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CA 2128249 C 2004/06/22

(11)(21) 2 128 249

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(86) Date de dépôt PCT/PCT Filing Date: 1993/11/30
(87) Date publication PCT/PCT Publication Date: 1994/06/09
(45) Date de délivrance/Issue Date: 2004/06/22
(85) Entrée phase nationale/National Entry: 1994/07/15
(86) N° demande PCT/PCT Application No.: EP 1993/003379
(87) N° publication PCT/PCT Publication No.: 1994/012055
(30) Priorité/Priority: 1992/11/30 (92203689.2) EP

(51) Cl.Int.^{5}/Int.Cl.^{5} A23L 1/064

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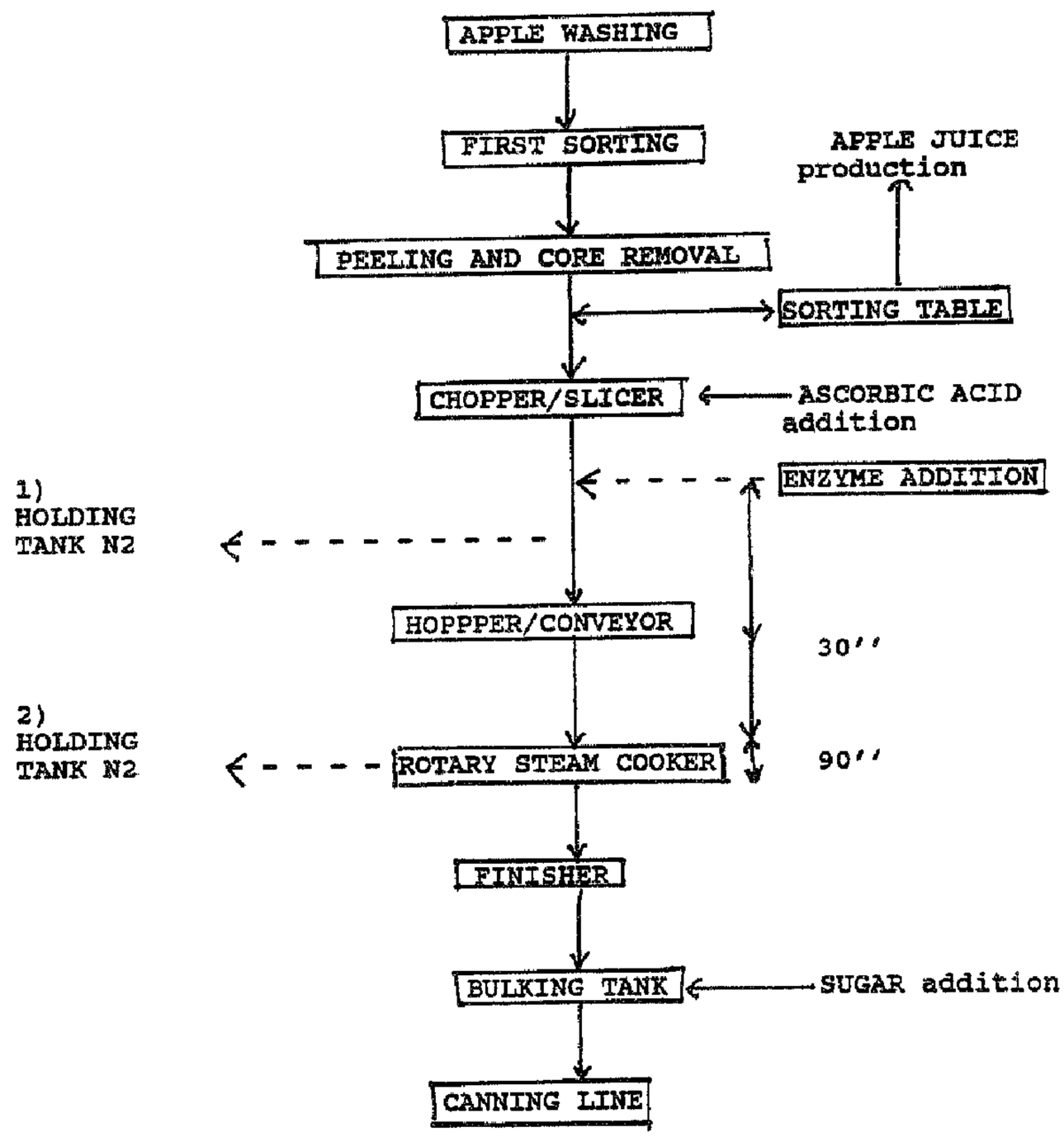
(54) Titre : UTILISATION DE LA PECTINE ESTERASE POUR LE TRAITEMENT DES FRUITS ET DES LEGUMES
(54) Title: USE OF PECTINESTERASE IN THE TREATMENT OF FRUIT AND VEGETABLES



(57) Abrégé/Abstract:
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PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :
A23L 1/06

A1

(11) International Publication Number: WO 94/12055

(43) International Publication Date: 9 June 1994 (09.06.94)

(21) International Application Number: PCT/EP93/03379

(22) International Filing Date: 30 November 1993 (30.11.93)

(30) Priority Data:
92203689.2 30 November 1992 (30.11.92) EP
(34) Countries for which the regional or international application was filed: NL et al.

