TRUEFOOD

Traditional United Europe Food

Contract no. FOOD-CT-2006-016264

Instrument: Integrated Project

Thematic Priority: Food Quality and Safety (# 5)

D3.1.4
Final report on mapping of representative total food chains of TF and list of critical points for product safety

Due date of deliverable: April 2008
Actual submission date: April 2008

Start date of project: 1 May 2006 Duration: 48 months

Organisation name of lead contractor for this deliverable: AUA – P05

Revision final

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)		
Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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Deliverable D 3.1.4

Final report on mapping of representative total food chains of TF and list of critical points for product safety

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Summary

Different food chains were mapped for the efficiency of the management of the food safety and those steps were identified that either introduce a hazard (emergence) or increase the food safety risks, thereby requiring better control in order to sustain compliance with established food safety-, hygiene requirements. An overall mapping of the food chain was performed to identify the number and type of environmental variables (intrinsic, extrinsic, implicit variables), the changes of which significantly affect product safety. AUA mapped the supply chains of fermented green olives, ready-to-eat fishery products, set and stirred yoghurts, cooked sausages and cooked cured meat products. In addition, CCH focused on the supply chain of air-dried, smoked sausage and composite products made of the use of these sausages as ingredients. In addition, the critical control points (CCPs) as well as the good hygiene practices (GHP) of traditional bottled soda water, honey, dry pasta, and fruit jams have been determined and mapped. Furthermore, in the WP5 of Truefood project several traditional food supply chains have been mapped across Europe and these data were made available for WP3. The Italian cheese and ham supply chains might be used for the model development of chilled supply chains later in the work of WP3.

Final report on mapping of representative total food chains of TF and list of critical points for product safety

1 Fermented Green Table Olives Supply Chain

Table olives are an economically important agricultural commodity for the processing industry in Greece and a popular fermented vegetable in Western countries together with cucumber (pickles) and cabbage (sauerkraut). World table olive production amounts to 1,785,500 tons in the 2005/2006 season, the majority of which comes from EU member-states, namely Spain, Italy and Greece, followed by Portugal and France to a lesser extend.

The traditional Spanish-style processing of green olives involves a three-step treatment in which olives are initially subjected to a lye solution (1.8-2.2%, w/v, NaOH) to hydrolyze the bitter constituent oleuropein, followed by a washing step to remove the excess of alkali. Subsequently, the drupes are immersed in brine (6-8%, w/v, NaCl), where a spontaneous fermentation takes place mainly by lactic acid bacteria. A brief outline of green olive processing by the Spanish method is presented below:

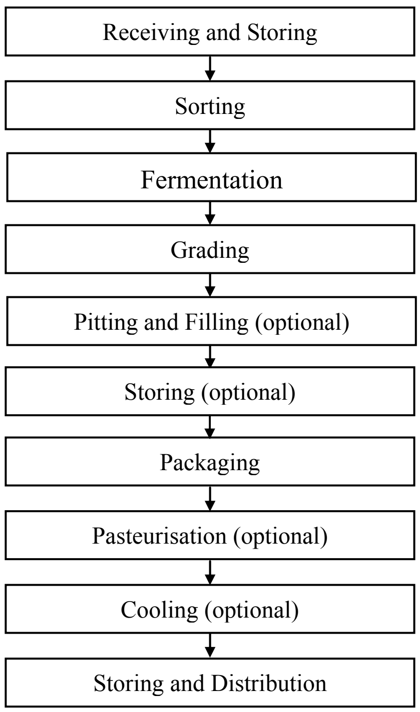

Figure 1. Manufacturing process for fermented green olives by the Spanish method

The product is promoted to consumption either directly to open markets, or indirectly to processing factories for further treatment. In processing factories, the fruits are treated according to the desired commercial type and produce the so-called "1st processing" product. This, remains in large vats until promoted for consumption either directly or indirectly for the production of added-value products (2nd processing). Direct promotion to the market is carried out by placing olives in brine, in plastic containers of various sizes and sold to regional retail outlets, open markets, caterings, super and hypermarkets. A substantial amount is sold "in bulk" in food stores, where the consumer is free to choose the type and amount needed. A part of the "1st processing" production is used by industries for making standardized products. These are normally labeled and have been subjected to a kind of thermal treatment to extend their shelf-life and stabilize their quality and sensory

Figure 2. Distribution channels of green table olives

characteristics. It must be stressed that the chill-chain distribution is maintained in Central and Regional Food Stores as well as in Catering Centers, whereas in Open Markets the product is exposed to environmental conditions, posing thus a threat in human health (Figure 2).

It is obvious that table olive quality is dynamic and changes to negative or positive direction according to the conditions of processing, preservation, packing and marketing. To maintain the highest quality and safety level for the products, it is necessary to favour the factors affecting quality in a positive way, while minimizing those factors having a negative impact on the product.

List of Critical Points for fermented green olive safety

In general, fermented olives are regarded as safe products as the physicochemical characteristics attained during the process (i.e., pH, acidity, salt content) can ensure the microbiological stability of the product. However, an important problem lies in the organization and structure of the table olive industry which remains craft and empirical and far from being controlled and modernized. Today the process depends almost exclusively on the microorganisms present in the raw material and processing environment. In addition, olives are not subjected to any treatment prior to consumption (e.g. cooking), and could thus become potential vehicles of foodborne pathogens. Today it is known that the product can harbour pathogenic bacteria such as *Escherichia coli* O157:H7, *Listeria monocytogenes* and *Bacillus* cereus.

Therefore, the following points during production, distribution and retail must be considered as critical.

1. Raw material, especially when olives are harvested directly from the soil
2. Poor hygiene and unsanitary procedures by field and processing personnel
3. Inadequate cleaning and sanitizing of processing equipment
4. Failure to wash the olives prior to brining
5. Fermentation process (proper values of pH, acidity, salt content)
6. Addition of starter cultures
7. Proper storage prior to marketing
8. Packaging
9. Distribution
10. Retail outlets

In fermented green olives the raw materials, ingredients and packaging materials used for the production are: olives, water, salt, additives (citric, lactic and ascorbic acids), glass or tin cans (in the case where the product is packed). A flow of all incoming materials in the process is given in Table 1.

Table 1. Flow of all incoming materials in green olive fermentation

Olives	Salt	Filling	Ascorbic, lactic and citric acids	Bleach	Packaging	Water
Receiving	receiving	receiving	receiving	receiving	receiving	
Washing						intake
Fermentation/ preservation	adding					intake
Grading						
Pitting (opt.)						
Filling (opt.)		adding				
Packaging			adding		filling with the products	intake
Pasteurisation (opt.)					Pasteurisation	
Cooling (opt.)					cooling	intake
Storing					storing	
Distribution					distribution	

For the hazard identification it has to be decided if a hazard requires consideration or not in the HACCP plan (Figure 3). It must be analysed carefully, using as much information as possible taken into account that the pre-requisite programs (PPs) control the environment hazards and the HACCP control the process hazards. So, a good way to do the analysis could be to ask oneself the following question: *is there any Preliminary Program, which reduces the likelihood of the hazard?*

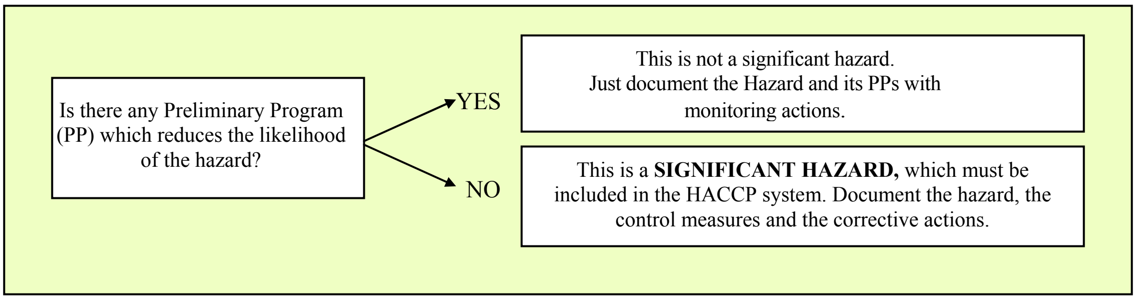

Figure 3. Decision tree for hazard identification.

Afterwards, a decision tree must be defined to verify potential critical control points (CCPs). The general approach for defining CCPs is shown in Figure 4.

