Pectin production from Syrian citrus peels

Preparation:

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Introduction:

The global annual production of citrus fruits is about 110 million tons, of which about 60% are oranges, 23% are mandarins and tangerines, 13.7 million tons are lemons, and 4.4 million tons are grapefruit.

The production of citrus juice produces large amounts of waste, amounting to 44-60% of the weight of the processed fruits. Thus, the amount of waste generated is about 5.4 million tons annually globally, only from lemon juice manufacturing operations alone.

In Syria, about 1.3 million tons of citrus fruits are produced annually, and citrus waste is never used in Syria, as citrus waste contains many useful components that can be extracted and used in the manufacture of many products, one of the most important component is pectin, as the peel Citrus fruits are one of the most important commercial sources of pectin.

Pectin is a polysaccharide found in plant cell walls. It consists of a linear chain of α-D-galacturonic acid molecules linked together by (1-4) glycosidic bonds, partially esterified by methanol, and periodically linked by L-sugar molecules - rhamnose and some other natural sugar molecules with side chains. The general structure of pectin varies according to the maturity of the plant.

The global market needs of pectin exceed 30,000 tons annually and it increases constantly.

Pectin is commercially produced in the form of a white or brownish-white powder. It is mainly extracted from citrus fruits. It is used in the food industry as a gelling agent, especially in the manufacture of jams and jellies, as a filler in the confectionery industry, as an emulsifier in the milk industry, as a stabilizer in the juice industry, and as a source of fiber in foodstuffs. Diet systems, and many other uses.

The chemical composition of pectin varies by plant, and within the plant, depending on the parts and age of the plant.

Despite the presence of pectin general, in most plant tissues, the sources that can be adopted as raw materials when making pectin are limited, according to the ability of pectin to form a gel depending on the molecular weight and the degree of esterification (DE).

Pectin is produced commercially from citrus peels or apple pulp as a by-product of juice processing.

Apple pomace contain about 15% pectin (on a dry matter basis), and citrus peels contain relatively higher amounts of 20-30% pectin.

This study aims to determine the optimal conditions for extracting pectin from citrus peels.

Theoretical study:

Pectin structure and classification

Pectin:

Pectin was first isolated and discovered by Henri Braconnot in 1825.

Pectin is a polysaccharide found naturally in all plant tissues. Pectin is found in different quantities in plant cell walls and has an important nutritional and technological value, as it plays a role in the plant cell wall as one of the most important materials that contribute to linking cellulose fibers with each other and with the rest of the plant polymers.

Pectin is a methanol-esterified polygalacturonic acid, consisting of a chain of 300 to 1000 galacturonic acid units.

Pectin structure:

Pectin is a polysaccharide consists of branched chains whose composition varies according to the method of extraction, raw materials, region and other environmental factors.....

The basic linear structure of pectin is a galacturonan and consists of consecutive D-α-galacturonic acid units linked together by glycosidic bonds at sites (1-4). These galacturonic acid brocks can be partially esterified by methanol.

The unesterified units of galacturonic acid can be either as free acids or as sodium, potassium or calcium salts.

Partially esterified pectin salts are called pectin, and when the degree of esterification is less than 5%, the salts are called pectin.

The ratio of the esterified acid groups in galacturonic acid to the total acid groups is called the degree of esterification (DE).

Pectin can be fully esterified by methylation when it is formulated and synthesized in the plant, but the highest DE esterification that can be obtained by extraction from natural raw materials is 80%.

Pectin can be produced with degrees of esterification (5-75%) by controlling the degree of de-esterification during production processes.

Classification of pectins:

Pectins are classified according to the degree of esterification (DE), which is the percentage of esterified galacturonic acid units to the total galacturonic acid units in the pectin molecule to:

1- High methoxylated pectin (HM):

Contains more than 50% metoxyl groups (DE > 50%), produced by normal extraction processes.

