Morris et al.	2010		It is used as thickening agent in the preparation of juices
63.	Pectin is obtained from the peel of Pontius trifoliate fruit	Kouassi L. Koffi et al.	2013	Used in skin diseases and other problems	Used as coloring agent
64.	Pectin is obtained from citrus peel waste.	Merve kaya et al.	2014	As a binder in tablet formulation	Used as stabilizing agent for jam and jellies
65.	Pectin is obtained from apple pomace	Lucia G. Miceli-Garcia et al.	2014	Helps to maintain the cholesterol level	Also act as thickening agent
66.	Pectin is obtained from lemon fruit	Verma C et al.	2018	Shows anti bacterial activity	Also act as skin cleanser
67.	Pectin is obtained from different fruits and vegetables	.https://www.livestrong.com	2017	It provide their characteristic activity	Provide a wide range of taste for formulations
68.	Oranges, grapefruit and lemons are some of the best sources of pectin.	.https://www.livestrong.com	2017	Anti-inflammatory and anti-oxidant	It is used as gelling agent, thickener and emulsifier in food products.
69.	Pectin is obtained from Orange peel.	Helen M Macdonald et al.	1994	It work as flavouring agent	It work as a flavouring agent
70.	Pectin is obtained from the cell wall of plant	https://www.thespruce.com/high-and-low-pectin-fruit-1327800	2017	Prevent liver disorder.	It is used in the preparation of conserves.

Besides using pectin as a Medicinal and Food grade product it is also used as pharmaceutical adjuvant as given in Table 2. Pectin has some qualities which makes it different than other products. It provides a different kind of attraction to the preparation which increases the market demand of the pectin and its product. It is helpful in increasing the bulk of formulation, it act as coating agent etc.[33-82]

Table 2: Various studies conducting on pectin as pharmaceutical adjuvant.

S.no.	Uses of pectin	Sources of pectin	Reported by
1.	It is used as thickening agent.	Different type of poly saccharides occurs Naturally	Bhavisha Rabadiya et al.
2.	According to demand it can be use as a coating agent.	anionic polysaccharides extracted from cell wall of most plants	Purvika sood et al.
3.	After chemical alteration, it can be use according to the demand.	It is produced by chemical synthesis or directly extracted from the animal biomass	Savita Dhir et al.
4.	Due to its biological origin it sometimes use in the medicinal preparations.	Naturally occurring polymers produced by all living organisms.	Alev Akpinar Borazan et al.
5.	It is also use in the paper industry.	Cellulose, Celluloses is use widely.	Colin D.M. et al.
6.	These are sometime use for their Aroma.	Apple pomace and Orange peel are the main sources .	Mehdi Rejaii et al.
7.	Pectin from various source, uses for their standard flavor	Olive,Pomegranate,grape,Banana, Fig are the main sources	Abdel Moneim E. Sulieman et al.
8	It provides the good gelling property to the pectin.	Burmese grapes	K. Mehraj Pasha et al.
9	Pectin from the papaya peels shows stabilizing properties.	Papaya peels	P C Sharma et al.
10.	It is used for good coloring quality.	pectin is obtained from two variety of quince	P.B. Jadhav et al.
11.	Used for the capsule shell formation	Animal origin is preferred	H. Padmaja et al.
12.	It is used as a flavoring agent	Pectin from Berberis lyceum fruit	Praveen Kumar G. et al.
13.	Used for the different applications like coating, thickening agent etc.	Pectin from various possible sources	Albert Ribas et al.
14.	Used as the colouring agent	Pectin from Quince crop	A. Allwyn Sundar Raj et al.
15.	Used as filler in tablet formation.	Apple pomace and citrus peels are rich in pectin.	Narmataa Muthu et al.
16.	Used as the sweetening agent.	Sugar beet pectin.	Korlepara Raja Gopal et al.
17.	It is used as the flavoring agent.	Pectin obtained from Lemon and orange peel	MDJC Sandarani et al.
18.	Used as the coating material.	Pectin from plant cell wall.	http://digitalcommons.unl.edu/foodscidiss/40
19.	It is mainly used as filler.	Pectin from Apple pomace	Albert Ribas et al.
20.	It is used as the flavoring and coloring agent.	Pectin from mango peels waste and apple pomace.	Md. Farid Hossain. Et al.
21.	It is used as the gelling agent.	Pectin from Hibiscus sabdariffa plant	Nidhi
22.	It is used as the stabilizing agent.	Pectin fron emulsions	http://www.grainprocessing.com/personal-care/body-powders.html
23.	It works as a coating agent.	Pectin from carrot cell wall.	Ermias Girma et al.
24.	It provides the elasticity to the preparation	Pectin from citrus peel and apple pomace.	S. Neidhart et al.
25.	It works as a sweetening agent.	Pectin from star-fruit juice.	https://www.sciencedirect.com/topics/medicine-and-dentistry/pectin
26.	It works as a colouring and sweetening agent	Pectin from the strawberry jam	Patel VI et al.
27.	It is used to work as flavoring agent.	Pectin from Guava peels and Citrus peels	https://www.sciencedirect.com/topics/medicine-and-dentistry/pectin
28.	It is used to increase the bulk of the preparation.	Pectin from Apple pomace	K.G. Praveen et al.
29.	It is generally used as coating	Pectin in cell wall of carrot.	LIVESTRONG.