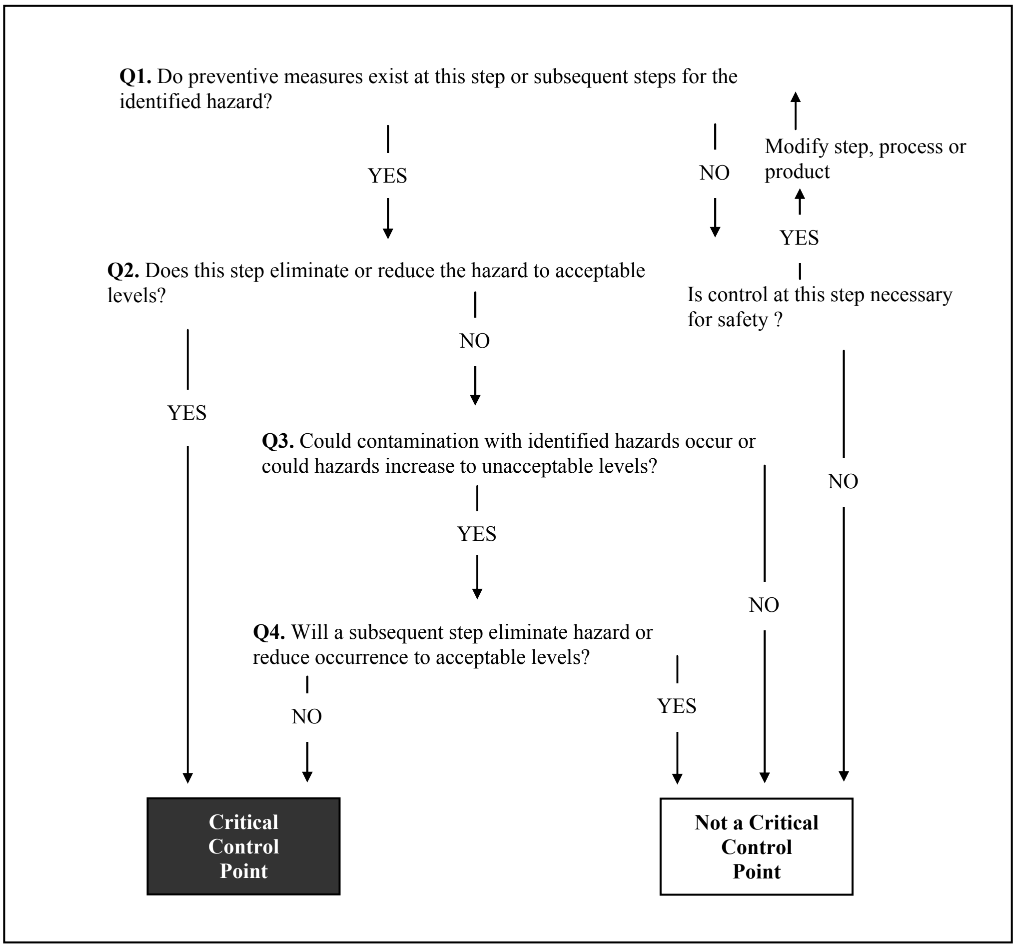

Figure 4. Decision tree for potential critical control points.

The application of the above diagram in green olive fermentation provides the following table (Table 2) of hazard analysis for the three main steps in processing, i.e. pre-fermentation treatments (intake of raw material, washing, sizing, storing), fermentation and preservation, storing of the final product.

Table 2. Hazard analysis in the three processing steps of green olives.

Step	Potential Hazard	Significant hazard?	Control measures	Q1	Q2	Q3	Q4	CCP	Justification
Receiving and Storing	Physical-chemical contamination	yes	PPs: - Adequate design of the equipment - Disinfection and cleaning programme - Maintenance of equipment programme	Yes	Yes	--	--	Yes	This step is designed to eliminate or reduce the hazard to acceptable level
Fermentation and preservation	Physical-chemical and biological contamination	yes	PPs: - Disinfection and cleaning programme - Maintenance of equipment programme - GMP - Process control	Yes	Yes	---	---	Yes	This step is designed to eliminate or reduce the hazard to acceptable level
Storing	Biological contamination	yes	- pH control - Temperature of refrigeration	Yes	No	Yes	No	Yes	This step is not designed to eliminate or reduce the hazard to acceptable level and the growth of microrganisms can perish the anchovies filling. It could happen if the storage period is too long.

Additionally, critical limits for each CCP must be identified. The maximum or minimum value for all biological, chemical and physical measurable parameters involved in the step has to be established. Thus, the Critical Limits are used to distinguish between safe or unsafe operating conditions at a CCP. However, if a CCP is identified but no Critical Limits can be established this point can only be considered as a CP and it has to be thoroughly controlled. For the establishment of the critical limits a revision of the legislation, internal norms of the company, literature and experimental validation must be performed. The critical limit should be an exact value but a range of tolerance can also be established to allow for instrumental and operator actuation.

For the most important step of green olive processing, i.e. "*Fermentation and Preservation*" the critical limits, monitoring activities, corrective actions, responsibilities, documentation and record keeping are presented in Table 3.

Table 3. Critical limits, monitoring activities, corrective actions, responsibilities, documentation and record keeping for the fermentation and preservation processing step of green table olives.

Process step	**Fermentation and preservation**
Hazard	Microbial growth due to bad preservation Microbial and physical-chemical contamination in the equipment
Critical limits	pH < 4.5
	Salt concentration > 6%
Monitoring Activity and Frequency	Periodical checking of the pH and the salt concentration in the preservation media. Checking to maintain the adequate level of the preservation media
Corrective Action Activity	Re-establishment of: - hygiene equipment general conditions - functionality of equipment Acidification and addition of salt Reestablishment of the levels in the fermentation tank Reestablishment of the GMP
Responsibility for Monitoring and Corrective Actions	Operator/ Supervisor
Documentation and record	Results of the inspections Analytical results Corrective actions

Form template for CCP in green olive fermentation by the Spanish method

In Greece, a major part of table olives is directed to local markets or exported "in bulk" in large containers. Production of "2nd processing" products is relatively small. However, there is potential for considerable increase, since these products apart from added value, result in quality improvement to the benefit of consumers.

A considerable volume of olives destined for domestic consumption is sold "in bulk" to regional food stores, open markets and supermarkets. This is an usual practice not only for Greece, but for other European countries as well. To ensure product safety and quality olives must be kept at all times under refrigerated storage according to GMP as also stipulated by the International Olive Oil Council.

European Legislation pertinent to table olive safety and quality

- *Council Directive 93/43 EEC on the Hygiene of Foodstuffs* that lays down the general rules of hygiene for foodstuffs and the procedures for verification of compliance with these rules. It states that the preparation, processing, manufacturing, packaging, storing, transportation, distribution, handling and offering for sale or supply of foodstuffs shall be carried out in a hygienic way. Systems of HACCP (hazard analysis and critical points control) should be developed.
- *Council Directive 2073/2005 EEC on the Microbiological Specification on Foods* that lays down the specifications for the microbiological acceptability of foods and food processing, handling and distribution. The use of these specifications is an indispensable part of the procedures based on HACCP and other measures of hygiene.
- *Council Regulation 178/2002 laying down General Principles and Requirements of Food Law.* This Regulation provides the basis for the assurance of a high level of protection of human health and consumers' interest in relation to food. It establishes common principles and responsibilities, the means to provide a strong science base, efficient organisational arrangements and procedures for decision-making in food. It also establishes the European Food Safety Authority.
- *CODEX Alimentarius Standard for Table Olives (CODEX STAN 66-1981)* laying down the principles applied to the fruit of the cultivated olive tree (*Olea europea sativa* L.) which have been suitably treated or processed and which is offered for direct consumption as table olives. The standard also covers olives packed in bulk containers which are intended for repacking into consumer size containers.

2 Ready-to eat Fishery products

The manufacturing process of ready to eat fishery products is described in Table 4. Following the corresponding manufacturing process, the products are vacuum-packed and stored at refrigeration temperature. Products are transported into temperature-controlled trucks to the retail locations, where they are kept at refrigeration temperatures. A schematic representation of the Chill-Supply Chain is shown in Figure 5, whereas a list of critical control points during the preparation of ready-to-eat fishery products is presented in Table 5.