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(81) Designated States: AU, BR, CA, HU, NZ, PL, RO, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

2128249

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: USE OF PECTINESTERASE IN THE TREATMENT OF FRUIT AND VEGETABLES

(57) Abstract

The present invention discloses the use of pectinesterase to demethoxylate high-methoxylated pectins. The pectinesterase makes possible the preparation of food containing fruit or vegetables in a more efficient way. Specifically, fruit and vegetable jams, jellies, compotes and soups are prepared without or with greatly reduced sugar and pectin addition. The present invention also discloses a process for producing apple sauce comprising the use of pectinesterase.

Use of pectin esterase in the treatment of fruit and vegetables

Technical field:

The present invention relates to the use of pectin esterase (E.C. 3.1.1.11) in the preparation of food containing fruits or vegetables. Specifically, the invention relates to the use of pectin esterase in the treatment of fruit or vegetables that is in the demethoxylation of pectin. The treated fruits or vegetables are then used in the preparation of jams, jellies, compotes, sauces and soups. The present invention further discloses a modification to the standard US apple sauce preparation process.

Background of the invention

Fruit and vegetable jams and jellies are normally prepared by cooking pretreated fruit and subsequent cooling. The pectin present in the fruit gelates, thereby giving the jam or jelly its rheological characteristics.

The pectin is mainly responsible for this gel formation due to its gelifying power. The gelifying potential of pectin is dependent on several conditions, mainly:

- dry substance content or brix,
- pH of the fruit or vegetable,
- concentration of pectin normally present,
- degree of methylation of the pectin.

Pectins are major constituents of the cell walls of edible parts of fruits and vegetables. The middle lamella which are situated between the cell walls are mainly built up from protopectin which is the insoluble form of pectin. Pectins are considered as intercellular adhesives and due to their colloid nature they also have an important function in the water regulation of plants. Water binding capacity is greatly increased by the amount of hydrophylic hydroxyl and carboxyl groups. The amount of pectin can be very high. For example, lemon peels are reported to contain pectin up to 30% of their dry weight, orange peels contain from 15-20% and apple peels about 10% (Norz, K., 1985. Zucker und Süsswaren Wirtschaft 38 5-6).

From a chemical point of view pectins consist of methoxylated polygalacturonic acid residues. Pectins are classified in different categories based on the degree of esterification and the degree of polymerisation.

On the basis of the degree of esterification pectins are divided into two groups:

1) high-methoxylated pectins with a degree of esterification higher than 50%, and

2) low-methoxylated pectins having a degree of esterification lower than 50%.

Both of these groups are capable of forming gels, however these gels differ in the mechanism by which they are formed. The high-methoxylated pectins form gels based on dehydration and electrical neutralisation of colloidal pectin-agglomerates. Gelation is stimulated if the pH is about 3 (dependent on the fruit or vegetable in question) and sugar, needed for the dewatering, is present in more

than 60% dry weight. Depending on the fruit, in practice, this often means that both sugar and high-methoxylated pectin have to be added to obtain the classical high sugar content jams. Structure forming interactions in the high-methoxylated pectin containing gels is based on hydrogen bond formation.

The low-methoxylated pectins are capable of forming gels with calcium ions or other divalent cations only. Gel formation with low-methoxylated pectins is based on ionic interactions. Calcium ions are naturally present in for example apples. No sugars have to be added in order to obtain suitable gelling properties. The amount of sugar and the pH in this case only influence the speed and temperature of gelifying. Low-methoxylated pectins are therefore perfectly suited for the preparation of low sugar content jams and jellies.

In practice pectin from fruits and vegetables generally has a high degree of methoxylation which necessitates the addition of large amounts of sugars to obtain suitable rheological characteristics. Furthermore, the degree of methoxylation varies with the time elapsed between the harvesting and the processing of the vegetables or fruit. This leads to a difference in the viscosity of the produced jams and jellies if the processing conditions are kept constant.

Summary of the invention

The present invention discloses the use of pectin esterase in the preparation of food containing fruits or

vegetables. Specifically, the invention discloses the use of pectin esterase in the treatment of fruit or vegetables that is in the demethoxylation of pectin. The treated fruits or vegetables are then used in the preparation of jams, jellies, compotes, sauces and soups.

The pectin esterase is used to demethoxylate the high-methoxylated pectins to obtain low-methoxylated pectins. The pectins obtained in this manner show calcium dependent gelation. This gel formation does not require the addition of sugars.

The present invention discloses jams and jellies obtained after the use of pectin esterase.

Furthermore, the present invention discloses a method for treating the crude fruit products with pectin esterase.

