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HACCP Case Study
Fruit Jam

1. Introduction

A family-owned medium-sized plant producing fruit spreads was asked to provide a HACCP plan for their product – fruit jam.

2. Terms of reference

The HACCP study covers food safety hazard analysis, CCP determination, preventive, control and corrective actions. Cleaning and sanitation operations (hygiene of production, sanitation of production and non-production areas) are covered by Good Hygiene Practice as a separate part of a HACCP plan to be applied at any step of production processes where needed. The same is applied for raw materials reception, storage and distribution and for labeling and packaging and dispatching of end products, which are done according to respective procedures. These are not fully covered by the HACCP study, only concise notes where made where important.

3. Product desctription

3.1 General

Fruit jam is a favourite way of fruit processing and is largely applied in Slovakia. Families often made their own produces, meanwhile consumers like industrially made jams as well. A wide scale of jams is produced of one or more kinds of fruit. Usually they are made from pulp and/or purée. A product may be made with whole fruit cut into pieces or crushed. Berries and other small fruits are most frequently used, though larger fruits such as apricots, peaches are also used when chopped. A consistency of a jam should be soft, even, without distinct pieces of fruit, however pieces or fruit may be semi-boiled, semi-jellied, easy to spread and without free liquid. Jams produced in the above-mentioned plant are one-fruit jams of even consistence without pieces of fruit made from following fruit: strawberries, apricots, raspberries, currants, sour cherries, blackberries, blueberries, rose hips, cornels.

3.2 Ingredients

Jams according to a kind may contain fruit according to the kind (purée, pulp), sugar, dye (caramel, E 150d), pectin, citric acid, starch syrup, chemical conservants (E 202, E 211), sulphur dioxide (SO_2)

3.3 Process

See Fig. 1 – generic flow diagram of jam production.

3.4 Product specifications

Microbiological – see Tab. 1 and 2.

Tab. 1: Maximum permissible levels of pathogenic microorganisms in foodstuffs.

Microorganism	Maximum permissible levels
Bacillus cereus	1.10^4/g
Campylobacter jejuni	Negat./25 g
Clostridium botulinum	Negat./10 g
Escherichia coli O 157:H 7and other verotoxin producing strains	Negat./25 g
Pseudomonas aeruginosa	1.10^3/g
Shigella sp.	Negat./25 g
Yersinia enterocolitica (enteropathogenic serotypes)	Negat./25 g
Listeria monocytogenes	Negat./25 g

Tab. 2: Maximum permissible levels of bacterial toxins and mycotoxins in foodstuffs.

Toxín	Maximum permissible levels
Staphylococcal enterotoxins	Negat.
Enterotoxin (Clostridium perfringes)	Negat.
Enterotoxin (Bacillus cereus)	Negat.
Verocytotoxin 1 and 2 (E. coli O 157:H 7)	Negat.
Botulinum toxin	Negat.
Ochratoxin A	0,01 mg/kg
Sterigmatocystin	0,005 mg/kg

Physicochemical

- Minimum weight share of fruit (g/kg)
  - generally – 350
  - for red and black currants and hip roses – 250.
- Minimum refractometric dry mass 60.
- Consistency – soft, even, without distinct pieces of fruit, semi-jellied, easy to spread and without free liquid. Jam must not contain stones.
- Appereance – bright colour – according to a sort – as determined in respective jam specifications.

Products must be in compliance with the national legislation – Food Code of Slovak Republic – based on the EU legislation transposed into the national legislation. These involve microbiological and physicochemical properties including pesticide residues and food additives (conservants, dyes, flavours, acidity regulators, others), which do not form a part of a product specification, but has to be met as a matter of obligation to the law.

3.5 Package

Glass jars: 350g, 300g, 240g, plastic packets: 150g, 20g, plastic pails: 4kg, 7kg.

3.6 Shelf life

12 months.