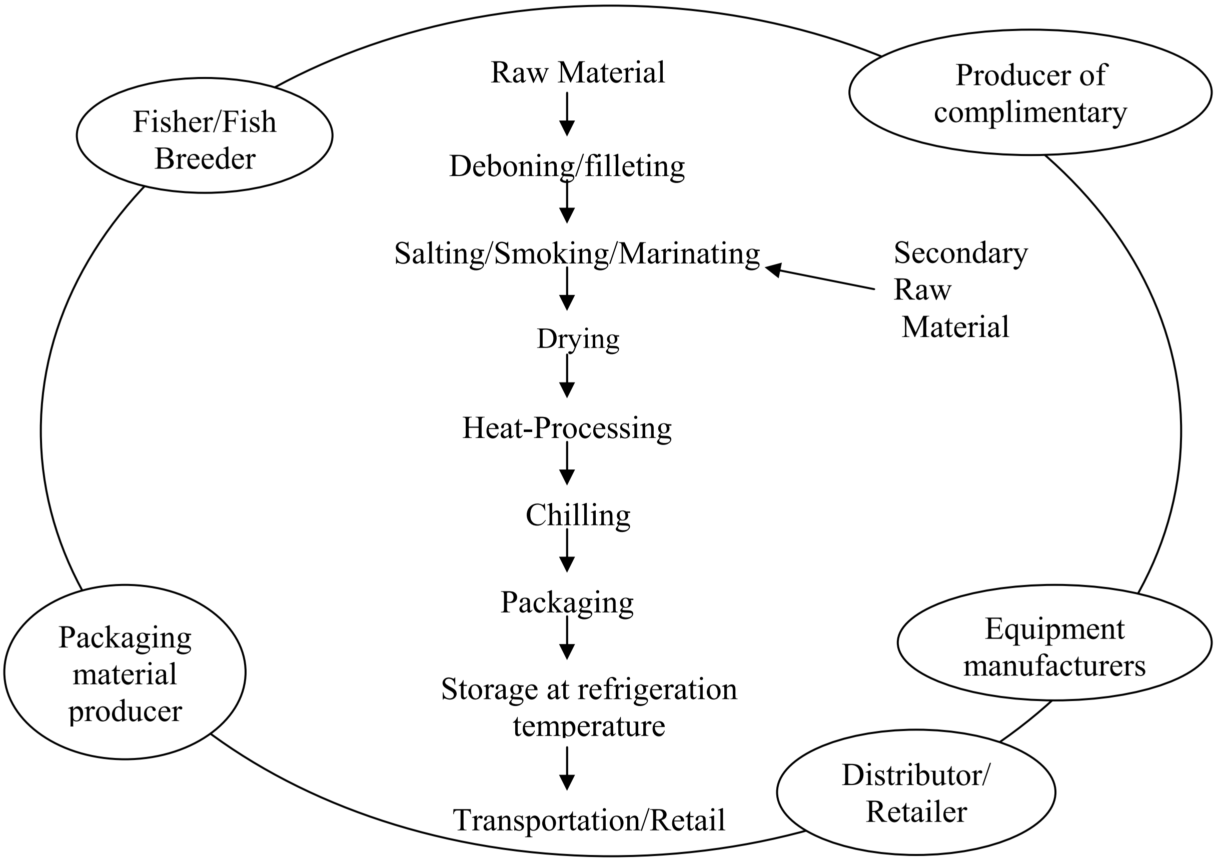

Figure 5. Chill-supply chain of ready-to-eat fishery products.

Table 4. Manufacturing process of traditional ready-to-eat fishery products.

Product type	Heat-Processing		Smoking Procedure		Acidification			% NaCl		
	Temp	*Time*	*Temp*	*Time*	*Acidification solution*	*Solution/ H_2O*	*Time*	*% Solution*	*Time*	*H_2O/ Product*
"Fishery Variety"	80°C	2h	_	_	Acetic acid 6%	70/30	20min	2%w/w.	_	_
Marinated Cuttlefish	80°C	2h	_	_	_	_	_	1%	_	_
Marinated Cod	_	_	_	_	Acetic acid 7%	48/52	1h	9%	1h	1/1
Smoked Cod	_	_	27°C	_	_	_	_	20%	45min	1/1

Note: Some of the information provided is purposely missing due to industrial confidentiality

Table 5. Typical CCPs and GHPs in the production line of ready-to-eat fishery products.

No	Operation	Hazard	CCP
1	Raw material (processed seafood)	Contamination / Bacterial Growth	CCP
2	Secondary raw material receiving (onion, garlic, lemon, spices, dressing, etc)	Contamination / Bacterial Growth / Foreign objects	GHP CCP
3	Secondary raw material handling (peeling, chopping, washing)	Contamination	GHP
4	Pre-chill ingredients	Bacterial Growth	GHP CCP
5	Mix ingredients	Contamination	GHP
6	Put in dish or storage container	Contamination	GHP
7	Refrigerated storage	Bacterial Growth	CCP
8	Distribution	Bacterial Growth	CCP
9	Display in Retail Outlet	Bacterial Growth	CCP

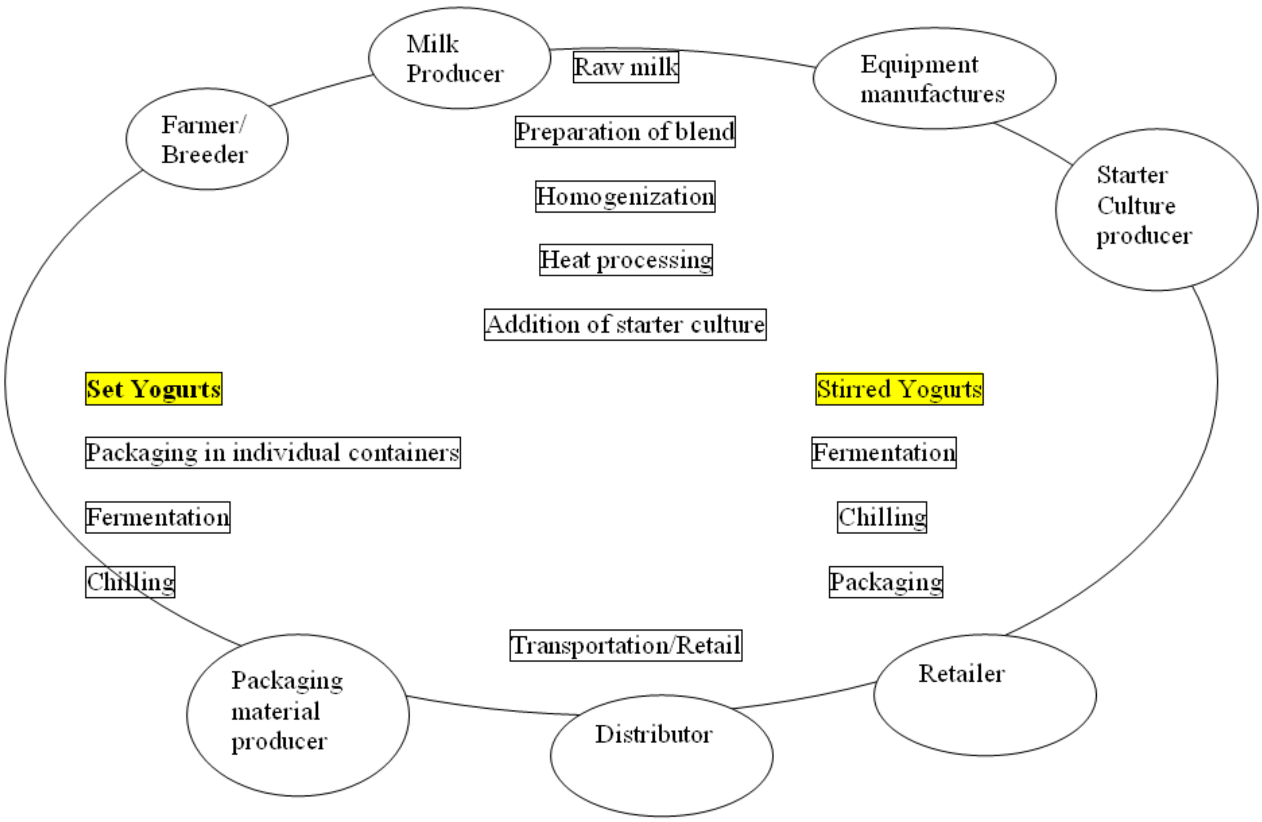

Figure 6. Food supply chain for set and stirred yogurt.

Yogurt is a well-known traditional fermented product. There are different types of yogurt, but the most common types are set and stirred yogurts. Processing and chill-supply chain of yogurt are presented in Figure 6.

List of Critical control points for yogurt safety

Yogurt is a low pH product stored at refrigeration temperatures, below 8^{o}C. Among the microbiological hazards identified, neither the presence and subsequent growth of pathogenic microorganisms, nor the production of enterotoxins can pose a risk to consumer health, provided that Good Manufacturing Practice and product distribution at low temperatures takes place.

Therefore, the following points during production and retail can be considered as critical.

1. Raw milk reception and storage
2. Pasteurisation of milk blend
3. Addition of starter culture

4. Fermentation (until pH reaches the required value within specific time frame)
5. Refrigeration
6. Packaging
7. Distribution
8. Retail

4 Cooked sausages and cooked cured meat products

Cooked sausages

Cooked sausages are mainly produced by defatted pork meat and/or deboned meat of turkey (MDM), pork lard, collagen, water, spices, flavour enhancers and preservatives (like salt, nitrites, and ascorbate), soya flour, dried skim milk and starch. All the ingredients are mixed together in the cutter machine and are stuffed in casings mainly made of collagen.

Frozen defatted meat and/or MDM first is weighted and then added with collagen into the cutter machine. Seasonings and ingredients are then added with cooled water or flake ice. With the machine operating frozen pork lard is then added and lastly the starch. The whole operation is carried out in appropriate chopping speed and time until emulsion is produced. During processing the temperature into the cutter does not exceed 12^{o}C. The emulsion is stuffed in casings of different size. Then, the stuffed product is placed in ovens in which it is dried, smoked and finally cooked. The sausages are heated until the core temperature is raised to 72^{o}C. After thermal processing, sausages are rapidly cooled down to a temperature of 35^{o}C. The temperature decrease is carried out by water. The finished product is stored at refrigerators (0-4^{o}C), and packed under vacuum or modified atmosphere in the packaging room prior to distribution. With regard to frankfurter style sausages, these are peeled before packaging. The flow diagram for the preparation of cooked sausages is presented in Figure 7.