	material.		COM
30.	It is Used as flavouring agent.	Pectin from Burmese grape fruit	ML Fishman et al.
31.	It is used to provide elasticity to the preparation.	Pectin is available as natural polymer	RAJENDRAAWASTHI et al.
32.	It works as sweetening as well as coating material.	It is a natural polysaccharide	Veronika Batori et al.
33.	It is used to provide aroma of the fruit to the preparation.	Pectin is obtained from mango peel	Mulay S. et al.
34.	They are used to provide stability to the product.	Pectin is obtained from tropical fruits.	Praveen kumar G. et al.
35.	It works as flavoring agent in the preparation.	Orange peels are collected from the orange trees in the tropical climate.	Sang -Ho Yoo et al.
36.	Here pectin works as the coating material.	Pectin is obtained from the primary cell wall of plant	http://digitalcommons.unl.edu/usdaarsfacpub/1771
37.	It works as stabilizing agent here.	Pectin is present in the middle lamella of the plant.	S.H. Christensen et al.
38.	It also work as the coating material	polysaccharide found in middle lamella of plant cell membrane	Pranati Srivastava et al.
39.	It provides the flavour to the preparation.	pectin is obtained from the lemon pomace at the maturity stages	Thakur BR et al.
40.	It is used as Neutral sugar according to requirement.	Pectin is obtained from the Apple Pomace	B. Veronika et al.
41.	As a binder in tablet formulation	Pectin was acid extracted from orange albedo by steam injection heating under pressure	http://ijpsr.com/articles/
42.	Have good gelling strength	Pectin is obtained from citrus fruit waste	Swarupa A et al.
43.	It work as good immunomodulator	Pectin is obtained from inner leaf gel of Aloe Vera Plant	Simon Bechard et al.
44.	Helps in target selectivity	Pectin is obtained from plants, used for specific drug delivery systems.	http://www.epharmacognosy.com/2012/03/pectin.html
45.	As a binder in tablet formulation	Pectin is a polysaccharide obtained from various plant sources	Boukroufa M et al.
46.	Helps to maintain good viscosity of the preparations	Pectin is collected from steam explosion of plant	Fishman ML et al.
47.	Used for improving skin tone etc.	Pectin is obtained from primary cell wall of plant	Thakur BR et al
48.	Have good gelling strength	Pectin was acid extracted from orange albedo by steam injection heating under pressure.	Pornsak sriamornsak et al.
49.	It is used in the preparation of various gel formulation	Pectin is obtained from Apple pomace and Orange peel	Mohamed Yassine Sayah at al.
50.	It is used as skin cleanser	Pectin is obtained from citrus fruit waste	Taylor & Francis Group