The present invention also discloses a process for obtaining apple sauce comprising the use of pectin esterase. Furthermore, the present invention discloses how the characteristics of the apple sauce are improved using pectin esterase in the standard US apple sauce preparation process. The invention also discloses how this standard process can be improved by a slight alteration in the process i.e. the introduction of a holding tank at a certain process stage.

Brief description of the Figures

Figure 1 is a schematic presentation of the apple sauce preparation process as used in the USA. The holding tanks 1) and 2) are suggested modifications to the standard process.

Description of the invention

The present invention discloses the use of pectin esterase in the preparation of food containing fruit or vegetables. The present invention discloses a method for preparing food containing fruit or vegetables comprising the addition of pectin esterase to the fruit or vegetable or to the pulp thereof to demethoxylate the pectin, and optionally, the addition of calcium chloride allowing the mixture to form a gel and further formulating the so-treated fruit or vegetable to obtain the desired food.

Preferably, the fruit or vegetable is selected from the group of fruits or vegetables containing high-methoxylated pectins.

Specifically, the invention is used in the preparation of fruit and vegetable jams and jellies, compotes, sauces and soups.

The inventors demonstrate that it is possible to treat crude fruit or vegetable products with pectin esterase, that due to this treatment the degree of methoxylation of the pectin is lowered and that the

resulting pectin gelifies with the calcium that is present in the fruit or vegetable. If the gelling is not complete it is possible to add high methoxylated pectin before enzyme addition or to add low methoxylated pectin.

This process works well with fruits or vegetables which contain high-methoxylated pectins, such as apple, strawberry, blackcurrant, orange, peach, pear, apricots and raspberry.

In the present invention both strawberries and apples were used. The first since it is a popular jam species and the second for its high content of high-methoxylated pectins.

Pectin esterases suitable for performing this process can be obtained from different sources. The pectin esterase of the present invention can be any pectin esterase from plants, bacteria or fungi, suitable for the degradation of high-methoxylated pectin. Preferably, the pectin esterase is from fungal origin. More preferably, the pectin esterase is obtained from Aspergilli, especially preferred is the use of pectin esterase obtained from Aspergillus niger.

In a most preferred embodiment purified pectin esterase is used. This purification can be performed in different ways.

The crude enzyme may be purified for example by liquid chromatography (ion exchange, gel filtration, affinity) (Ishii et al., 1980. Deutsches Patentamt

Auslegeschrift 2843351) or by selective inhibition of the pectin depolymerases (pH shock, heat shock, chemical inhibitors, chemical or organic solvents extraction) (Smythe C. et al., 1952. United States Patent US 2,599,531). Another source for obtaining purified pectin esterase as defined for the present application is pectin esterase obtained by recombinant DNA technology. An example of the use of recombinant DNA technology is the expression cloning of the Aspergillus niger pectin esterase. The cDNA sequence of this gene has been reported (Khanh et al. Nucl. Acids Res. 18 4262 (1990)). As expression host Aspergillus niger could be used. However, in view of the possible contamination of the pectin esterase with polygalacturonase, pectin lyase and other pectin depolymerases it may be preferable to use a heterologous host organism for producing the pectin esterase.

Suitable host organisms include bacteria and fungi. Preferred species are Bacilli, Escherichia, Saccharomyces, Kluyveromyces and Aspergilli.

The pectin esterase treatment of the present invention can be performed on entire fruits or vegetables, it can also be performed on presliced or ground fruits or vegetables.

The pectin esterase treatment of fruit or vegetables is performed as follows;

- pectin esterase is added to the crude or pretreated fruit or vegetable, the amount may vary as long as a

clear effect on the viscosity of the final product is detectable. Effective amounts, as shown for example in Examples of the present invention range from about 30 - 500 PE units per kg. These values merely serve as indications. It is understood that the effect of pectin esterase does not only depend on the amount of enzyme added but also on the time the enzyme performs its activity.

- also required for obtaining the desired gels is the addition of cations. In the present description this is illustrated by the use of calcium chloride. Again calcium ions are added in effective amounts. In Example 1 this is 250 ppm in the form of calcium chloride.
- the temperature of the reaction is not critical and may range from 10-70°C.
- reaction time again is not critical. Under application conditions it is desirable to keep reaction times low, for economical reasons. It is shown that a reaction time of about 10 minutes leads to a considerable improvement in the quality of apple sauce.
- finally the reaction is stopped by heat inactivation of the enzyme. This inactivation may coincide with the sterilisation of the product before canning or packaging.

The treatment leads to an increased firmness and viscosity of the product. After enzymatic treatment the fruits or vegetables can be added to dairy, bakery or confectionery products such as yoghurts, ice creams or desserts. The products can also be used as jams or jellies or fillings for chocolates, cakes or sweets. Another use is in the coating of other food products. By treating entire fruits or vegetables prior to freezing the firmness

of the fruits or vegetables after defreezing is increased. The pectin esterase treatment can also be used to improve the firmness of the entire fruits or vegetables. Pectin esterase treatment before blanching or cooking can be used to retard or prevent softening of the fruit or vegetable.