Cooked cured meat products

They are prepared from a wide variety of cuts of meat. For example, for cooked ham, boneless pork from the hind leg cut into large muscle pieces is used, whereas for cooked bacon boneless pork from the belly is chosen. The cure contains nitrite, salt and other components such as ascorbate, phosphate, antioxidants, spices and sugar.

After butchering to remove fat and rinds, unfrozen meat is mechanically pumped with brine. In each incision a quantity of brine is injected under pressure (1.5-2.0 atm.) directly into the muscle tissue. During pumping the temperature is held at 2^{o}C while that of the brine at 1-4^{o}C. After brining the meat is transferred into tumbling machine under vacuum and low temperature (0-2^{o}C). Then, the meat is subjected to "massage" which is interrupted by short periods of rest. After tumbling, meat is stuffed in casings or nets and subjected to heat processing. Heat treatment could also include drying and smoking except cooking. Heat treatment is complete when a core temperature of 70-72^{o}C is reached. Then, rapidly cooling down at 35^{o}C is carried out in a period of 15 min by water. The finished product is stored at 0-4^{o}C, and then it is either sold in whole parts, or cut down in two parts or slices in the cutting room and packed under vacuum or in modified atmospheres. The production line of cooked cured meat is shown in Figure 8.

General hygiene control and critical control points

For both, cooked sausages and cooked cured meat products crucial factors for their hygiene and safety are the temperature in the processing lines which must be held below 12^{o}C and the sanitation, not only of the personnel but also of the equipment and the plant. It is obvious that a good hygiene practice is a prerequisite tool for an effective HACCP system. Moreover, it is necessary for all products to avoid moving back and forth to minimize possible cross-contamination and their movement from one step of the processing line to another has to be done quickly with no delay.

Incoming materials and especially raw meat may support the growth of microbes because they are used in large quantities. For this reason they are consisted as a general hygiene control point (GHCP1) and are examined at each receipt. Certified suppliers and rigorous criteria for raw material with low microbial counts and absence of pathogens can greatly contribute to the hygienic quality and safety of the final product.

Cooked sausages. During chopping procedure of all ingredients into the cutter the temperature must be held below 12^{o}C (GHCP2). The core temperature during heat processing is a CCP (CCP1). The cooked sausages are heated until they reach an internal temperature well over 72^{o}C. To avoid the growth of any thermotolerant bacteria or spores potentially present, it is essential to cool the product rapidly after processing and to prevent storage at high ambient temperatures. Reducing temperature from 72^{o}C to 10^{o}C has to be succeeded in 2 hours. The time needed to cool down the cooked sausages is a CCP2. Water used to reduce temperature could be a source of contamination and in this way contaminants could be transferred to product surfaces. For this reason it is essential to examine (at least monthly) the microbiological quality of the water. Major sources of contamination are the slicing machines, conveyor belts and personnel-handling product during packing. To avoid any contamination during this final step the plant must establish high standard of hygiene conditions into the slicing and packaging room. During storage at chilling conditions the temperature has to be at $4^{o}C$ or less in order to ensure the microbiological safety of the cooked products.

Cooked, cured meat products. Thawing of frozen meat is carried out in water baths. To avoid proliferation after resuscitation of injured microorganisms water has to be continuously renewed. In other cases, water must be changed at the appearance of blood fluids (CCP3). It is well known that blood itself is an excellent medium for bacteria cultivation. To avoid contamination of thawed meat fresh brine must always be added. In most cases, old brines contain salt tolerant bacteria. The whole procedure has to be maintained at low temperatures according to good hygiene practice. Additionally, the time intervals between brine injection and tumbling should not exceed one hour.

Cooking, cooling, slicing and packing are critical control points (CCPs), as described for cooked sausages. More specific, thermal processing and cooling down are CCP4, and CCP5, respectively.

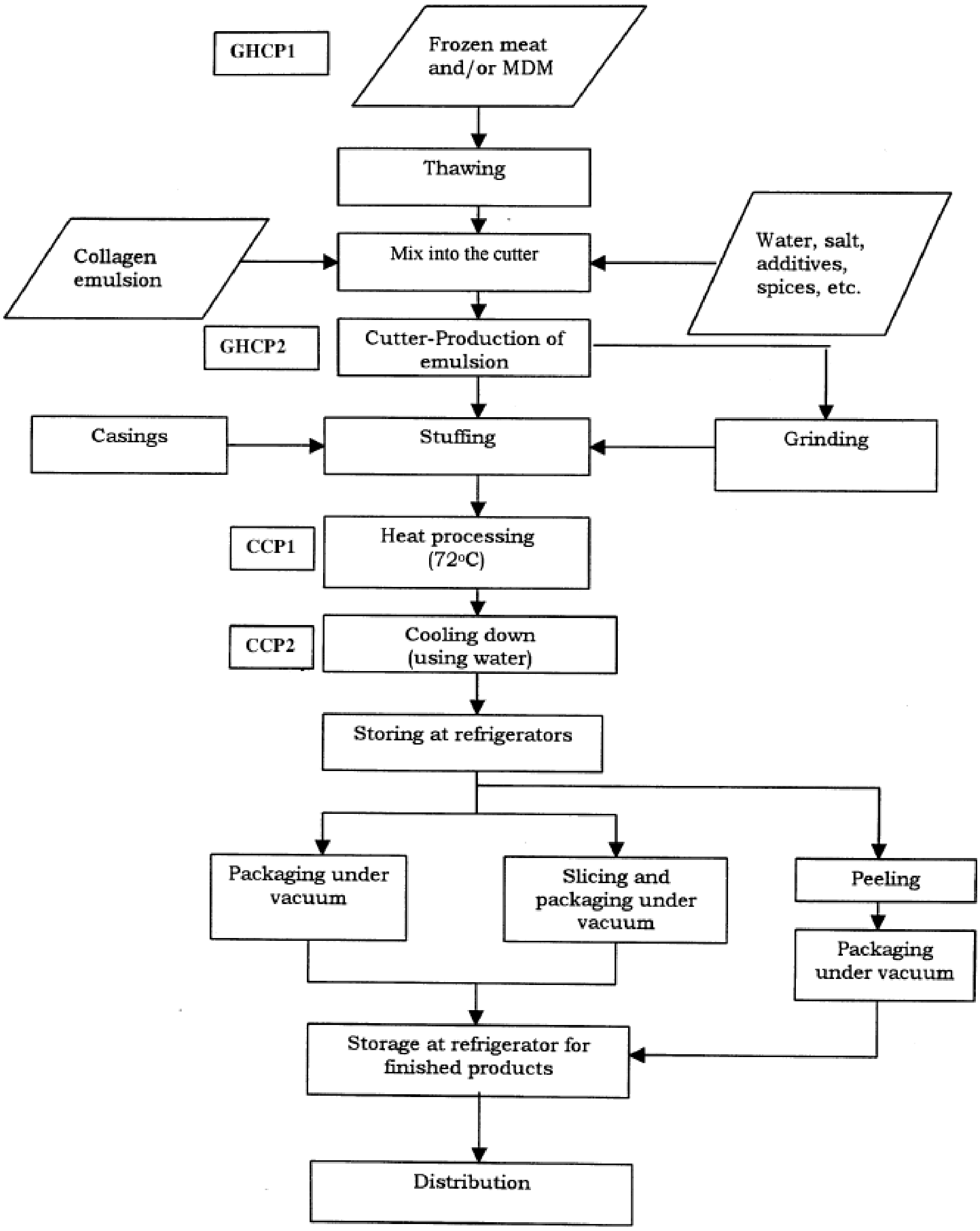

Figure 7. Flow diagram of the preparation of cooked, cured sausages with general hygiene control points (GHCPs) and critical control points (CCPs) of the process