CONCLUSION

The reason behind using pectin is its pharmaceutical applications biological origin. There are large numbers are available from which we can get pectin easily. We can use it according to the demand of its consistency of gel. Since it has large number of sources that's why it shows various properties according to the source from which it is collected. And the major advantage behind using pectin as a pharmaceutical and food grade product is that it has no side effects since it has biological origin. Pectin has made a positive public connection. Its ability to make medicinal and food grade product makes it different from others. Pectin can be easily found in comparison to other natural products. Pectin provides a number of applications. Pectin helps in formulation of jam, jellies, confectioneries, conserves, fruit juices and many more products can be easily form. In case of medicinal products mainly it work as binding agent in tablets, it is also used as flavoring agent, coloring agent, coating agent, stabilizing agent. Pectin is also useful in the formulation of the shell of capsule.

Hence we can say that pectin is very important and easily available natural product. Which can be get easily from various sources and applicable in a wide range of requirement.

REFERENCE

1. Vandana Tyagi, Pramod Kumar Sharma, Rishabha Malviya, Pectins and Their Role in Food and Pharmaceutical Industry: A Review, Journal of Chronotherapy and Drug Delivery, 2015; 6(3): 65-77.
2. Vandana Tyagi, Pramod Kumar Sharma, Rishabha Malviya, Pectins and Their Role in Food and Pharmaceutical Industry: A Review, Journal of Chronotherapy and Drug Delivery, 2015; 6(3): 65-77.
3. Vandana Tyagi, Pramod Kumar Sharma, Rishabha Malviya, Pectins and Their Role in Food and Pharmaceutical Industry: A Review, Journal of Chronotherapy and Drug Delivery, 2015; 6(3): 65-77.
4. Rajendra Awasthi et al, Selection of Pectin as Pharmaceutical Exception on the basis of Rheological behavior, International Journal of Pharmacy and Pharmaceutical Sciences, 2011; 3(1): 229-231.
5. www.healthbenefitstimes.com
6. Robert A. Baker. Reassessment of Some Fruit and Vegetable Pectin Levels. JOURNAL OF FOOD SCIENCE, 1997; 62(2): 225-229.
7. W. Elizabeth Devi et al. Extraction of Pectin from Citrus Fruit Peel and Its Utilization in Preparation of Jelly. International Journal of Engineering Research & Technology, 2014; 3(5): 1925-1932.
8. Colin D. May et al, industrial Pectins: Sources, production and Applications, Elsevier Science Publishers Ltd. England, 1990; 12: 79-99.
9. SUDHAKAR D. V, ISOLATION AND CHARACTERIZATION OF MANGO PEELS PECTIN, JOURNAL OF FOOD PROCESSING AND PRESERVATION, 2000; 24(3): 209-227.
10. R Sureshkumar, et al. Formulation and evaluation of pectin-hydroxypropyl methylcellulose coated curcumin pellets for colon delivery. Asian journal of pharmaceutics.2009, pp 138-142.
11. Srinivasan B. et al. CHEMICAL MODIFICATION AND CHARACTERIZATION OF PECTIN AS A POTENTIAL DRUG RELEASE RETARDANT. International Journal of Research in Ayurveda & pharmacy, 2011; 2(2): 640-647.