Retarding vegetable softening by cold alkaline pectin deesterification before cooking has been reported (van Buren and Pitifer. J. Food Sci. 57 1022–1023 (1992)) and it is to be expected that enzymatic deesterification also retards the indicated softening.

Apart from the direct uses of the treated fruit or vegetables as mentioned above, the application of the low-methoxylated pectins diminishes or abolishes the required use of sugars or other gelifying agents. After treatment of high-methoxylated pectin containing fruits or vegetables with pectin esterase the use of texturing agents such as exogenous pectin or of gelling or thickening agents obtainable from higher plants, seaweeds, animals or microorganisms (such as alginate or carageenan) can be largely diminished.

A further advantage of the use of gels from low-methoxylated pectins is that in comparison with high-methoxylated pectin gels the gels are irreversible. This means that heating and subsequent cooling does not destroy the gel. This heating and cooling is responsible for the well-known increase in fluidity of the jams upon storage. To the expert it is clear from the above that pectin esterase may be used in any foodstuff where low-methoxylated pectins normally are applied. Examples of

such foodstuffs are, apart from the mentioned jams and jellies, all kinds of fruit fillings, glazes and aspics. Instead of using low-methoxylated pectin as such the low-methoxylated pectin can be obtained by in situ formation from high-methoxylated pectins through the action of pectin esterase. In principle the formation of the (partially) demethylated pectin can be performed during any phase of the manufacturing process.

The present invention is illustrated by treatment of apples and strawberries with pectin esterase and it is shown that the viscosity is considerably increased after using the demethoxylating enzyme; this effect is even more pronounced upon the addition of calcium chloride. The gel firmness, measured as grams of counter-pressure using a Stevens Texture Analyser, increases upon treatment with pectin esterase. By adding calcium chloride the firmness can even be increased more.

In other examples it is shown that under normal processing conditions the viscosity of apple sauce is increased following treatment with pectin esterase.

Use of pectin esterase leads to a better consistency as measured by the flow ring method. Consistency is an important measure for the quality of apple sauce. Other improvements related to the use of pectin esterase in apple sauce preparation process are, a better mouthfeel and the absence of free run juice.

The results of the industrial trials indicate that pectin esterase can be used with its profitable effect without any alterations to the present production process.

The incorporation of pectin esterase in the present US standard apple sauce production process, without altering the process as such, leads to a very short reaction time for the pectin esterase (80-120 seconds). Even with this short reaction time pectin esterase gives clearly favorable effects on the product quality. This prompted the inventors to study the effect of a longer reaction time of the pectin esterase on the quality of the apple sauce. Bench-scale experiments indicated that increase of the reaction time to about 10 minutes increases the product quality even more.

Therefore, as another aspect the present invention discloses an altered production process for the preparation of apple sauce. The alteration consists of the introduction of a holding tank in the apple sauce preparation process in order to increase the effective reaction time of pectin esterase. It is suggested to keep the holding tanks under nitrogen and at room temperature if positioned at position 1) at position 2) the temperature is preferably about 60°C. The preferred. holding time is about 10 minutes and the volume of the tank should be chosen accordingly.

The present invention therefore discloses a process for preparing apple sauce wherein the following steps are performed;

1) washing of apples,

2) sorting to remove bad apples,

3) peeling and removal of the core,

4) sorting to remove bad apples,

5) crushing, chopping or slicing of the apples,

6) hopping of the apples to the cooker,

7) steam cooking of the apples,

8) finishing i.e. removing of stamens, peels, seed and other undesired particles,

9) addition of sugar,

10) canning,

characterized in that pectin esterase is added to the apples after crushing, chopping or slicing of the apples.

In an improved version of this process a holding tank is added after the enzyme addition step and before the steam cooking step. The holding tanks are preferably kept under nitrogen and the holding time, which varies with the temperature, the amount of enzyme added and the desired apple sauce consistency.

The use of pectin esterase in the apple sauce process allows for the production of top (constant) quality apple sauce during the whole season. As mentioned before the degree of methoxylating changes with the time after harvesting. The quality of the apple sauce using a standard process thus depends on the freshness of the fruits used in the process. Enzymatic demethoxylation leads to a constant and reproducible degree of methoxylation and thus to a constant quality gel or apple sauce.

Examples

Experimental

Assay of pectin esterase activity

One PE unit as used in the present specification is defined as the amount of enzyme which hydrolizes one micro-equivalent carboxymethyl in one minute under reaction conditions at 30°C and pH=4.5. The substrate is Apple pectin Ruban Brun 0.5% with a methylation degree of over 70% in water.

One PE Unit = 0.98 PE International Unit. Experiments are performed with pectin esterase which is preferably free from pectin lyase and polygalacturonase activities. Purification can be performed by standard methods as mentioned in the description.