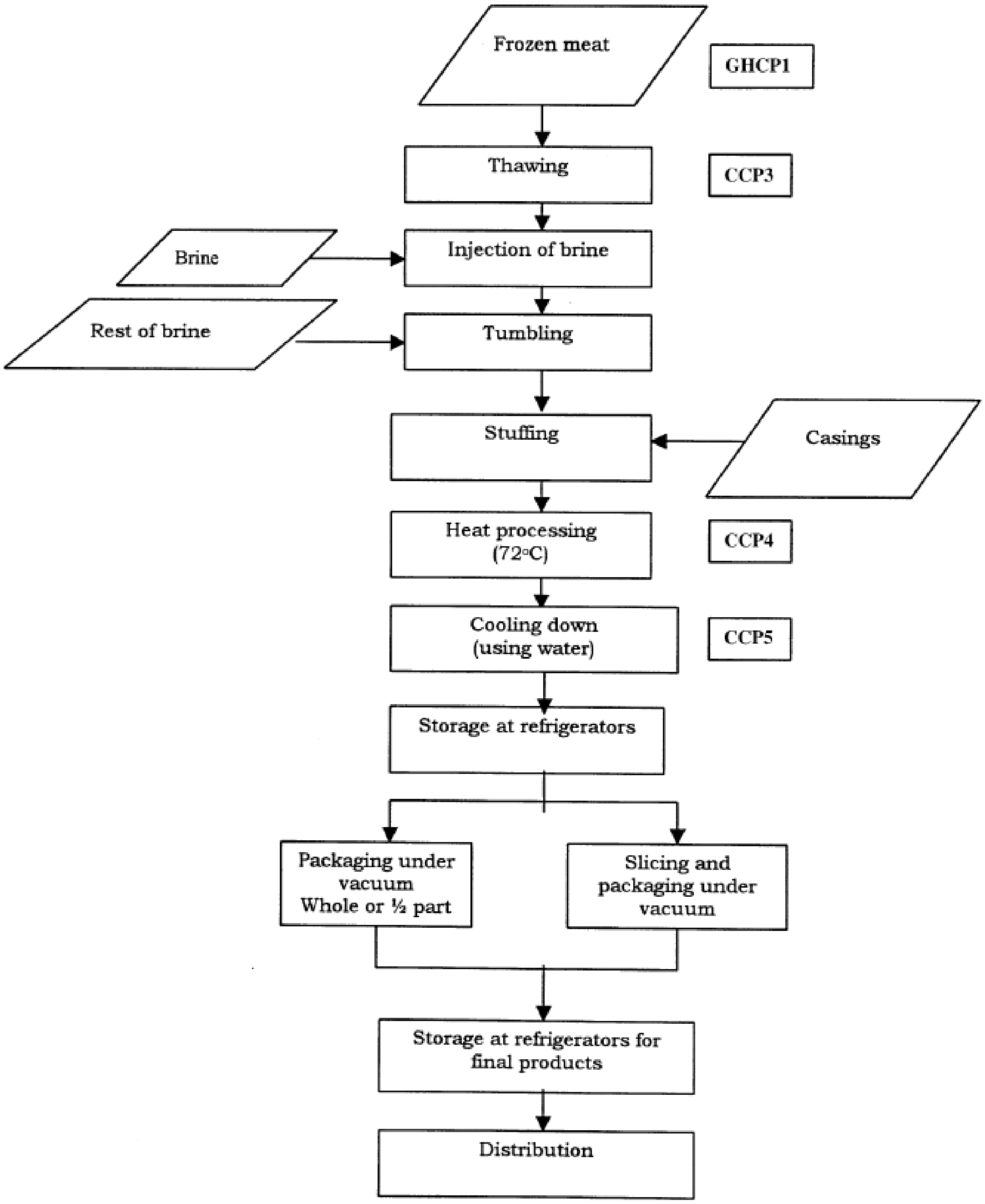

Figure 8. Flow diagram of the preparation of cooked, cured meat products with general hygiene control points (GHCPs) and critical control points (CCPs) of the process

5 Hungarian air dried, smoked sausage supply chain

Sausage is a meat product made of chopped pork meat, pork bellies, small amount of beef meat (in some varieties), red pepper, garlic, pickling salt and some spices, filled into a casing of pig or other animal intestine and is preserved by smoking and drying.
Identification number through NACE (CPA) 15.13.12.15 (sausages not of liver). This is one of the most well known group of typical traditional Hungarian food products (Figure 9).

Although fully dried, smoked, air fermented sausages are thought to be safe by the general public opinion in the light of the detailed microbiological screening this is not true for all types of products and for all uses as ingredients of composite products.

Fully dried versions of smoked, naturally fermented, air dried sausages have a low water activity (a_w < 0.92), therefore the presence and growth of pathogens do not represent a realistic risk through the distribution chain, if the processing was properly controlled, and the sliced product is chilled properly. However in less dried versions - called as “smoked sausages”, and as “peasant sausages” – which are made with similar technology, but having higher water activity (a_w = 0.95 ± 0.01) there is a potential for growth of pathogens even at chilled temperatures. False consumer practices in storage and handling may create risks.

At none of the products can the complete *Listeria monocytogenes* free status ensured, only a low incidence level (lower than the food safety criteria) can be achieved. If some of the processing steps – like purchasing of ingredients, weighing in by the recipe, filling, smoking, curing, first period of the fermentation – are not properly controlled high level of pathogenic contamination may occur. During the manufacturing notable changes occur in the intrinsic properties of sausages that might contribute to the growth/inactivation/survival of pathogens as this is described in the literature (Tables 6-8) and found in the real industry practice in Hungary (Table 9).

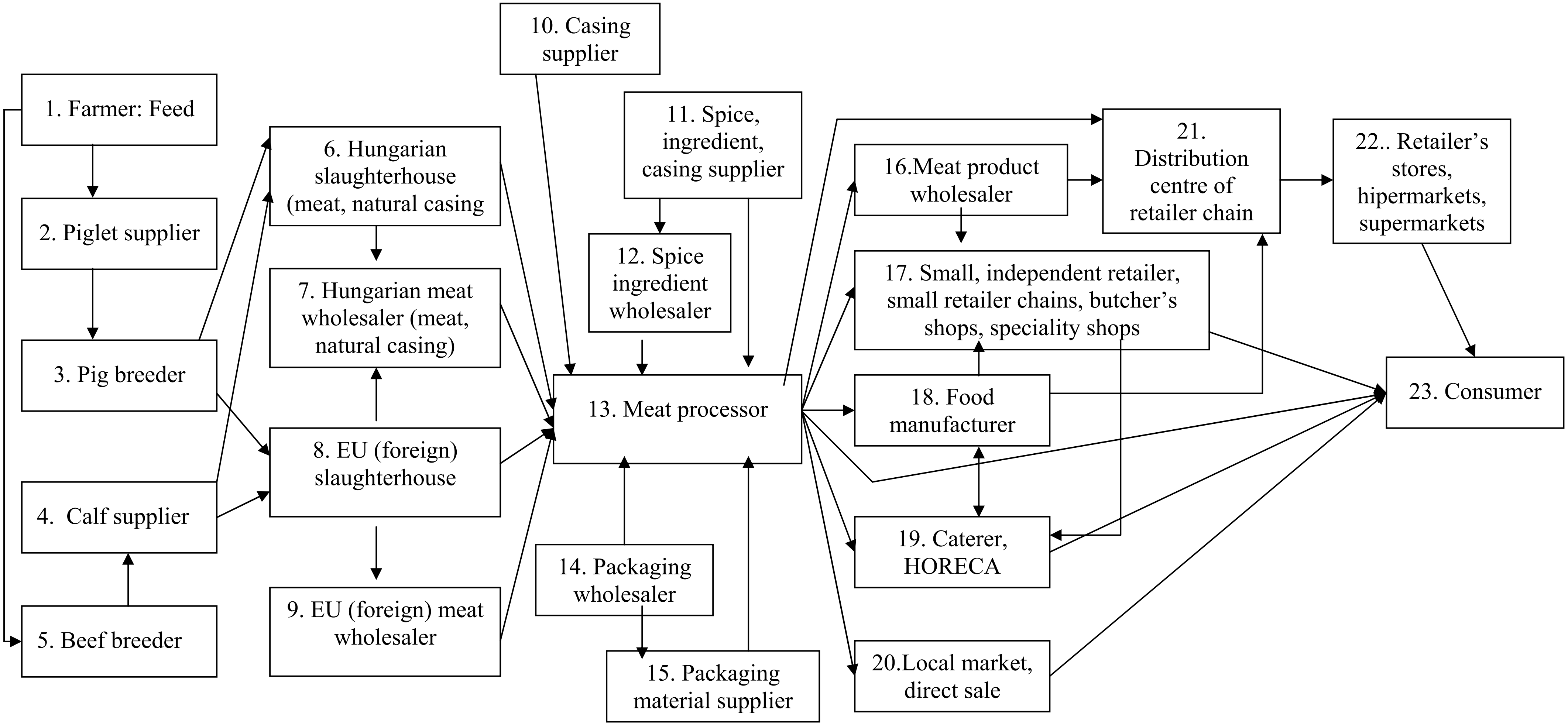

Figure 9. Aid dried, fermented, smoked sausage / salami supply chain.

Table 6. Changes of pH during fermentation and ripening of sausages (mean values of three batches) (J. Gasparik-Reichardt *et al.,* 2005).

Country/day	0	2	4	7	14	28
Greece	6.25	5.70	5.37	4.91	4.85	4.90
Serbia and Montenegro	5.47	5.34	5.26	5.15	5.06	5.27
Bosnia and Herzegovina	6.15	5.58	5.03	4.81	4.82	4.86
Croatia	6.15	6.00	5.84	5.21	5.23	5.38
Hungary	5.89	5.84	5.79	5.64	5.48	5.53
Italy	5.73	5.54	5.40	5.34	5.50	5.66

Table 7. Changes of salt % and a_w during fermentation and ripening of sausages (mean values of three batches) (Gasparik-Reichardt *et al.,* 2005).

Country/day	0	14	28
Greece	2.39 / 0.86	3.89 / 0.83	4.05 / 0.78
Serbia and Montenegro	2.42 / 0.92	3.15 / 0.87	3.73 / 0.85
Bosnia and Herzegovina	2.36 / 0.96	3.80 / 0.90	4.32 / 0.90
Croatia	1.51 / 0.97	2.22 / 0.95	2.29 / 0.94
Hungary	2.30 / 0.96	3.94 / 0.92	4.71 / 0.86
Italy	2.52 / 0.97	3.11 / 0.93	3.34 / 0.92

Table 8. Fermentation and ripening conditions of fermented sausage studied (Rantsiou *et al*., 2005).

