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Extraction, characterization and utilization of pectin from apple peels

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Abstract
The objective of this research aimed to extract pectin from Apple peels and utilized it for the production of jam. Pectin was extracted from Apple peel powder by the method given by Georgiev *et al*. (2012) using 0.05M of four different acids (Hydrochloric Acid, Nitric Acid, Citric Acid, Sulphuric Acid). Jam was prepared using the pectins extracted from the Apple peels and sensory evaluation was determined. Sensory experiment indicates that blanched Apple Peel (T3) treated with Hydrochloric Acid has the best overall acceptability (8.9) and is more recommended for jam preparations comparative to other treatments. The pectin extracted for blanched peels using different acids were Citric Acid (5.25%), Nitric Acid (11.75%), Hydrochloric Acid (11%) and Sulphuric Acid (12.25%) and for un-blanched peels were Citric Acid (9.1%), Nitric Acid (5.17%), Hydrochloric Acid (6.75%) and Sulphuric Acid (14.5%) respectively. Hence, Blanched apple peels have been found to achieve greater yield than Un-blanched peel.

Keywords: Extraction, hydrochloric acid, nitric acid, citric acid, sulphuric acid

1. Introduction
Food waste becomes an important global concern, particularly in developing and underdeveloped countries (Raveendran Sindhu *et al*. 2020) [17]. It is the food sector that is responsible for producing the volumes of waste with major environmental effects. Its usage as a nutrient after a composting cycle, or as livestock feed is an option for farmers with either little or negative economic effects. Food industry by- products are often abundant in bioactive compounds (Martins, N.; Ferreira, I. C. F. R. Wastes and By- Products 2007, Schieber, A.; Stintzing, F. C.; Carle, 2001) [19]. Therefore, in terms of greater productivity of the industry, it is important to find effective and environmentally sustainable ways to maximise the efficiency of such product (Lowe, E. D.; Buckmaster, D. R. Dewatering, 1995) [12].
At present, apple is considered one of the the most commonly eaten fruits worldwide (Lamperi, L *et al*. 2005, Henrıquez *et al*. 2014) [7]. Apple plays a very important role in our daily diet and is the most preferred product of many individuals which is broadly developed fruit in mild districts (Kaushal and Joshi 1995, Kaushal *et al*. 2002, Agrahari and Khurdiya 2003) [8, 9, 1]. The universe creation of the apple is around 58 million tons from a region of about 5.26 million ha (FAO 2005) [5]. Currently, India is in the ninth biggest maker of apples on the planet contributing around 33% of the world's Apple production of the world with a yearly creation of 1.42 million tons from a region of 0.25 million ha (Anon 2004). One of the huge problems challenging the food industries throughout the world is how to make good usage of the waste-materials. About 50% waste from the raw materials are collected from the food processing industries. The waste mainly consist of pomaces, un-ripe fruit, cull-fruit, core, peel or mechanically damaged fruit. Peels are the significant waste as the whole fruit is utilized for preserved making after the peeling. Currently, the peels are either fed to animal or tossed into garbages. Respectively Mandarin orange peel and pomace, guavas, jack fruit, papaya, Assam lemon, mango peels, and apple's peels and pomace are studied for their pectin (B.S. Virk& D. S. Sogi-2004) [4]. For the past couple of centuries, Pectin has been using as a gelling agents (oakenfull and scott, 1984). Pectin is a complex polysaccharide composed mostly of galacturonic acids unit linked by α-(1→4) linkage. Pectin is a polysaccharides used in food and pharmaceutical industries as thickening and gelling agent (May, 1990) [14].
Pectin is a ubiquitous natural polymer contained in the primary walls of non woody plant cells, and increasing use as hydrocolloid (a material capable of trapping waters and forming gel at low concentration) by the food industry is expanding rapidly into other industrial sectors. Also in the food industry, traditional use as a gelling agents, thickening agent and stabilizers are being complemented by the emerging utilization of pectin as a fat replacer and health-promoting functional ingredient.

The quantities of pectin varies considerably in Apple pomace (10-15%), Citrus peel (25-35%), Sugar beet (10-20%) and Sunflower (15-25%). Pectin used in food is defined as polymer that contains galacturonic acid units of at least 65%.

2. Materials and Methods

2.1. Raw materials and reagent

Fresh fruits of cultivar Kinnaur Apple was procured from Safal Sarvodaya Enclave, Delhi. Skinned the apple with stainless knife and washed with distilled water.

Apple peel was stabilized using two methods *viz*.,

- Un-blanched: Un-blanched peels oven dried at 60 ºC.
- Blanching: Boiling the apple peel in hot water at 80 ºC for 5 minutes and dried in the oven at 60 ºC.