3.7 Nutritional values

Average values: energy – 240 Kcal/100g, fat – 0.2%, proteins – 0.47%, saccharides –60.3%.

3.8 Intended use
General public: adults, children (mostly from 5 years).

3.9 Uses
As a ready procuct for a direct consumption with bread or pastry, as an ingredient for the preparation of baked cakes and sweets.

3.10 Consumer instructions
Store in a dry and dark place.

4. Process Flow Diagram

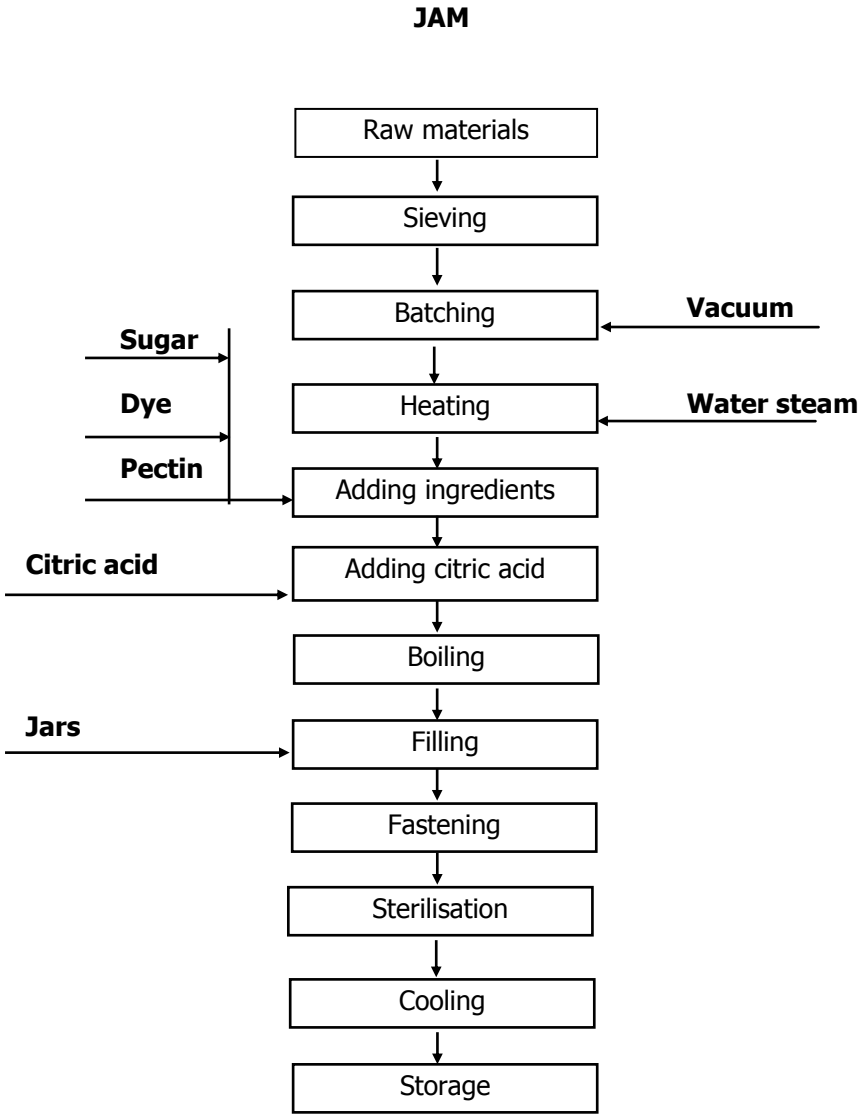

Fig. 1: Generic flow diagram of jam production.

4.1 Raw materials

Jam is produced from fresh or frozen fruit in a form of juice or pulp. The raw materials are purchased from producers proving a certificate, decision on production authorisation or import of raw materials, or certificate from State Veterinary and Food Administration of SR of raw material safety and fitness for use in human consumption.