12. Rajendra Awasthi et al, Selection of Pectin as Pharmaceutical Exception on the basis of Rheological behavior, International Journal of Pharmacy and Pharmaceutical Sciences, 2011; 3(1): 229-231.
13. Patel Shailendra et al., Natural Binding Agents in Tablet Formulation, International Journal of Pharmaceutical & Biological Archives, 2012; 3(3): 466-473.
14. Ghanshyam yadav et al, Application of natural polysaccharide for delivery of biopharmaceuticals, International Journal of Pharmacy & Life Sciences, 2013; 4(6): 2756-2765.
15. Sujitha B et al, A Role of Natural Polymers used in formulation of Pharmaceutical Dosage forms: a Review, International Journal of Pharmacy & Technology, 2013; 4(4): 2347-2362.
16. Hamid Nasri et al, New concepts in Nutraceuticals as alternative of pharmaceuticals, International Journal of Preventive medicine, 2014; 5(12): 1487-1499.
17. Pranati Srivastava et al, Sources of Pectin extraction and its application in pharmaceutical industry- An overview, Indian Journal of Natural Products and resources, 2011; 2(1): 10-18.
18. E. Jackcina Stobel Christy et al, Extraction of pectin from fruit wastes – an effective method of Municipal solid waste management, International Journal of Advance Research, 2014; 2(2): 936-944.
19. Suman R Yadav et al, Extraction and characterization of pectin from different fruits, International Journal of Applied research, 2015; 1(9): 91-94.
20. Kiranmoy karmakar et al, Application of Natural Gum as a Binder in Modern drug delivery, Journal of Analytical & Pharmaceutical Research, 2016; 3(4): 1-8.
21. P. Kanmani et al, Extraction and Analysis of Pectin from Citrus Peels: Augmenting the Yield from Citrus Limon using Statistical Experimental Design, Iranica Journal of Energy & environment, 2014; 5(3): 303-312.
22. Ermias G. et al, Extraction and characterization of pectin from selected fruit peel waste, International Journal of scientific and research publication, 2016; 6(2): 447-454.
23. Ghanshyam Yadav, Nitin Sharma, Mayank Bansal and Nishi Thakur, Application of natural polysaccharide for delivery of biopharmaceuticals, International Journal of Pharmacy & Life Sciences, 2013; 4(6): 2756-2765.
24. Rathod Hetangi, Patel Vishnu and Modasia Moin, In situ gel as a Novel approach of gastroretentive drug delivery, International Journal of Pharmacy & Life Science, 2010; 1(8): 440-447.
25. https://www.dietaryfiberfood.com/dietary-fiber/pectins.php
26. Ansari Afaque Raza Mehboob, Naik suresh Ramnath, and waghmode Chetan Satish, Natural Pollysaccharide as Drug Targeting tool to colon: Recent Applications and Future Prospective, International Journal of Pharmaceutical, Chemical and Biological Sciences, 2015; 5(2): 440-455.
27. R. Sharda, G.Venkateswarlu, S.Venkateswar and M. AnandRao, Applications of Cellulases-Review, International Journal of Pharmaceutical, Chemical and Biological Sciences, 2014; 4(2): 424-437.
28. Beli R. Thakur, Rakesh K. Singh, Avtar K. Handa, & Dr. M. A. Rao, Chemistry and uses of pectin — A review, Critical Reviews in Food Science and Nutrition, 1997; 37(1): 47-73.
29. Hamid Farhangi, Maryam Ajilian, Masumeh Saeidi, Gholam Hasan Khodaei, Medicinal Fruits in Holy Quran, International Journal of Pediatrics (Supplement 4), 2014; 2: 89-102.