Example 1

Pectin esterase treatment of fruit and influence on firmness

In the present experiments strawberries and apples were used.

Strawberries, without the green parts, were ground using a Waring blender for 30 seconds at low speed.

Apples; a blend of 33% Golden Delicious, 33% Red Delicious and 33% Granny Smith were first cut into small pieces, without the stem. Subsequently the apples were strained with the aid of a Roto shredder fixed on a Hobart

mixer (model N-50G, speed 2). The mass was then grinded, for 30 seconds (high speed), using a Waring blender (model 32BLBO).

The fruit pulp (strawberries and apples were treated in the same manner) was divided into six portions of 300 grams and each portion was poured into an erlenmeyer flask.

Pectin esterase (240 PE units/g) was added to the pulp in two different concentrations. As can be seen in Table 1, flasks 1 and 2 were blanks. Flasks 3 and 4 contained 250 PE units/kg and flasks 5 and 6 contained 500 PE units/kg.

The flasks were placed in a waterbath (50°C) and stirred using a magnetic stirrer. After one hour, calcium chloride was added to flasks 2, 4 and 6 and enzyme activity was stopped by placing all erlenmeyers in a boiling waterbath for 2.5 min.

Finally, the hot pulp was poured into plastic cups (300 ml) and left to stand for 24 hours at room temperature.

Firmness of the jellies was measured with the aid of a Stevens Texture Analyser. Thereto a cylindrical plunger (TA4 1,5 inch) is brought into the gel at a constant speed (0.5 mm/s). Firmness is defined as the force required (in g) to penetrate the gel for a specified depth (5mm). Duplicate measurements were performed. Results are shown in Table 1.

Table 1

Gelfirmness in grams counterpressure for penetration of 5mm.

Flask	Strawberry	Apple
1 Blank pulp	13	45
2 Blank pulp + 250 ppm $CaCl_2$	13	45
3 Pulp + 250 PE u/kg	73	121
4 Pulp + 250 PE u/kg + 250 ppm $CaCl_2$	56	250
5 Pulp + 500 PE u/kg	126	144
6 Pulp + 500 PE u/kg + 250 ppm $CaCl_2$	117	249

The low firmness of flasks 1 and 2 indicates that no gelification has occurred.

Flask 3 shows that gelification takes place in both apple and strawberries after addition of pectin esterase. Higher PE concentrations lead to increased firmness (flask 5).

The influence of calcium on gelification clearly depends on the type of fruit. The relatively low calcium concentration of apples, apparently inhibits a quick gelification of the high concentration of demethylated pectin. Addition of calcium then increases the gel strength and the rate of gelification.

In strawberries the calcium concentration is relatively high, in combination with a low pectin concentration the addition of calcium results in a non-

optimal calcium pectin ratio. This leads to a lower gel strength.

Example 2

Influence of pectin esterase treatment on viscosity of apple sauce under large-scale processing conditions

In a typical large scale (3-5 tons) process the apples (Golden Delicious) are washed and ground. The temperature of this pulp is brought to 90°C by addition of fresh pulp to pulp kept at 94°C in a ratio of 1:9 (the so-called Hot-break process). The pulp is kept at 90°C for 10 to 15 min. before further processing.

Rapidase™ 9236 was added during the grinding at 150 g/ton and at 300g/ton. Viscosity was measured by taking samples at different times and cooling these samples to a standard temperature. Subsequently, these samples were applied on a plate having a fixed inclination and the distance travelled by the front of the pulp was measured after 1 or 2 minutes. The distance is a measure for the viscosity of the sample.

Results are shown in Table 2.

Table 2

Dose Rapidase™ 9236	150 g/ton			300 g/ton	
Temp. of measurement	33°C	21°C		21°C	
	distance (mm) measured after				
	1 min.	1 min.	2 min.	1 min.	2 min.
Time of measurement after start of PE addition					
0	40	34	38	29	32
20	35	30	34	30	31
25	30	27	30	25	28
30	30	26	29	27	29
35	30	25	30	28	30
40	31	26	30	29	31
45	33	27	31	30	31
55	34	30	34	28	30

It can be calculated that the pulp was fully mixed with enzyme between 25 and 40 minutes. After and before these times the pulp was increasing respectively, decreasing in amount of pectin esterase.

It can be concluded that viscosity increases due to pectin esterase treatment under processing conditions. With 300 g/ton the increase in viscosity was less than expected probably due to an overdosage of pectin esterase with a concurrent lack of a sufficient amount of calcium.

Example 3

Use of pectin esterase in an industrial process for production of apple sauce

Enzyme preparation

In the present example pectin esterase from Aspergillus was used; the enzyme had an activity of 260 PE units/g.

Viscosity measurement

Viscosity measurement was performed using the flow ring (via flow) as recommended by the USDA (United States Department of Agriculture).