Note: The raw materials are at reception transported to the storerooms or cold stores immediately after the reception, where they are stored till distribution to further processing. Storerooms should be clean, dry, cool and with good airing. Storage conditions depend on a kind of raw material and should

be such that the health safety of raw materials is not impaired. Temperature and humidity in storerooms are daily monitored. When defects are discovered during a control, the raw materials must not be used and are discarded. At distribution a visual control of a raw material is done, as well as a check of expiration date or minimal shelf life date. When defects are discovered, the raw materials are controlled in laboratory for sensoric, microbiological and physicochemical properties. If the raw materials fulfill the conditions, they may be used for processing – otherwise they have to be discarded. When opening a storage tank with a raw material care has to be taken not to contaminate a content by a lid or mechanical impurities. An entry laboratory control is done to obtain data on acidity and dry mass of a raw material to calculate the needed amounts of additives to be added to a specified amount of raw materials. Data on amounts of distributed raw materials are recorded.

4.2 Sieving

The defined amounts of raw materials are sieved when needed or suitable before batching into a vacuum jacketed steam vessel to make them homogenous. Sieved raw materials are gathered in a mixing vessel.

4.3 Batching

Raw materials are transported from a mixing vessel to a vacuum vessel using vacuum.

4.4 Heating

The inlet of water steam is shut open. The content of a vacuum vessel is heated to 85°C for approx. 30 min to remove a preservation agent, SO_2, what is controlled in laboratory and data are recorded. Refractometric dry mass (Rf) should be at least 22% at the end of this stage.

4.5 Adding of ingredients

To the content of a vacuum vessel the ingredients are added: food dye, sugar, pectin (when the content of pectin in fruit is insufficient), possibly starch syrup, in needed amounts. Sugar is added in a smaller amount at the beginning and the main part is added after SO_2 is volatilised. Powdered pectin is added before and liquid pectin after adding of the main sugar part. Liquid pectin (4% solution) is prepared by gradually dissolving a needed amount in hot water (80°C). Alternatively, powdered pectin may be mixed with sugar in 1:3 ratio and dissolving in hot water (60-70°C). Pectin has to be completely dissolved before adding, not leaving undissolved remains. The process continues at the same conditions to the point, when Rf reaches a level 59%. At the end of this stage, food dye is added.

Note: Store rooms for storage of additives should be clean, dry, cool and with good airing. Temperature and humidity in storerooms are daily monitored. A visual control of an additve is done, as well as a check of expiration date or minimal shelf life date. care has to be taken when manipulating an additive to prevent contamination with mechanical impurities. Data on amounts of an additive used are recorded.

4.6 Adding of citric acid

When Rf achieves the value of 59, citric acid as an acidity regulator to achieve an stabilise pH value less than 4.6 (generally approx. 3.5) in a product is added in a needed amount.

Note: Store rooms for storage of additives should be clean, dry, cool and with good airing. Temperature and humidity in storerooms are daily monitored. A visual control of an additve is done, as well as a check of expiration date or minimal shelf life date. care has to be taken when manipulating an additive to prevent contamination with mechanical impurities. Data on amounts of an additive used are recorded.

4.7 Boiling

The content of a vacuum vessel is quickly brought to the boiling point – the time of bringing to the boiling point should be shortest possible. The content of a vacuum vessel is boiled till Rf = 60,8%. Rf is measured and recorded at every batch.

4.8 Filling in jars

When Rf = 60.8%, the heating is stopped and the product may be filled in the jars. Filling is done using automatic filler. During filling, the temperature of the product should not drop below the point when pectin is going to harden, as it would not jelify even after re-heating. The filled jars must be of prescribed minimum weight. Besides weight control the jars are controlled also visually.
Note: Before using the jars these have to be controlled for damage, sorted out if broken, washed with warm water (50°C) and left to drain. In case an outer package of a delivery is damaged, the jars has to be desinfected using a sanitation programme in a separate room.