High methoxylated pectins are capable of forming thermally irreversible gels in aqueous media at pH values as low as (pH=3) and high solute content above 55%.

2- low metoxyl Pectin LM :

Contains less than 50% metoxyl groups (DE<50%), produced by modifying the extraction method or consequent an acidic treatment.

These pectins are characterized by their ability to form a gel in the presence of divalent salts, usually calcium ions Ca2+, at low solute values and a wide range of pH values. This gel is thermally reversible.

3- **Low Methoxyl Amidated Pectin LMA**:

Produced by treating pectin during manufacturing with ammonia, it contains less than 50% of methoxyl groups (DE<50%) and (5-25%) immobilized groups

Highly methoxylated pectin HM is mainly used as a gelling agent in food products, especially in the manufacture of jams and fruit preserves. It is also used in the manufacture of milk and yogurt desserts, cakes and jellies, and as a stabilizer in dairy products, fruit juices and soft drinks.

Low methoxyl LM pectin is used to prepare gels for low levels of dissolved substances and is used in various food industries such as the production of jams and jellies with low sugar content and as a thickening agent in the manufacture of juice concentrates.....

- In general, LM pectin is obtained industrially by de-esterification from HM pectin under appropriate acidic or alkaline controlled conditions. Enzymes can also be used to extract pectin and to de-esterify, but this method is still not used due to economic considerations.

When ammonia is used for de-esterification, a different type of pectin, LM, is produced, in which some carboxylic groups are amideised. The presence of some carboxylic groups in the amide formula makes pectin more amenable to gel formation when the calcium content changes with greater thermal reversibility.

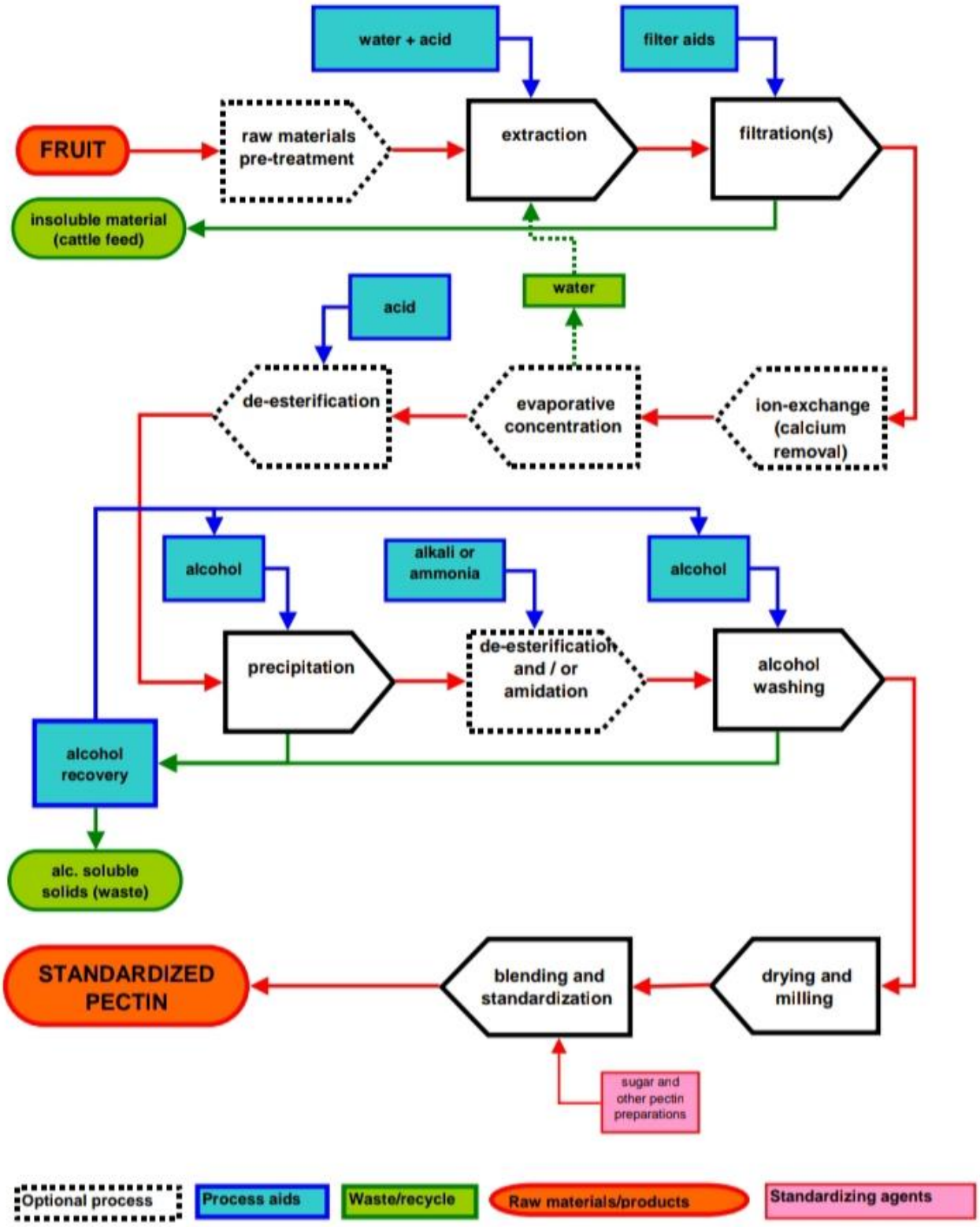
Pectin is produced commercially mainly from citrus fruits (oranges - lemons - grapes - fruits .....) and it can also be extracted from apples and beetroot, as the sources of pectin production are considered by-products of the juice industry. Then the raw materials are dried and transported to the pectin factories.