Free run juice measurement

Free run juice was estimated visually. Quantities are indicated as follows:

+++ a lot of free run juice

++ medium amount of free run juice

\+ small amount of free run juice

\- no free run juice

Mouthfeel test

The mouthfeel is graded by tasting. The following gradations are given:

\- poor taste

\- medium taste

\- good taste

\- very good taste

Description of the industrial apple sauce preparation process

Industrial apple sauce preparation is performed by the following processing steps. The process described is the one normally used in the USA. This process differs from the one used in Europe. The process is schematically presented in Figure 1.

Description of the process for apple sauce preparation in the USA

The process for apple sauce preparation comprises the following steps:

1) washing of apples
2) 1st sorting to remove bad apples
3) peeling and removal of the core
4) 2nd sorting to remove bad apples
5) crushing)
   chopping) different types of crushers
   slicing)
6) hopper conveyor - conveyor to cooker
7) steam cooker - pulp heating to 93°-94°C
8) finisher – removing of stamens, peels, seed and other undesired particles
9) bulking tank for sugar addition
10) canning line

Experiments

Three trials were performed at industrial scale. Pectin esterase was added during transport of the sliced apples on the conveyor to the cooker. Effective reaction

time for the pectin esterase was therefore very short, 80-120 seconds. The temperature during the reaction on the conveyor was 60°C. As mentioned before the mixture was heated by mixing with a mixture of 93°-94°C in a ratio of 1:9.

I. Contact time enzyme (max): 80 seconds.
Medium quality of apples, chopper: coarse particles.
Enzyme 1200g/ton apples.
Temperature 60°C at the place of addition.

	Average consistency	Free run juice	Mouthfeel
No enzyme (before test)	6.37	++	ND
With enzyme	6.01	+	ND
No enzyme (end of trial)	7.04	+++	ND

II. Contact time enzyme (max): 120 seconds.
Good quality of apples, chopper : small particles.
Enzyme 1000g/ton apples.
Temperature 60°C at the place of addition.

	Average consistency	Free run juice	Mouthfeel
No enzyme (before test)	5.9	-	good
With enzyme	5.4	-	very good
No enzyme (end of trial)	5.9	-	good

III. Contact time enzyme (max): 120 seconds.
Good quality of apples, chopper: small particles.

Enzyme 600g/ton apples.

Temperature 60°C at the place of addition.

	Average consistancy	Free run juice	Mouthfeel
No enzyme (before test)	6.26	++	good
With enzyme	5.75	-	very good
No enzyme (end of trial)	6.32	++	good

It can be seen that through the addition of pectin esterase, without any alterations to the apple sauce production process, the taste of the apple sauce can be improved.

The criterion of consistency is the most important for grading different apple sauce preparations, it is related directly to the level and quality of pectin in the apple. The industrial trials show an improvement of the consistency of the apple sauce after the use of pectin esterase.

In addition to the increase in consistency an improvement of mouthfeel was observed. Furthermore, the absence of free run juice is another sign of increased quality of the apple sauce upon usage of pectin esterase.

The difference between the starting values is due to the fact that the measurements have been performed at three different production facilities, the apples were not the same brand and possibly from a different season.

Example 4

Effect of pectin esterase on consistency at different dosage

One gallon can of apple sauce was recovered from the canning line (Example 3, second trial) before cooling and at a temperature of 65-70°C.

Four trials have been performed on 500 gram samples of apple sauce. The trials consisted in the addition of different amounts of pectin esterase. The mixtures were kept at 60°C for 10 minutes, subsequently the temperature was raised to 92°C in a microwave oven. The consistency and the amount of free run juice were measured as described in Example 3.

Trial	dosage	consistancy	free run juice
1	control	5.70	+
2	200g/ton	5.0	-
3	400g/ton	4.85	-
4	600g/ton	4.50	-

The results indicate that the quality of the apple sauce is further improved, as evidenced by the consistency and the amount of free run juice, by increasing the reaction time and concentration of the pectin esterase.

Values below 5.5 can easily be reached and this value is considered to be of importance in pricing of the product.

Example 5

Effect of pectin esterase on consistency at different temperatures

The apple sauce was recovered from the canning line as described in the previous example. The apple sauce (500 gram samples) was heated to the indicated temperatures and pectin esterase was added in an amount of 400g/ton. The samples were left to cool. Consistency, free run juice and mouthfeel were determined as described in Example 3.

Trial	temperature	consistancy	free run juice	mouthfeel
1	control	5.70	+	good
2	82°C	5.45	-	good
3	75°C	5.30	-	very good
4	70°C	5.0	-	very good
5	65°C	gel	-	-
6	60°C	gel	-	-

The results indicate that the consistency, free run juice and mouthfeel improve upon using pectin esterase. This effect is temperature dependent as can be expected for enzyme activities.

Claims

1. A method for preparing food containing fruit or vegetables comprising;

- the addition of pectin esterase to the fruit or vegetable or to the pulp thereof to demethoxylate the high-methoxylated pectin to obtain low-methoxylated pectin,
- and optionally the addition of calcium chloride,
- allowing the fruit derived demethoxylated pectin to form a gel,
- and formulating the so-treated fruit or vegetable to obtain the desired food.