4.9 Fastening of lids

When jars are filled the lids are fastened using automatic machine.
Note: Tightness of lids is controlled laboratory for every delivery of lids according to the norm STN 16 0201. When defects are discovered, a delivery must not be used. At the beginning and during a work shift the tighteness is controlled. Records on the tightness during a production process are kept. In case of breaking a jar, following five jars withoul lids put on are discarded. If the lids are delivered packaged in protective plastic wrap, they may be directly used, otherwise they has to be washed with warm water (50°C).

4.10 Sterilization (CCP)

Filled and fastened jars are transported to an autoclave by a conveyor. The temperature of water should be approx. 98°C and the length of sterilization should be 25 min, so that the interior temperature in a jar is 85°C minimum held for 5 min. When the sterilization conditions are not met, microbial decay and swelling threaten and a batch could be destroyed. For every batch, the temperature and time of sterilization at the beginning, during and in the end are monitored, measured and recorded. Immediately after sterilization and cooling a sample is taken to verify in laboratory whether the sterilization conditions were met. If it is found out the sterilization was insufficient all products of this batch has to be discarded.

4.11 Cooling

Sterilized jars are cooled in an autoclave. The length of cooling should be the shortes possible and should not exceed 30 min. to avoid microbial decay due to propagation of spore forming microorganisms. The resultant temperature in the centre of jar should be 30°C.

When the conditions of cooling are not met, microbial decay and swelling threaten and a batch could be destroyed. For every batch, the temperature and time of cooling are monitored, measured and recorded.

4.12 Storage

When cooling is finished, jars are visually controlled for mechanic damage, transported to a device where labels are put on. Labelled jars are put in pallets and transported to store rooms, where they are stored and from where they are dispatched to purchasers or consumers by vehicles.
Note: Store rooms for storage of products should be clean, dry, cool, with soft light and good airing. Temperature (max. 30°C) and humidity (up to 70%) in store rooms are monitored and recorded daily. When the conditions of storage are not met, microbial decay and swelling threaten and products could be destroyed.
From every batch a sample is taken to control microbiology, physicochemical parameters, sensoric properties, weight and labeling. When the products are leaving a storeroom, they are visually controlled for swelling.
In case the storage conditions measured are not as defined, the products are controlled in laboratory. It they do not fulfill the specification or if the laboratory control of a batch sample proves defects in any of the characteristics or swelling is observed the whole batch or swelled jars have to be discarded. If the results of the control allow it, such products could be re-used as a raw material.
Records are kept also on distribution of finished products to customers.
Besides own production control a producer is obliged to regularly control his products for quality and safety in an authorized laboratory.

4.13 General conditions

Hygiene of production, sanitation of production and non-production areas

At every step Good Manufacturing Practice, Good Hygiene Practice and personal hygiene has to be employed. Following controls by responsible persons of these are done regularly:

1. visual control of cleanness of devices – befor and after cleaning
2. visual control of cleanness of workplace – before and after every work shift
3. laboratory control of cleanness of devices by means of microbial sampling from surfaces – monthly
4. laboratory control of cleanness of worker´s hands by means of microbial sampling from hand surface – monthly
5. control of compliance with instrustions and principles
6. laboratory determination of concentration of an effective substance in a sanitation solution.

Quality of water

For the whole process (cleaning of devices, other activities in which raw materials or ingredients are coming into contact with water or water cleaned surfaces) potable water is used. For cooling not potable water may be used provided that water is treated to be safe. When re-used it has to be disinfected prior to use. Laboratory control is done monthly, in which microbiology, foreing matters, chlorine remains are controlled. Once in a year a control is done by the State Health Institute.

Quality of air

Sufficient airing should be secured, where needed a device for steam escape should be installed to prevent condensation on surfaces of devices, walls, ceiling and constructions. Any further steps should be made to secure a good quality of air to prevent the secondary contamination of raw materials or products. Quality of air is controlled in laboratory monthly.