Country	Fermentation	Ripening
Greece	24°C and 95% RH, gradually reduced to 19°C and 88% RH after 7 days. Sausages were smoked the 2nd day for 90min and the 3rd day for 30min	14-16°C and 78-80% RH for a minimum of 4 weeks. No smoke was applied.
Hungary	17°C and 70% RH for 8hrs. Smoking for 2h at maximum temperature of 20°C and 75% RH. After smoking, 20°C and 80% RH for 2 days.	15°C and 75% RH for approximately 4 weeks. No smoke was applied.
Italy	22°C and 85% RH for 2 days and gradually reduced to 12°C with a rate of 2°C per day with RH between 60 to 90%. No smoke was applied.	12°C and RH of 65-85% for 3 weeks. No smoke was applied.

Table 9. Overview of sausage process specifically comparing cooking with not cooking in real industry practice in Hungary.

Step Title	Time	Temperature	Evidence of *Listeria*	Comments
1. Raw Material Intake			**Paprika, Pepper, Other spices:** 3-5cfu/g *Lm*, frequency <1%. **Meat, Sausage case**: not found. **Paste**: 3-5cfu/g @17%	
2. Storage of ingredients, weighing			No change on detectable level	
3. Cuttering / Mixing	"short"	-6ºC - 3ºC	NO HAZARD	
4. Filling				
5. Smoking	3-4 days	10ºC - 18ºC	• No measured values from sausage • Need to take anti-microbial effect of smoking and spices into account In all probability reducing the temperature to 12ºC would solve any potential for problems here.	After 2 days of smoking, the water activity of the sausage is measured at **0.924, 0.926** pH=5.6
6.1 Maturing/ripening	14-28 days	10ºC - 18ºC	• Gonzalez (2000) showed that *Lm* could not grow to dangerous levels during maturation if a_w is reduced to 0.88	• Temp controlled until A_w <0.93 • After 2 days of smoking, 1 day of maturing the water activity of the sausage is measured at **0.919, 0.921**
6.2 Maturing		Controlled but higher than 6.1 (14 - 18ºC)		• After maturing, product has A_w of <0.89 • After 2 days of smoking, 2 day of maturing the water activity of the sausage is measured at **0.917**

7. Optional: vacuum packing as a whole, not sliced product				
8. Slicing		Max 12°C	Realistic probability of cross-contamination occurring at this step. Infrequent findings of *Lm* back this up	Salt content of finished product <5%. Measured values are 4.5-4.8%. Nitrate maximum is 0.025%
9. MAP				70±1%N2, 30±1%CO2, residual O2 maximum 2%
10. Chilled storage before dispatch	Shelf life for uncooked product 180 days (120 days is suggested by the manufacturer), 90 days for cooked products	Maximum 5ºC		
11. Chilled transport		Maximum 5ºC		
12. Client's chill storage		Maximum 5ºC?		pH 5.6
13. Place slices on chilled pizza		Maximum 5ºC		Pizza concasse = Bostwick of 8% and salt content = 1.5%
14. Chilled storage of the pizza	Shelf life is 5 days	6.6 ± 2.4°C		
15. Storage / cooking by consumer	Assume 70ºC for 2 minutes. Before or after potential storage for 5 days at 7.1 ± 2.7 ºC?			

During handling, storage and distribution of composite products like chilled pizzas, sandwiches growth of pathogenic bacteria can't be excluded, especially in the case of temperature abuse or too long storage (Figure 10). During chilled or temporary ambient storage contact surfaces of dried sausages, salamis with sauces higher water activity, water absorption can take place, which will enable the growth of pathogens. As a consequence of that typical CCPs are partly related to the manufacture of the traditional sausages and salamis itself, to the slicing, packaging of ready-to-eat products and to the manufacture, handling, storage, distribution and consumer handling of composite products (Table 10).

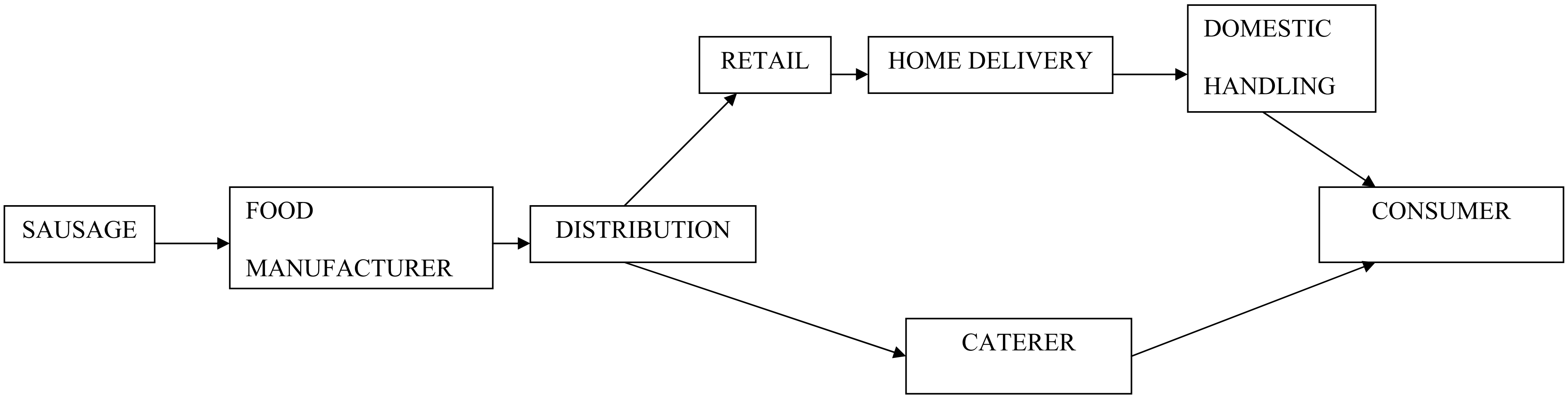

Figure 10. Supply chain of composite products made from aid dried, fermented, smoked sausage/salami.

Table 10. Typical CCPs or GHPs with higher risks.

Meat cutting – purchasing meat	GHP
Cleaning of intestines (potential source of *Listeria monocytogenes*)	GHP
Purchasing of spices, spice mixes (potential source of *Listeria monocytogenes*)	GHP/CCP
Weighing in the recipe	GHP
Filling of sausage	CCP
Smoking of sausages	CCP
Maturing, fermentation of sausages	CCP
Slicing and packaging of sausages	GHP
Distribution to retailers, wholesalers, further processors	o Low risk at some types of products (fully dried $a_w = 0.93 \pm 0.01$) o GHP with high risk, at "farmers" type and "flamed" type ($a_w = 0.95 \pm 0.01$) of sausages
Time-temperature of storage, distribution, handling of chilled composite products, for which traditional sausages are used as ingredients (at like pizzas, sandwiches, cold plates)	GHP
Labelling of shelf life	GHP
Consumer practices during home handling	GHPs/CCPs

6 The Italian cheese supply chain

Within the Work package 5 of the TRUEFOOD-project it was decided to investigate food supply chains of the Italian cheese sector, specified through NACE (CPA) 15.51.40.70 (Cheese and curd – Processed cheese, excluding grated or powdered cheese). The task is to describe the ultimate supply chain by a graph showing the focal company and all downstream and upstream members, as well as to provide some key indicators of economic importance.

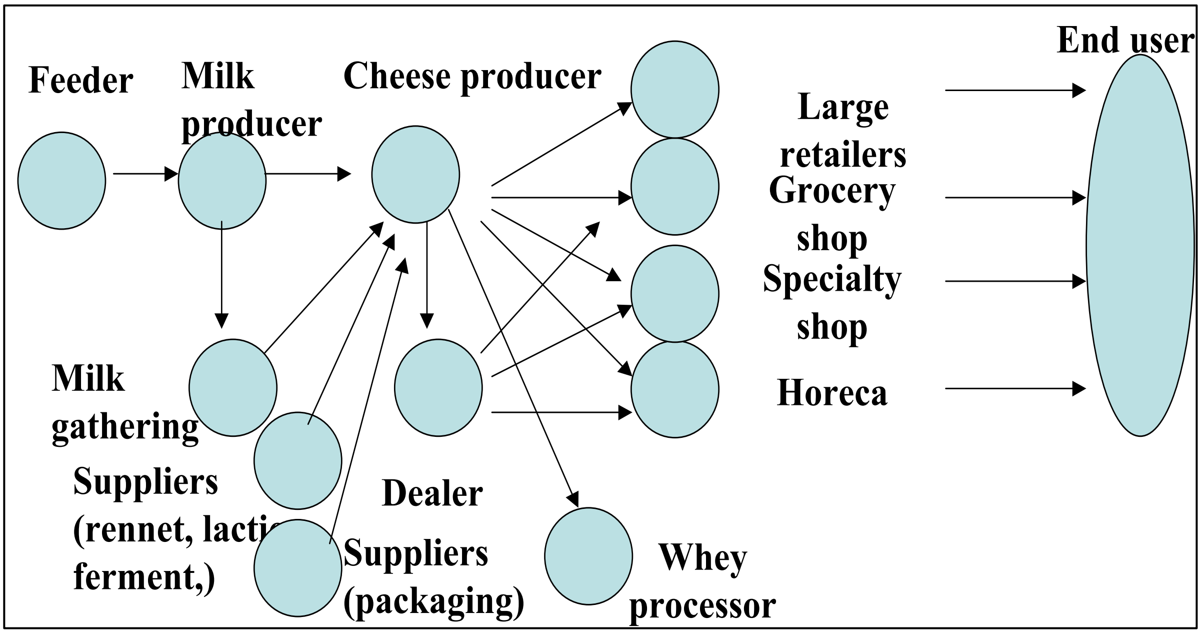

Figure 11. Supply chain of Italian cheese.