2. The method of claim 1, wherein the fruit is selected from the group consisting of fruits or vegetables containing high-methoxylated ectins.

3. The method of claim 1 or 2, wherein the fruit is selected from the group consisting of apple, strawberry, orange, peach, pear and blackcurrant.

4. The method of claim 1 to 3, characterized in that no pectin or gelling or thickening agent is added to prepare the food formulation.

5. The method of any one of claims 1 to 4, characterized in that the pectin esterase is from fungal origin.

6. The method of claim 5, wherein the fungus is an Aspergillus.

7. The method of claim 1, wherein the pectin esterase is purified.

8. A process for preparing apple sauce wherein the following steps are performed;

1) washing of apples,
2) sorting to remove bad apples,
3) peeling and removal of the core,
4) sorting to remove bad apples,
5) crushing, chopping or slicing of the apples,
6) hopping of the apples to the cooker,
7) steam cooking of the apples,
8) finishing, which comprises the step of removing of stamens, peels, seed and other undesired particles,
9) addition of sugar,
10) canning,

characterized in that pectin esterase is added to the apples after crushing, chopping or slicing of the apples to demethoxylate the high-methoxylated pectin to obtain low-methoxylated pectin.

9. The process according to claim 8 comprising the additional step of placing the enzyme treated apples in a holding tank prior to the steam cooking step.