4.14 Identification of CCPs

No	Process Step	Potential hazard description	Control measures	* Q 1	* Q 2	* Q 3	CCP Y/N
1	Raw materials	B – microbial decay C – residues of foreing matters P – glass fragments	Control of raw material and accompanying documentation at the reception Control of shelf life date or expiration date Entry laboratory control Control of packages at the reception Sensoric control	Y	Y	N	N
2	Sieving	B – ineffective or inappropriate sanitation of sieving device P – mechanic impurities	Compliance with Good Hygiene Practice, control of sanitation effectivity Regular maintenance and control of devices, visual control before use	Y	Y	N	N
3	Batching	B – ineffective or inappropriate sanitation P – mechanic impurities	Complience with Good Hygiene Practice, control of sanitation effectivity Regular maintenance and control of devices, visual control before use	Y	Y	N	N
4	Heating	-	-	N	-	-	N
5	Adding ingredients	B – microbial contamination, shelf life expiration P – mechanic impurities	Control of shelf life date or expiration date Compliance with storage conditions and regular recording Laboratory control at suspicion Visual control	Y	Y	N	N
6	Adding citric acid	B – microbial contamination, shelf life expiration P – mechanic impurities	Control of shelf life date or expiration date Compliance with storage conditions and regular recording Laboratory control at suspicion Visual control	Y	Y	N	N
7	Boiling	-	-	N	-	-	N
8	Filling	B, P – damaged packages, use of	Use of package material with certificate	Y	Y	N	N

		unwholesome package materials	Visual control Proper sanitation and control Compliance with Good Hygiene Practice				
9	Fastening	B, P – improper fastening	Control of fastening and recording	Y	Y	N	N
10	Sterilisation	B – insufficient and improper sterilization – temperature, time	Compliance with sterilization time and temperature, control and recording Prolongation of time or increase of temperature when temperature is insufficient	Y	N	-	Y
11	Cooling	B – inadequate cooling – microbial decay at slow cooling caused by a propagation of spore forming microorganisms	Rapid cooling, control of temperature and time, recording	Y	Y	N	N
12	Storage	B – improper storage conditions – microbial decay, impairment of physicochemical parameters	Compliance with storage conditions, control and recording Sanitation, control Visual control Laboratory control	Y	Y	N	N

B: Biological, C: Chemical, P: Physical
* Questions of the Decision Tree
Q1 Is there a hazard associated with this process step?
Yes: Go to Q2 / *No*: Proceed to next step
Q2 Are you or the consumer going to process this hazard out of the product in a subsequent step?
Yes: Go to Q3 / *No*: CCP.
Q3 Is there a cross-contamination risk to the facility or to other products which will no be controlled?
Yes: CCP / *No*: Proceed to next step

4.15 Controlling of CCPs

Process Step	**Hazard**	**Monitoring**	**Frequency**	**Critical points**
Sterilisation, pasteurisation	B	Temperature	Every batch	98°C for 25 min

B: biological

References

EU legislation (transposed into national legislation):

- Commission Regulation (EC) No 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs
- Council Directive 2001/113/EC of 20 December 2001 relating to fruit jams, jellies and marmalades and sweetened chestnut purée intended for human consumption.

National legislation (transposed EU legislation):

- Regulation of the Ministry of Agriculture of the Slovak Republic and the Ministry of Health of the Slovak Republic of 6 February 2006 No 06267/2006-SL, by which a Head of Food Code of the Slovak Republic regulating microbiological conditions on foodstuffs and packages for them is issued
- Regulation of the Ministry of Agriculture of the Slovak Republic and the Ministry of Health of the Slovak Republic of 23 June 2004 No 1685/2004-100, by which a Head of Food Code of the Slovak Republic regulating fruit jams, jellies and marmalades and sweetened chestnut purée is issued.