Pectin manufacturing processes:

Pectin manufacturing processes include three or four basic stages: extraction of pectin from raw materials, purification of the liquid extract, separation of pectin from solution by precipitation, deesterification and amide degradation of the resulting highly methoxylated pectin using an acid or base (optional step).

The extraction of pectin is done with hot diluted mineral acid at pH = 2. The extraction time varies according to the raw material and according to the type of pectin required from one factory to another.

- The hot pectin extract is separated from the solid residue by filtration or by using centrifuges, then the pectin is precipitated with alcohol (ethanol or isopropanol), and low methoxyl pectin is obtained by de-esterification of the resulting pectin under acidic or alkaline conditions, then the precipitate is separated and washed with more alcohol to remove impurities, dried, milled and coated.


water + acid
filter aids
FRUIT
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acid
de-esterification
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ion-exchange (calcium removal)
alcohol
alkali or ammonia
alcohol
precipitation
de-esterification and / or amidation
alcohol washing
alcohol recovery
alc. soluble solids (waste)
STANDARDIZED PECTIN
blending and standardization
drying and milling
sugar and other pectin preparations
Optional process
Process aids
Waste/recycle
Raw materials/products
Standardizing agents

Practical study:

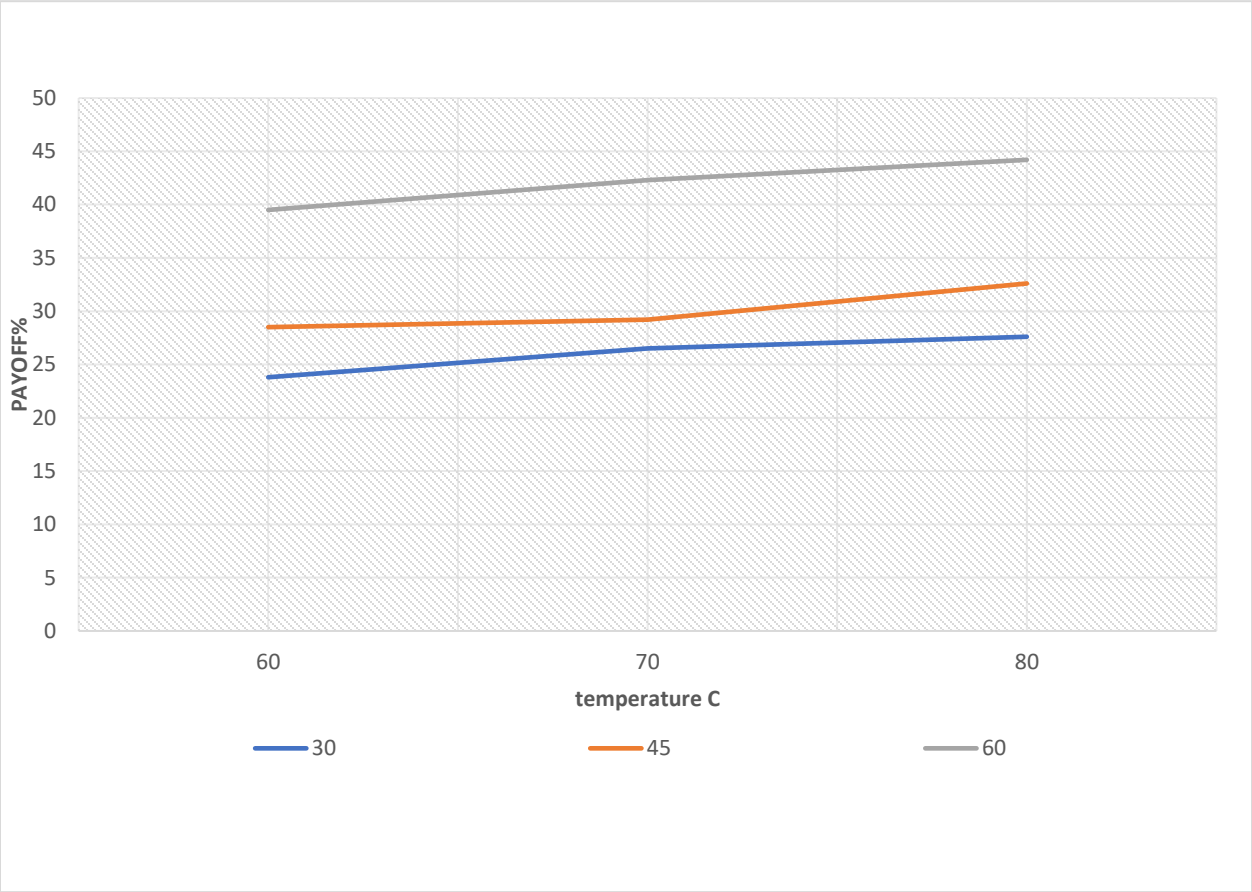
Pectin was extracted in this research from lemons and oranges, which were washed well to get rid of dirt, dust, and pesticide residues, then peeled and cut the peels into small pieces, then dried in the drying oven at 60 oC until weight stability, then ground and stored in airtight containers Close at room temperature

The extraction process was carried out by placing 5 g of powdered lemon peels and orange peels, each separately, in a conical flask with a capacity of 250 ml, and adding 150 ml distilled water, then acid was added as a mediator to extract the pectin, where nitric acid was used at different values of pH 1.5, 2, 2.5, and the extraction took place in a water bath. hot, heated with stirring to 60, 70, 80 oC for 45, 30, 60 min respectively for each mixture of given pH