The focal firm of the chain is the cheese producer that can try to shorten the chain by buying milk directly from milk producers and large retailers and other channels of distribution. However, cooperative of milk producers often are able to intermediate milk, whereas the distribution to the very fragmented grocery shops in Italy can force the cheese producer to give the product to a dealer in the so-called “tentata vendita”, a contract by which the dealer formally buy all the product, attempt to sale out to groceries, with the clause that in case it doesn’t succeed, then the producer will buy back the unsold quantity.

7 The Italian dry ham supply chain

Within the WP 5 of the TRUEFOOD project it was decided to investigate food supply chains of the Italian dry ham sector, which is included in NACE 15.13.11.10 (hams; shoulders and cuts thereof with bone in of swine, salted, in brine, dried or smoked).

The task is to describe the ultimate supply chain by a graph showing the focal company and all downstream and upstream members, as well as to provide some key indicators of its economic importance.

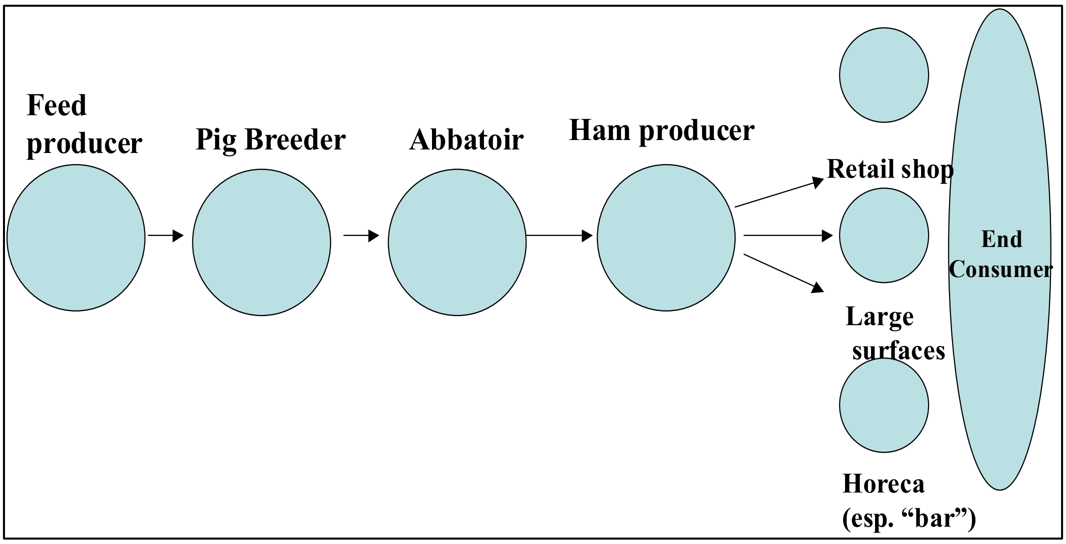

Figure 12. Supply chain of Italian dry ham.

The focal firm is the ham producer. Dry ham can be produced even by highly skilled households, especially where local tradition gives the necessary know-how, supply and micro-climate for drying process.

However, overall the sector is characterized by an oligopolistic core, that has internalised most phases of production, with a tight control of the chain and a fairly strong position vis-à-vis distribution channels.

8 The bottled soda water production chain

Bottled soda water, also known as carbonated or sparkling water, is water into which carbon dioxide gas has been dissolved. Soda water is produced by "charging" a refillable bottle by filling it with water and then adding carbon dioxide. The process of dissolving carbon dioxide gas is called carbonation, resulting in the formation of carbonic acid (which has the chemical formula H_2CO_3).

Possible sources of microbiological contamination:

- Spoilage bacteria in water supply pipes
- *Escherichia coli* and other pathogens in the water system after maintenance

Possible sources of chemical contamination:

- Chemical residues in returnable bottles and packaging material
- Cleaning and disinfecting agents
- Lubricants of equipments, materials dissolved from equipments
- Chemicals used for pest control
- Water (nitrite/nitrate, heavy metals, residues of cleaning and disinfecting agents)

Sources of physical contamination:

- Returnable bottles (e.g. fragments of glass)
- Parts and pieces from equipment, devices, and factory environment

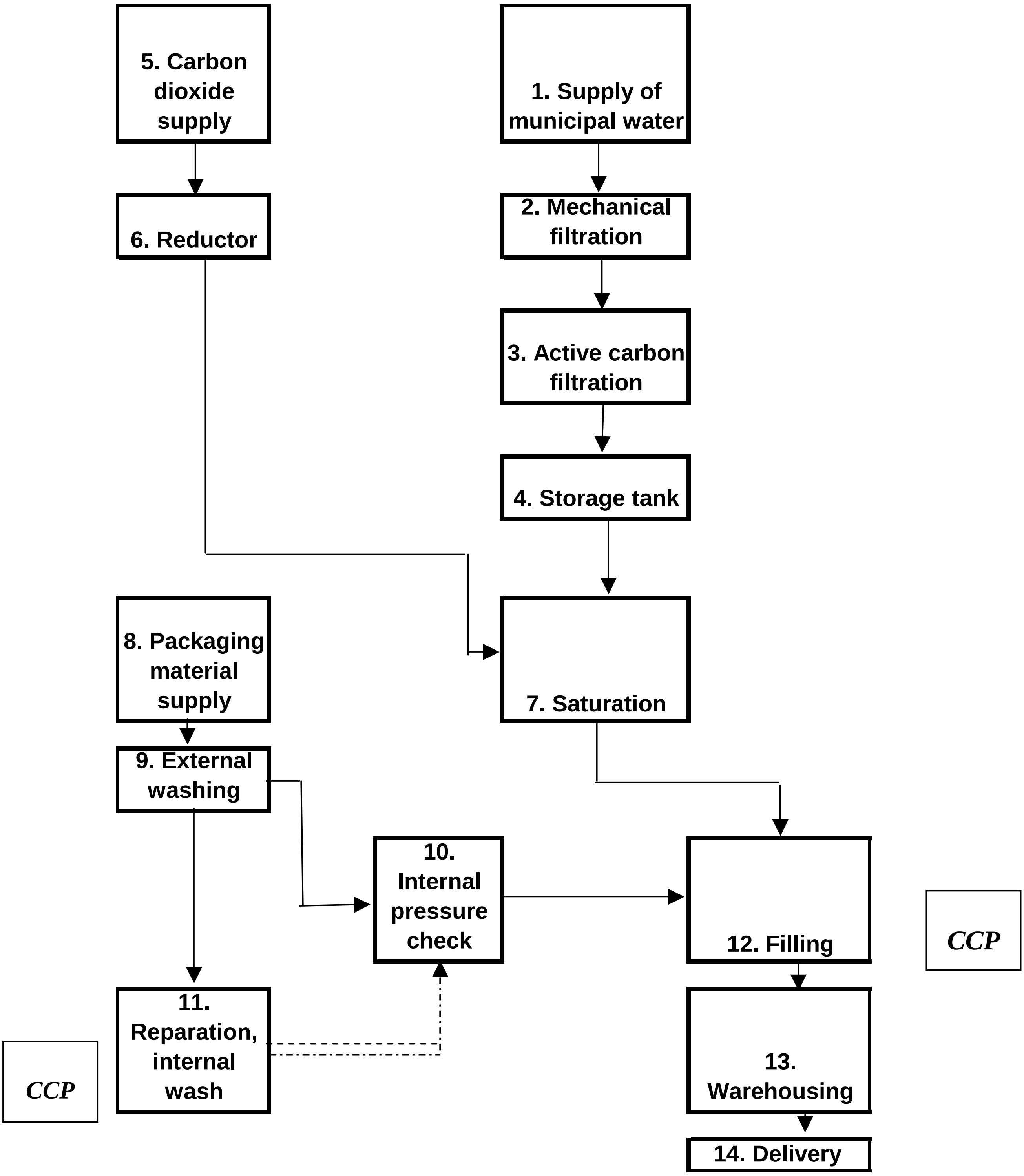

Figure 13. Production flowchart of bottled soda water.