30. Md.Farid Hossain, Md.Anwarul, Shaheen Akhtar, Mustafa Anwar, Nutritional Value and medicinal uses of Minor Fruits: Burmese Grape (Baccaurea ramiflora Lour.), International Journal of Nutrition and Food Sciences, 2017; 6(5): 211-214.
31. Boshra V, Tajul AY, Papaya- an ainnovative Raw Material for food and Pharmaceutical Processing Industry, Health and the Environment Journal, 2013; 4: 68-75.
32. Alev Akpinar Borazan and Caglayan Acikgoz, Effect of Quince Variety on the Quality of Pectin: Chemical Composition and Characterization, International Journal of Pharmaceutical, Chemical and Biological Sciences, 2017; 7(4): 393-400.
33. Bhavisha Rabadiya, Paresh Rabadiya, A Review: Capsule Shell material from gelatin to non animal origin material, International Journal of Pharmaceutical Research and Bio-science, 2013; 2(3): 42-71.
34. Purvika Sood, Rajni Modgil and Monika Sood, Berberis lycium a Medicinal Plant with Immense Value, INDIAN JOURNAL OF PHARMACEUTICAL & BIOLOGICAL RESEARCH, 2012; 1(1): 1-9.
35. Savita Dhir, Kasim Ali Saffi, Neha Kamalpuria and Dinesh Mishra, An Overview of in situ gelling system, I NTERNATIONAL J OURNAL OF P HARMACY & L IFE S CIENCES, 2016; 7(8): 5135-5156.
36. Alev Akpinar Borazan and Caglayan Acikgoz, EFFECT OF QUINCE VARIETY ON THE QUALITY OF PECTIN: CHEMICAL COMPOSITION AND CHARACTERIZATION, INTERNATIONAL JOURNAL OF PHARMACEUTICAL, CHEMICAL AND BIOLOGICAL SCIENCES, 2017; 7(4): 393-400.
37. D.M. Colin, lndustrial Pectins:Sources, Production and Applications, Carbohydrate Polymers, 1990;12:79-99
38. Mehdi Rejaii, Esmaeil Ataye Salehi, Properties of sugar brrt pulp pectin: A systemic review, International Journal of Pharm Tech Research, 2016; 9: 364-368.
39. Abdel Moneim E. Sulieman, Kawther M. Y. Khodari, Zakaria A. Salih, Extraction of Pectin from Lemon and Orange Fruits Peels and Its Utilization in Jam Making, International Journal of Food Science and Nutrition Engineering, 2013; 3(5): 81-84
40. K. Mehraj Pasha, P. Anuradha and D. Subbarao, Application of Pectinases in industrial sector, International Journal of pure and Applied sciences and Technology, 2013; 16(1): 89-95.
41. PC Sharma, Anil gupta and P Kaushal, Optimization of method for extraction of pectin from apple pomace, Indian Journal of Natural Product and resources, 2014; 5(2): 184-189.
42. P.B. Jadhav, N.D. Chavan, P.K. Modi and G.B. Suryawanshi, Production of by-products from wastes of food processing industries, International Journal of processing and Post Harvest Technology, 2010; 1(2): 114-117.
43. H. Padmaja, S. Sruthi and Meena Vangalapati, Review on Hibiscus sabdariffa- A valuable herb, International Journal of Pharmacy & Life Sciences, 2014; 5(8): 3747-3752.
44. 44) K.G. Praveen, V.Suneetha, Microbial Pectinase as Potential Tool for Specific and Controlled Drug Delivery System, Research Journal of Pharmacy and Technology, 2017; 10(6): 1877-1880.
45. Albert Ribas, Sandy Van Buggenhout, Paola Palmero, Marc Hendrickx, Ann Van Loey, Investigating the role of pectin in carrot cell wall changes during thermal processing: A microscopic approach, Innovative Food Science and Emerging Technologies, 2014; 24: 113-120.

A. Allwyn Sundar Raj, S. Rubila, R. Jayabalan and T. V. Ranganathan, A Review on Pectin: Chemistry due to General Properties of Pectin and its Pharmaceutical Uses, Open Access Scientific Reports, 2012; 1(12): 1-4.