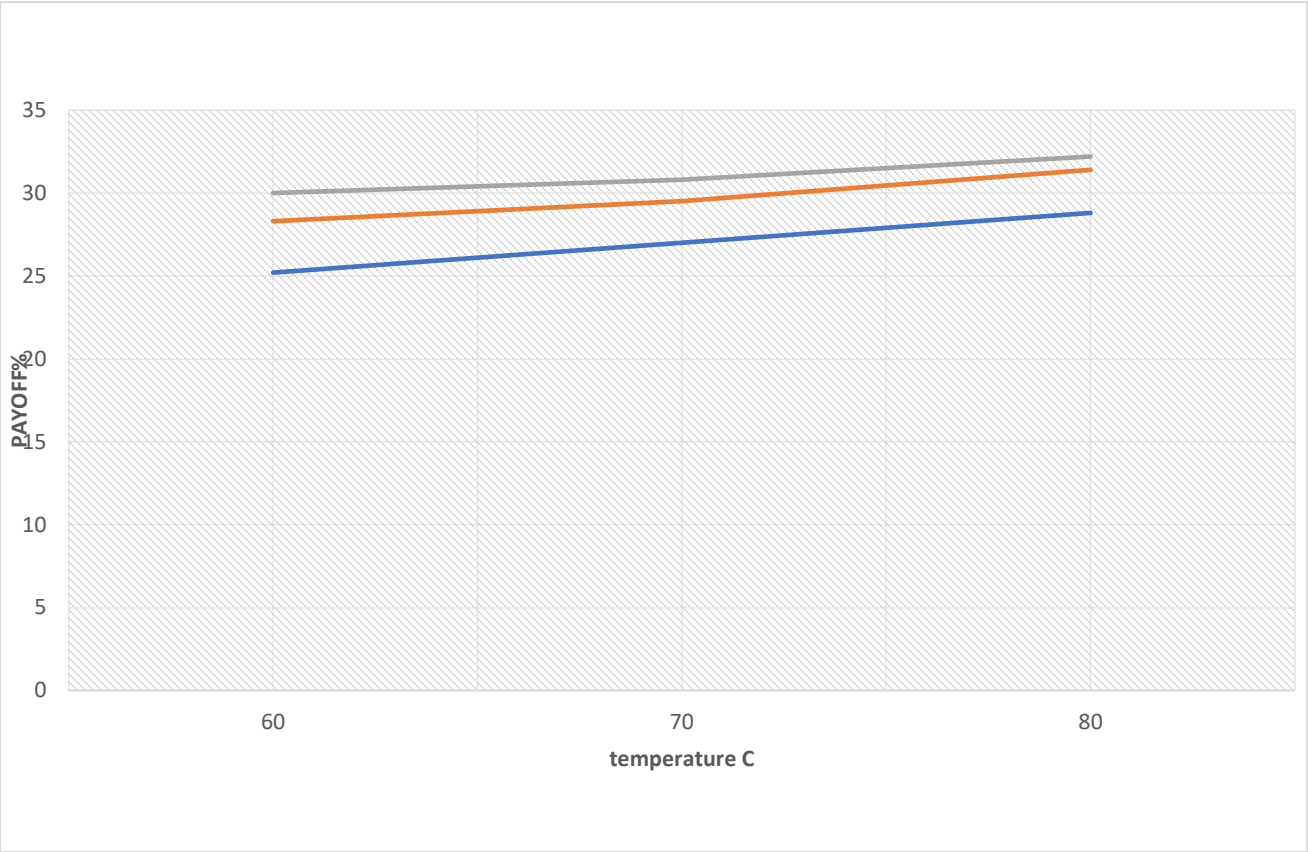
Then the hot acid extract was filtered and cooled to room temperature

The pectin was precipitated by adding 99% ethanol (1:1) at 4 oC for 3 hours. Then the formed precipitate was filtered and washed with ethanol several times.