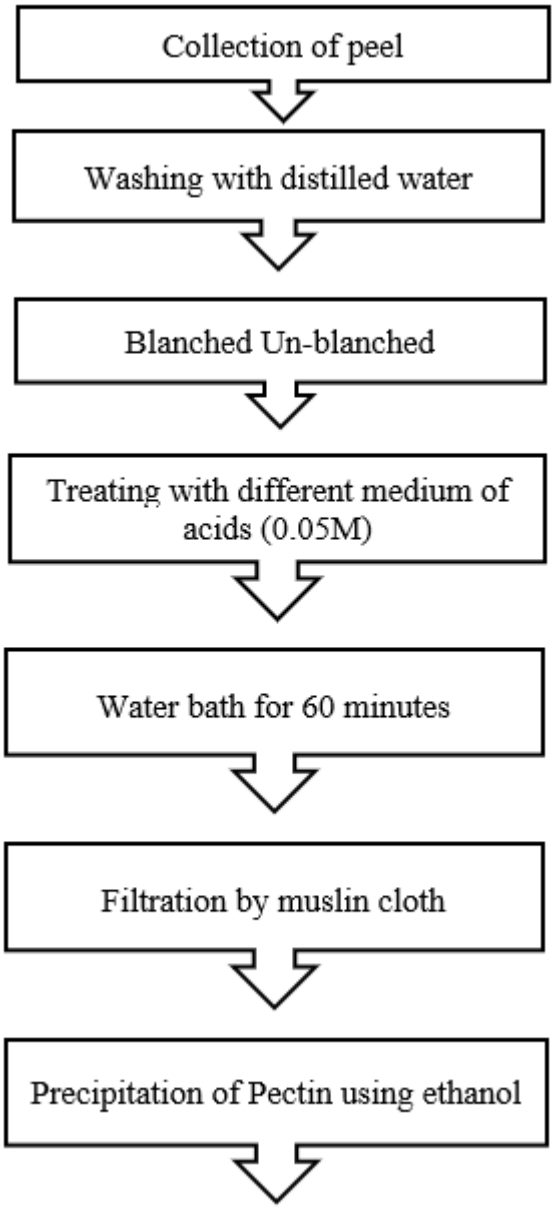
Both the blanched and un-blanched peels were cleaned, pulverized and sieved through a 60-mesh sieve. The powder was stored in an airtight container for future use.

2.2. Extraction of pectin from dried apple peel

The procedure which was used to extract the pectin was based on the method given by Georgiev *et al*. (2012) [6] Pectin was extracted from selected blanched and un-blanched Apple peel using, i.e., 40g, of the powder of the dried apple peel was then transferred into four 1000ml of conical flask containing:

- 300 ml of Nitric acid (0.05 M)
- Citric acid (0.05 M)
- H_2SO_4 (0.05 M)
- HCL (0.05 M)

Afterwards the mixture is heated at 80 °C for 60 minutes over water bath. Then, the pH is checked at 15 minutes intervals. The extract of hot acid is filtered through filter funnel fitted with two layers of muslin cloth. An equal volume of 95% ethanol is applied to the filtrate and allowed to precipitate at 4 °C for overnight. Pectin was then extracted in 90 minutes, using each acid at 80 ºC. The Precipitate is then filtered by muslin cloth and dried at 50 °C in the oven, and the dried pectins are ground into powder for pectin characterisation. On the bases of pectin yield suitable acids, durations of extractions time is identified for each type of apple peels powder and yield suitable acids, durations of extractions time is identified for each type of apple peels powder and bulk quantities of pectin was expected by the identified standards.



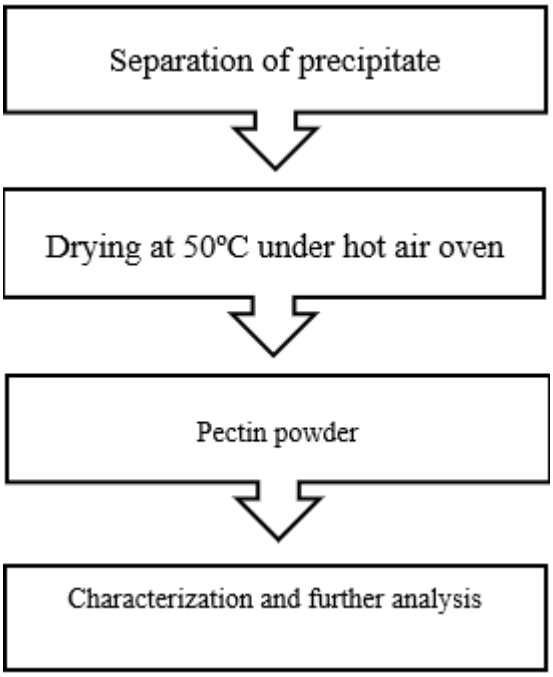


Fig 1: Processing of Apple Peels

2.3. Determination of pectin yield.

The pectin yield (PY) was calculated from the following equation proposed by Li, Jia, Wei, and Liu (2012). It is determined by the percentage obtained pectin to the amount of Apple peel powder taken;