46. Narmataa Muthu, Su Yin Lee, Kia Kien Phua, and Subhash Janardhan Bhore, Nutritional, Medicinal and Toxicological Attributes of Star-Fruits (Averrhoa carambola L.): A Review, Bioinformation, 2016; 12(12): 420–424.
47. Korlepara Raja Gopal, Adarsh M. Kalla and Keerthi Srikanth, High Pressure Processing of Fruits and Vegetable Products: A Review, International.
48. Journal of Pure & Applied Bioscience, 2017; 5(5): 680-692.
49. MDJC Sandarani, A Review: Different Extraction Techniques of Pectin, Journal of Pharmacognosy & Natural Products, 2017; 3(3): 1-14.
50. http://digitalcommons.unl.edu/foodscidiss/40
51. Albert Ribas, Sandy Van Buggenhout, Paola Palmero, Marc Hendrickx, Ann Van Loey, Investigating the role of pectin in carrot cell wall changes during thermal processing: A microscopic approach, Innovative Food Science and Emerging Technologies, 2014; 24: 113-120.
52. Md.Farid Hossain, Md. Anwarul, Shaheen Akhtar, Mustafa Anwar, Nutritional Value and medicinal uses of Minor Fruits: Burmese Grape (Baccaurea ramiflora Lour.), International Journal of Nutrition and Food Sciences, 2017; 6(5): 211-214.
53. Nidhi, A Review on Biopolymers with their Applications, International Journal of Physics, Chemistry and Mathematical Fundamentals, 2016; 15(1): 8-15.
54. http://www.grainprocessing.com/personal-care/body-powders.html
55. Girma Ermias and Mr. Worku Teshome , Extraction and characterization of pectin from selected fruit peel waste, international Journal of Scientific and Research Publications, 2016;6(2):447-454
56. S. Neidhart, M. Reiter, M. Mensah-Wilson et al. Possibilities for Improving Quality of Fruit Juices and Drinks from Tropical Fruits by Homogenization and Addition of Pectin, Sustaining Food Security