10. Food obtainable by a method according to any one of claims 1 to 7 or a process according to claim 8 or 9.

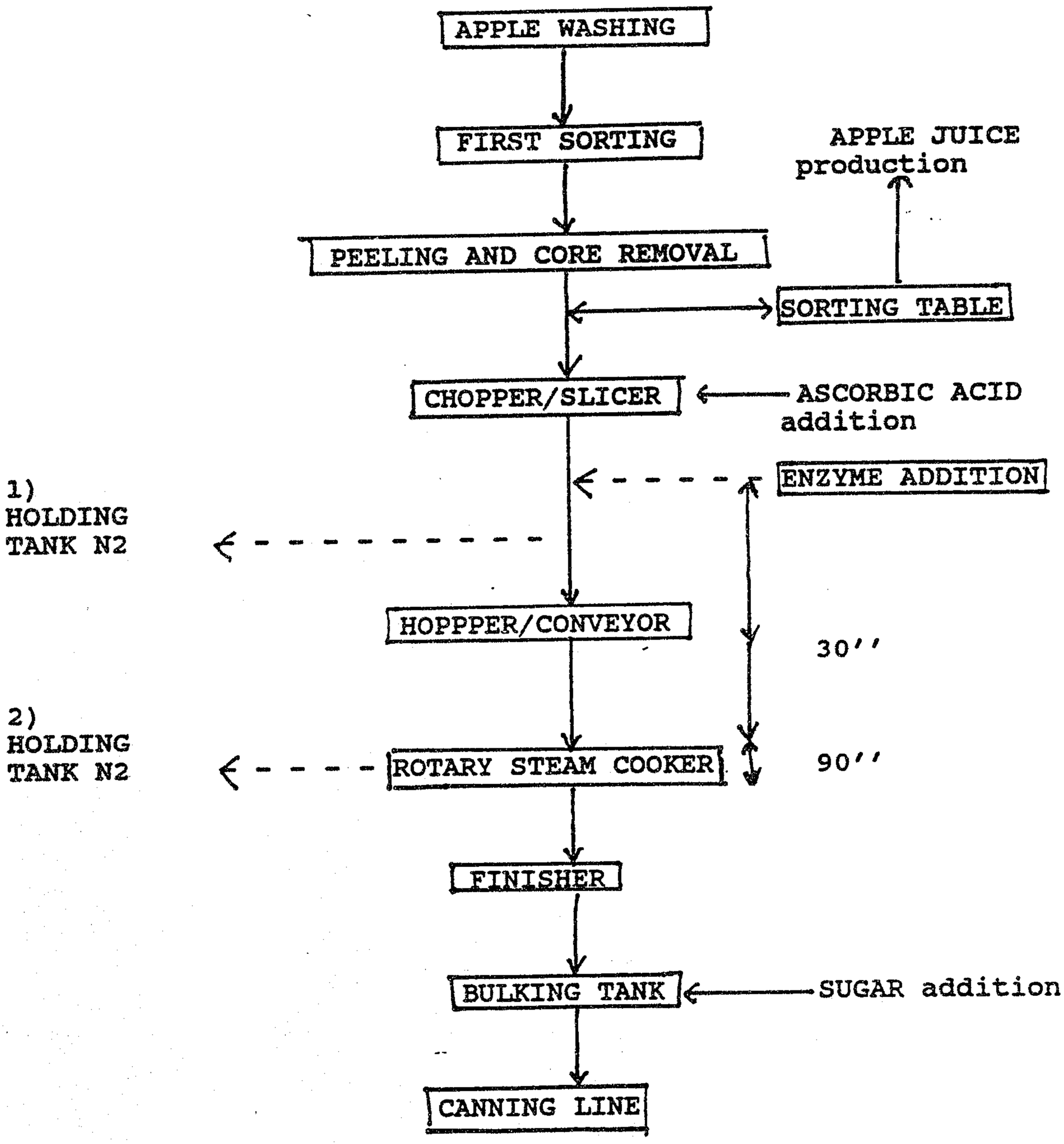
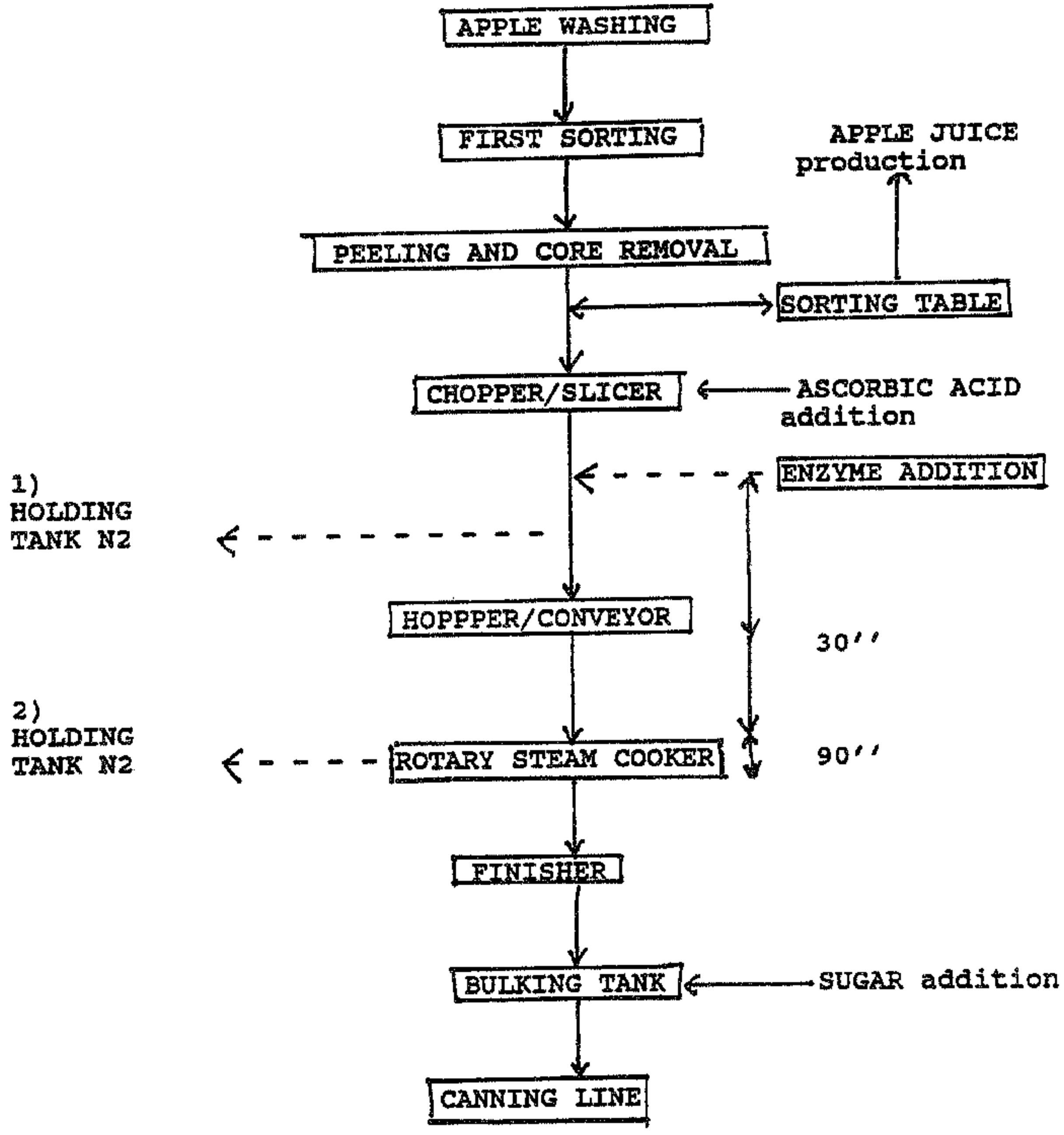

APPLE WASHING
FIRST SORTING
PEELING AND CORE REMOVAL
APPLE JUICE production
SORTING TABLE
CHOPPER/SLICER
ASCORBIC ACID addition
ENZYME ADDITION
1) HOLDING TANK N2
HOPPPER/CONVEYOR
30''
2) HOLDING TANK N2
ROTARY STEAM COOKER
90''
FINISHER
BULKING TANK
SUGAR addition
CANNING LINE

FIGURE 1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