$$PY\ (g) = \frac{\text{Amt of Dry Pectin obtained(g)}}{\text{Amt of Apple peel powder taken (g)}} \times 100$$

2.4. Processing of Jam

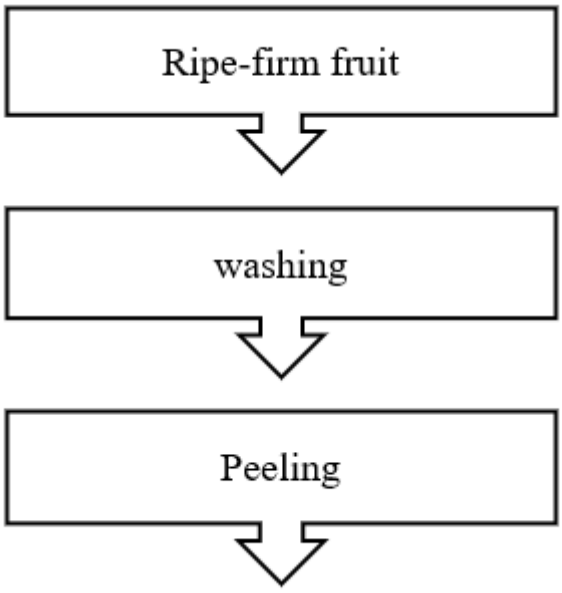
The pectin which was extracted from apple peel was utilized for the preparations of jam. The jam is prepared in accordance with the FPO specification.

Apple, strawberry, black grapes and banana were the fruits used for the preparation of jam. For every 55% of sugar about 45% of fruit pulp should be used. The jam specification is 68.5% TSS, 45% fruit pulp, and 0.5-0.6% citric acid per 100gm of the product prepared.

The fruits were washed thoroughly under running tap water, Using stainless steel knife the fruit are cut into small pieces. It was prepared by homogenizing the fruits in blenders. The mixture is cooked slowly for about 15-20 mins with occasional stirring.

During boiling, in a spoon a portion of jam is taken out and cooled. It was allowed to drop, instead of flowing into a continuous stream, if the substance dropped off in the form of a sheet or flake. It means that you have reached the end point and that the product is ready. The prepared jam is then shifted to a sterilized bottle, cooled and sealed with lid.

The sensory evaluation was carried out by a panel of semi-trained judges according to the procedure as reported by Amerine *et al*. (1965) [2] on 9 point hedonic scale. At a time six samples were kept for evaluation and the average score of minimum five judges for each attribute like color and appearances, texture, analyse, taste and overall acceptability is recorded. The data collected are analyzed using factorial randomized designs as per the procedure outline by Pamse and Sukhatme (1967) [16].