and Managing Natural Resources in Southeast Asia - Challenges for the 21 st Century, 2002; 1-3.
57. https://www.sciencedirect.com/topics/medicine-and-dentistry/pectin
58. Patel VI, Patel HA, Jani M, Shah A, Kumar S , Patel JA, Formulation and Evaluation of Okra Fruit Mucilage as a Binder in Paracetamol and Ibuprofen Tablet, International Journal for Pharmaceutical Research Scholars, 2012;1(4):156-161
59. http://digitalcommons.unl.edu/foodscidiss/41
60. K.G. Praveen, V. Suneetha, Microbial Pectinase as Potential Tool for Specific and Controlled Drug Delivery System, Research Journal of Pharmacy and Technology, 2017; 10(6): 1877-1880.
61. LIVESTRONG.COM.
62. ML Fishman, PN Walker, HK Chau, AT Hotchkiss, Flash extraction of pectin from orange albedo by steam injection, Biomacromolecules, 2003; 4(4): 880-9.
63. A. Rajendra, Selection of Pectin as pharmaceutical Excepient on the Basis of Rheological Behavior, International Journal of Pharmacy and Pharmaceutical Sciences, 2011; 3(1): 229-231.
64. B. Veronika, J.Mostafa, A. Dan, R.L. Patrik, J.T.Mohammad,and Z. Akram, Production of Pectin-Celluiose Biofilms: A New Approach for Citrus Waste Recycling, International Journal of Polymer Science, 2017; 1-10.
65. S. Mulay, A. Bele, A.Borade and A. Khale, ALOE VERA– NUTRACEUTICAL TO PHARMACEUTICAL, INDIAN DRUGS MANUFACTURERS' ASSOCIATION, 2014; 51(3): 1-64.
66. K.G. Praveen, V. Suneetha, Microbial Pectinase as Potential Tool for Specific and Controlled Drug Delivery System , Research Journal of Pharmacy and Technology, 2017; 10(6): 1-3.
67. H.Y. Sang, L.F. Marshall, T.H.J. Arland, G.L. Hyeon, Viscometric behavior of high-methoxy and low-methoxy pectin solutions, Food Hydrocolloids, 2006; 62-67.
68. http://digitalcommons.unl.edu/usdaarsfacpub/1771.
69. H.-U. Endreß S.H. Christensen, Handbook of Hydrocolloids (Second edition), A volume in Woodhead Publishing Series in Food Science, Technology and Nutrition, 2009; 274–297.
70. S. Pranati and M. Rishabha, Sources of Pectin, extraction and its applications in pharmaceutical industry- An overview, Indian Journal of Natural Products and Resources, 2011; 2(1): 10-18.
71. BR Thakur, RK Singh and AK Handa, Chemistry and uses of pectin- a review, Crit Rev Food Sci Nutr, 1997; 37(1): 47-73.
72. B. Veronika, J.Mostafa, A. Dan, R.L. Patrik, J.T.Mohammad,and Z. Akram, Production of Pectin-Celluiose Biofilms: A New Approach for Citrus Waste Recycling, International Journal of Polymer Science, 2017; 1-10
73. http://ijpsr.com/articles/
74. Swarupa A, Revathi, Swaroopa, Pandu Rangam, Pallavi, J.V.C Sharma, FORMULATION AND EVALUATION OF SUSTAINED RELEASE MICROSPHERES OF FINASTERIDE, International Journal of Pharmacy, 2015; 5(2): 57-65.
75. B. Simon, M.M. Jean, Pectin-gelatin microglobules: effect of a cross-linking agent (formaldehyde) on in vitro dissolution rate, International Journal of Pharmaceutics, 1986; 31(1-2): 91-98.
76. http://www.epharmacognosy.com/2012/03/pectin.html
77. Boukroufa M, Boutekedjiret C, Petigny L et al, Bio-refinery of orange peels waste: a new concept based on integrated green and solvent free extraction processes using ultrasound and microwave techniques to obtain essential oil, polyphenols and pectin, 2015; 24: 72-79.
78. Fishman ML, Cooke PH, Coffin DR, Nanostructure of native pectin sugar acid gels visualized by atomic force microscopy, ACS Publications, 2004; 5(2): 334-341.
79. Thakur BR, Singh RK, Handa AK et al, Chemistry and uses of pectin — A review, Critical Reviews in Food Science and Nutrition, 2009; 37(1): 47-73.
80. Sriamornsak P, Application of pectin in oral drug delivery, Expert Opinion on Drug Delivery, 2011; 8(8): 1009-1023.
81. Sayah MY, Chabir R, Nadia ELM et al, Comparative Study on Pectin Yield According To the State of the Orange Peels and Acids Used, International Journal of Innovative Research in Science, Engineering and Technology.
82. Canovas GVB, Davidson PM, Dreher M et al, Food Polysaccharides and Their Applications, 2006.
83. Sayah MY, Chabir R, Nadia ELM et al, Comparative Study on Pectin Yield According To the State of the Orange Peels and Acids Used, International Journal of Innovative Research in Science, Engineering and Technology, 2014; 3(8): 15658-15660.
84. Morris GA, Ralet MC, Bonnin E et al, Physical characterization of the rhamnogalacturonan and homogalacturonan fractions of sugar beet(Beta vulgaris) Pectin, 2010; 82: 1161-1167.
85. Koffi KL, Yapo BM, Besson V**,** Extraction and characterization of gelling pectin from the peel of Poncirus trifoliata fruit, Biomedical & Life Sciences | Earth & Environmental Sciences, 2013; 4(11): 614-619.
86. Kaya M, Sousa AG, Crepeau MJ et al, Characterization of citrus pectin samples extracted under different conditions: influence of acid type and pH of extraction, 2014; 114(6): 1319-1326.
87. Garcia LGM, Pectin from Apple Pomace: Extraction, Characterization, and Utilization in Encapsulating Alpha-Tocopherol Acetate, 2014.
88. Verma C, Singh RK, Singh RB et al, Biochemical and In-silico Studies on Pec_n Methylesterase from

G9 Variety of Musa acuminata for Delayed Ripening, 2015; 9: 15-23.
89. https://www.livestrong.com.
90. https://www.livestrong.com.
91. Macdonald HM, Evans R, Spencer WJ, The use of continuous-flow electrophoresis to remove pectin in the purification of the minor pectinesterases in lemon fruits (citrus limon), Journal of the Science of Food and Agriculture, 1994; 64(1): 129-134.
92. https://www.thespruce.com/high-and-low-pectin-fruit-1327800.