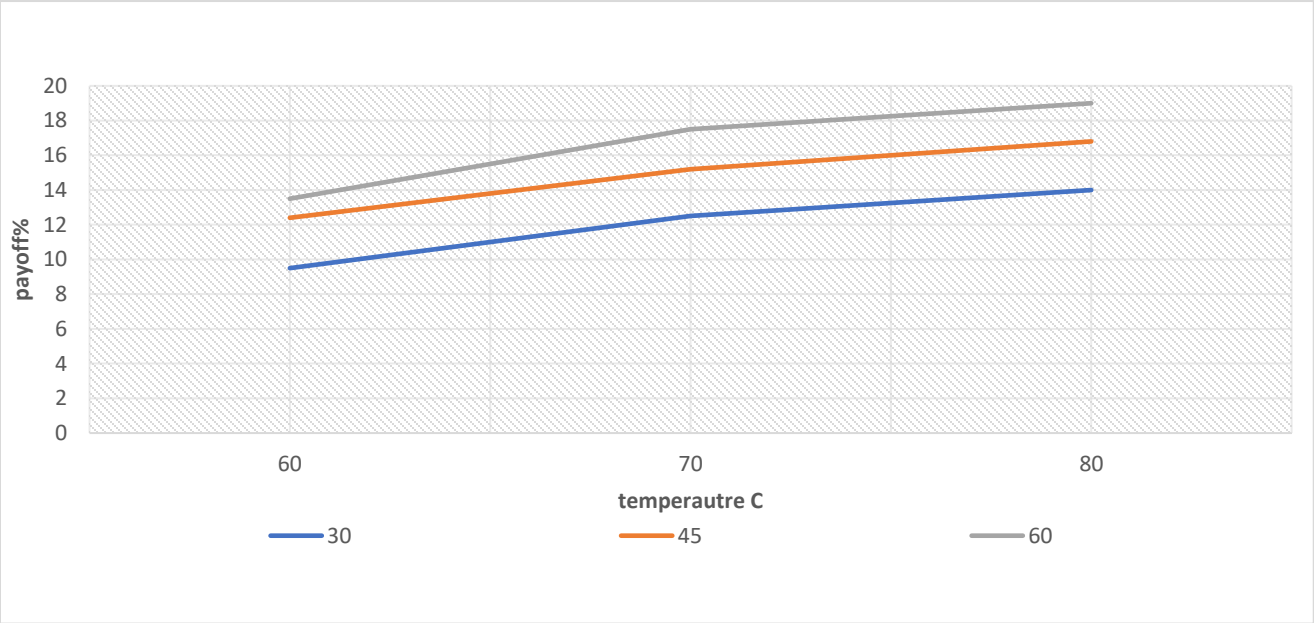
The results showed a great convergence in the yield between lemon and orange peels, and the yield was studied at different values as follows:



Effect of time and temperature on pectin yield at pH = 1.5



Effect of time and temperature on pectin yield at pH = 2.



Effect of time and temperature on pectin yield at pH = 2.5

Comparing the previous results, we conclude that with an increase in the pH value: pH < 1.5

The yield of pectin extracted from lemon peels decreased, and the best recorded yield of pectin was

% 44.2 at pH=1.5, extraction time 60 min, and temperature 80°C

Conclusions and Proposals:

1- The highest yield of pectin was obtained from lemon peels under the studied conditions at a temperature of 80 degrees Celsius and an extraction time of min60, pH = 1.5.

2- This study can be used to determine the best conditions and extract pectin within wider ranges of temperatures and extraction times, and compare it with other extraction media and different raw materials.

Economic Feasibility Study:

The economic feasibility of a factory with a capacity of producing 200 kilograms per month of pectin and under the salary scale in Syria has been studied, and the results have shown the following:

Fixed capital costs	51,855 dollar
Working capital costs	6,314 dollar
Assuming to work for three months	18,942 dollar
Depreciation	5188 dollar
Taxes	4000 dollar
Annual fixed costs	6402 dollar
Variable costs	78,080 dollar
Annual operating costs	84,493 dollar
Annual profit	76,043 dollar

Payback period	0.681
ROI	90%

All values are excellent and recommend the adoption of the project. There is also a marketing advantage, which is that, according to the latest statistics, only 9%, of citrus fruits waste in Syria is recycled.

the reviewer:

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