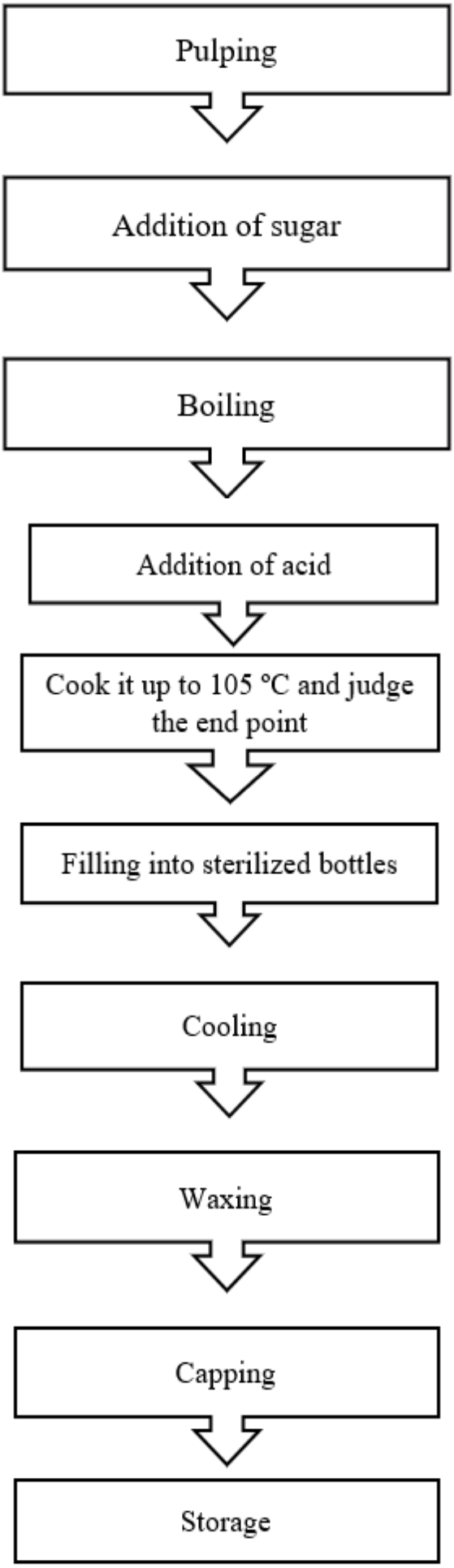


Fig 2: Flow chart of Jam preparation

3. Results and Discussions

3.1. Physical composition

The result showed that there was significant difference in balanced and un-blanched peels of the apple with respective to the weight of the fruit and peel weight, 1 kg of dried blanched peel obtained 100 gm of powder and 176 gm from 1 kg of un-blanched peel after sieving with 60 mesh sieves.

3.2. Extraction of Pectin

Pectin was extracted from blanched and un-blanched apple peels using 0.05 M four different acid i.e., Citric acid, Nitric acid, HCL and H_2SO_4. Suitable time of extractions with acid medium is identified for each type of apple peel. Extracted pectins from each type of apple peels were characterized and utilized as pH, solubility, appearance (color) and yield.

The extracted pectin using different acids i.e. Citric Acid, Nitric Acid, H_2SO_4 and HCL and were ranged between 5.17 - 14.5%. The yield of pectin was measured using Gravimetric method (Sadashivam and Manickam 2010) [18]. Apple peel treated with un-blanched sulphuric acid had a higher pectin level (14.5%) than those of blanched apple peel treated with sulphuric acid (12.25). The pectin extracted for blanched peels using different acids were Citric Acid (5.25%), Nitric Acid (11.75%), Hydrochloric Acid (11.00%) and Sulphuric Acid (12.25%) and for un-blanched peels were Citric Acid (9.1%), Nitric Acid (5.17%), Hydrochloric Acid (6.75%) and Sulphuric Acid (14.5%) respectively. Hence, Blanched apple peels have been found to achieve greater yield than un-blanched peels, so it is used for further studies.

Table 1: Pectin Yield

Name of the acid	Pectin Yield (%)
Blanched Peels	
Citric acid	5.25
Nitric acid	11.75
Hydrochloric acid	11.00
Sulphuric acid	12.25
Un-blanched Peels	
Citric acid	9.10
Nitric acid	5.17
Hydrochloric acid	6.75
Sulphuric acid	14.50

3.3. Sensory evaluation

Sensory evaluation indicated equal acceptance for all the products prepared by using apple peel pectin. The acceptance of the products with respect to color, flavor, taste and texture was rated quite superior on a nine-point hedonic scale. The ratings for the different sensory characteristics of various products is shown in the (Table 2). Thus, apple peel pectin can successfully be utilized for the preparation of various products in the food industry.

The consistency of the jam prepared from 9 treatments with pectin extracted shows major variations in the sensory evaluations. In sensory evaluation of the jam, the highest score and lowest score was recorded respectively

A. Appearance- (T3)-8.8 & (T8) - 6
B. Aroma- (T3) - 9 & (T5) - 6
C. Texture- (T3) – 9 & (T5) - 6
D. Taste - (T3) - 8.5 & (T5) – 6

Table 2: Mean sensory scores of Mixed Jam using Pectin extracted from different treatments (9 point Hedonic Scale)

Treatment	Appearance	Aroma	Texture	Taste	Overall Acceptability
T0	6.1	7.0	6.8	7.0	6.7
Blanched					
T1	7.0	7.0	7.0	7.0	7.0
T2	6.5	7.8	7.5	7.0	7.2
T3	8.8	9.0	9.0	8.5	8.9
T4	7.5	7.0	7.3	7.0	7.2
UN-Blanched					
T5	8.0	6.0	6.0	6.0	6.5
T6	7.0	7.6	8	6.5	7.5
T7	7.9	8.5	8.8	8.5	8.4
T8	6	7.5	6.5	6.5	6.6
C.D @ 5%.	0.007	0.173	0.173	0.173	0.173
SE (m)	0.002	0.058	0.058	0.058	0.058
SE (d)	0.003	0.082.	0.082	0.082	0.082
C.V.	0.058	1.335	1.335	1.406	1.364

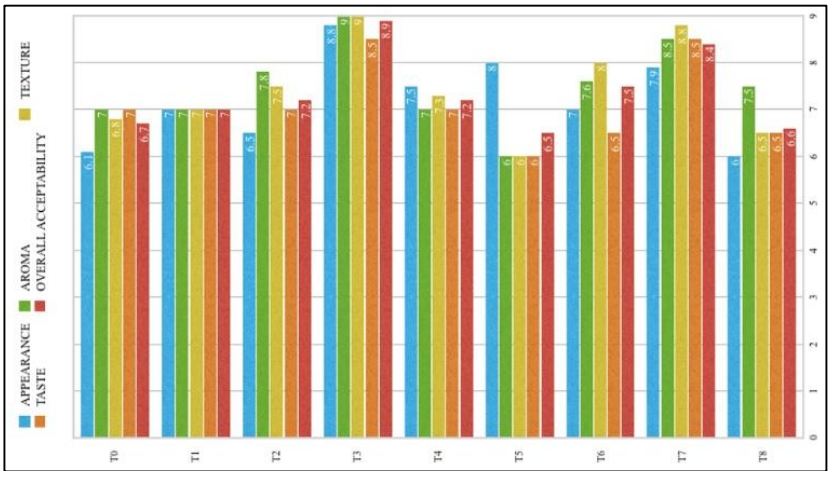


Fig 3: Graph showing Mean Sensory of Mixed jam using Pectin extracted from different treatments

Blanched (T3) 8.9 recorded the highest rating overall acceptability while (T5) 6.5 recorded the lowest overall acceptability.

Sensory experiment indicates that blanched Apple Peel (T3) treated with Hydrochloric Acid has the best overall acceptability (8.9) and is more recommended for jam preparations comparative to other treatments.

****abbreviations**

T_0: Jam prepared from laboratory pectin (Control).

T_1: Jam prepared from pectin extracted from Sulphuric Acid treated blanched Apple Peel.

T_2: Jam prepared from pectin extracted from Citric Acid treated blanched Apple Peel.

T_3: Jam prepared from pectin extracted from Hydrochloric Acid treated blanched Apple Peel.

T_4: Jam prepared from pectin extracted from Nitric Acid treated blanched Apple Peel.

T_5: Jam prepared from pectin extracted from Sulphuric Acid treated un-blanched Apple Peel.

T_6: Jam prepared from pectin extracted from Citric Acid treated un-blanched Apple Peel.

T_7: Jam prepared from pectin extracted from Hydrochloric Acid treated un-blanched Apple Peel.

T_8: Jam prepared from pectin extracted from Nitric Acid treated un-blanched Apple

4. Conclusions

The pectin extracted using different acids i.e. Citric Acid, Nitric Acid, H_2SO_4 and HCL Acid were ranged between 5.17 - 14.5%. The yield of pectin was measured using Gravimetric method (Sadashivam and Manickam 2010) [18]. Apple peel treated with un-blanched sulphuric acid had a higher pectin level (14.5%) than those of blanched apple peel treated with sulphuric acid (12.25%).

The pectin extracted for blanched peels using different acids were Citric Acid (5.25%), Nitric Acid (11.75%), Hydrochloric Acid (11%) and Sulphuric Acid (12.25%) and for un-blanched peels were Citric Acid (9.1%), Nitric Acid (5.17%), Hydrochloric Acid (6.75%) and Sulphuric Acid (14.5%) respectively.

Hence, Blanched Apple peels have been found to achieve greater yield than un-blanched peels.

Jam was successfully prepared from Blanched Apple Peel Extracted Pectin (BWAPEP) with important parameters studied. Blanched Apple Peel Extracted (BWAPEP) gave its necessary for acceptable results in gel formation, sensory evaluation showed wide acceptance for Hydrochloric Acid Treated (BAPEP) followed by Hydrochloric Acid treated (UBAPEP) was significant. For 7 days of storage the jam was encouraging for improved shelf life and stability at room temperature. With its essential appropriate characteristics, the jam preparation is capable of being commercialized for industrial use.

*BAPEP - Blanched Apple Peel Extracted Pectin.

*UBAPEP - Un-Blanched Apple Peel Extracted Pectin.

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