No.	Operation	Hazard	CCP
1.	**Supply of municipal water**	Presence of scale, rust or sand in the water	
		Presence of nitrite, nitrate and heavy metals in water	
		Presence of *Salmonella* spp, *E. coli*, Coliforms	
2.	**Mechanical filtration 15 µm**	Physical contamination due to insufficient filtration.	
		Microbiological cross-contamination due to unclean filter	GHP
3.	**Active carbon filtration**	Carbon particle from the filter	GHP
		High chlorine content due to the impermeable filter	GHP
		Microbiological cross-contamination due to unclean filter	GHP
4.	**Storage tank**	Residue of disinfecting agent	GHP
		Growth of spoilage microorganisms in the tank	GHP
5.	**Carbon dioxide supply**	Metal contamination from the valve	
		Presence of foreign gas	
6.	**Reductor**		
7.	**Saturation**	Physical hazard of rotating parts	
		Residue of cleaning	GHP

		and disinfecting agent	
8.	**Packaging material supply**	Plastic bottle Physical**:** -sharp plastic, metal contamination of the bottle due to the removal siphon-head Chemical: -petrol -petroleum -diesel due to the damaged seal Microbiological: - Presence of pathogens due to air contamination	GHP GHP
		Stainless steel and aluminium balloon Microbiological: Growth of spoilage organisms due to long storage of empty balloons at the consumer	GHP
9.	**External washing**		
10.	**Internal pressure check**	Presence of pathogens in the siphon-head	GHP
11.	**Separation, internal wash**	Plastic bottle Physical: -sharp wood -metal -plastic in the bottle Chemical: -residue of cleaning and disinfecting agents	GHP GHP

		Microbiological: Survival of spoilage organisms due to inadequate washing	CCP GHP
		Metal balloon Use of non-food lubricant	GHP
12.	**Filling**	Physical: insufficient over-pressure in the bottle Chemical: residue of cleaning and disinfecting agents in the filling head	CCP GHP
13.	**Warehousing**	Microbiological spoilage due to insufficient storage time and temperature	GHP
14.	**Delivery**	Bottle damage	GHP
		Microbiological cross-contamination of siphon-heads from the vehicle	

Table 11. Typical CCPs and GHPs in the production line of bottled soda water

9 Dry pasta production chain

Product description:

Following the temporary storage of the flour and liquid egg from approved suppliers, the dough is kneaded. The shaped and cut dough is dried and cooled. The dry and cold product is either temporarily stored or packaged right after cooling. The product is metal detected, stored and finally delivered.

The hazards of dry pasta production:

Chemical: residues from pest control, cleaning and sanitizing agent residues

Physical: foreign material from flour, factory environment, equipment and devices, such as metal, rubber, wood, stone, glass, plasterwork and sharp plastic.

Microbiological: moulds and mycotoxins, pathogens (*Salmonella* spp., *Staphylococcus aureus*).

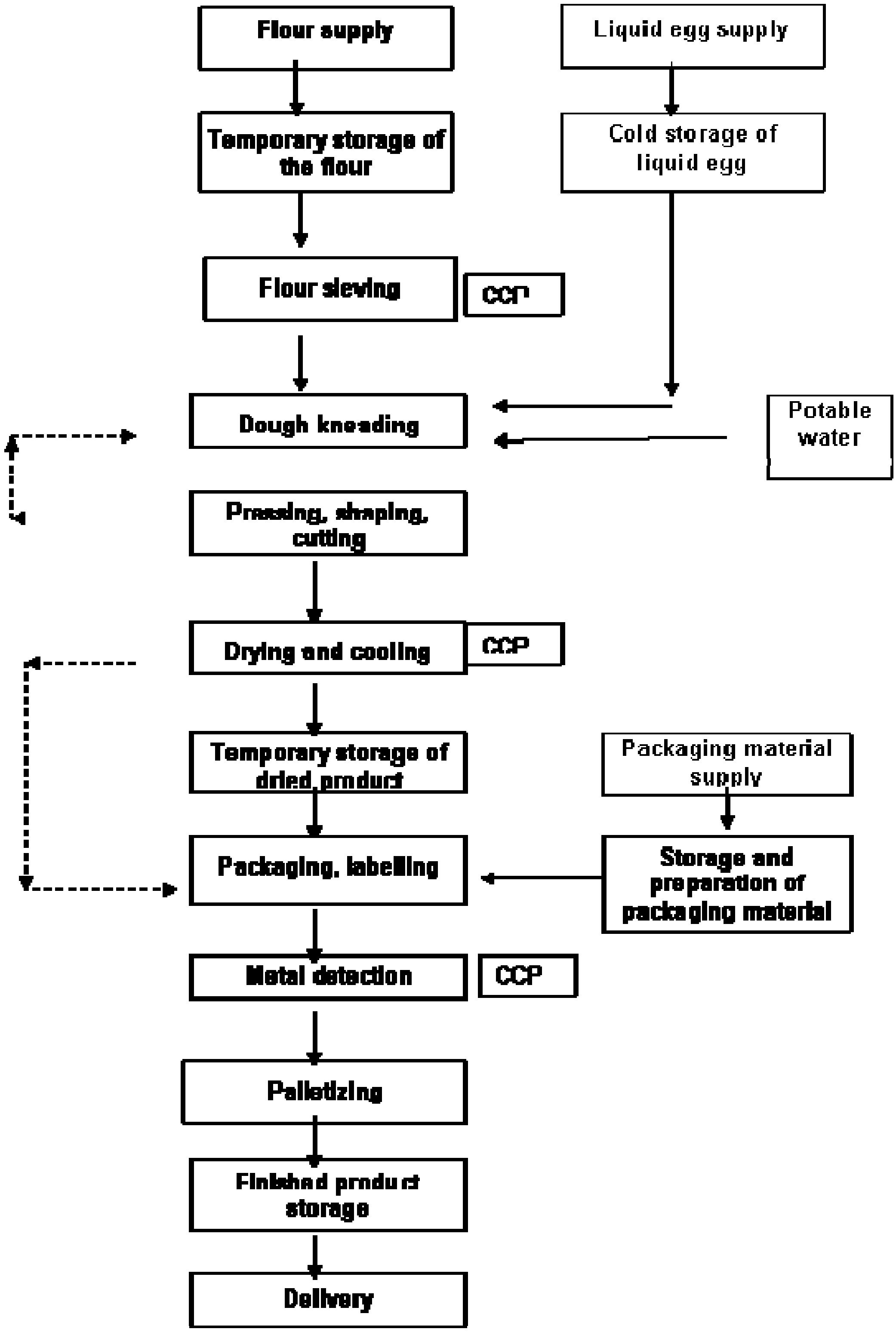

Figure 14. Flowchart of dry pasta production chain

No.	Operation	Hazard	CCP
1.	**Flour supply**	Presence of mould and mycotoxin in the supplied flour	GHP
		Foreign material in the supplied flour	--
2.	**Temporary storage of the flour**	Contamination from pest control	GHP
3.	**Flour sieving**	Foreign material	CCP
4.	**Liquid egg supply**	Presence of Salmonella in the supplied lot	GHP
5.	**Cold storage of liquid egg**	Growth of vegetative pathogens due to inadequate storage temperature and time	GHP
		Cross-contamination with pathogens from environment and storage tanks	GHP
6.	**Potable water**	Presence of vegetative pathogens in the water	GHP
7.	**Dough kneading**	Cross-contamination from personnel with Salmonella, *Staphylococcus aureus*	GHP
		Cross-contamination with pathogens from environment and equipment	GHP
		Foreign material from environment	GHP
		Contamination from pest control	GHP
		Residue of sanitizing agent	GHP
8.	**Pressing, shaping, cutting**	Cross-contamination from personnel with Salmonella, *Staphylococcus aureus*	GHP
		Cross-contamination with pathogens from environment and equipment	GHP
		Foreign material from environment	GHP
		Contamination from pest control	GHP
		Residue of sanitizing agent	GHP
9.	**Drying and cooling**	Survival of vegetative pathogens due to inadequate drying temperature and time	CCP
10.	**Temporary storage of dried product**	Cross-contamination with pathogens from environment and equipment	GHP
		Foreign material from environment	GHP

No.	Operation	Hazard	CCP
11.	**Packaging material supply**	Contaminated packaging material	GHP
12.	**Storage and preparation of packaging material**	Cross-contamination with pathogens from environment	GHP
13.	**Packaging, labelling**	Cross-contamination from personnel with Salmonella, *Staphylococcus aureus*	GHP
		Cross-contamination with pathogens from environment and equipment	GHP
		Foreign material from environment	GHP
14.	**Metal detection**	Inadequate metal detection	CCP
15	**Palletizing**	Foreign material from environment due damaged packaging	GHP
16.	**Finished product storage**	Moulds due to inadequate storage conditions	GHP

Table 12. Typical CCPs and GHPs in the production line of dry pasta

10 Fruit jams production chain

The fruit jams are cooked from one or more types of fruits to reach a given concentration, or the concentration is adjusted with added sugar. The products of given refraction are filled into clean jars and after closure they are subjected to heat treatment at 100°C for 30 minutes. The high quality raw material, concentration of the jams and the heat treatment of the closed jars ensure the safety of the processed final product.

	Minimum refraction %	Shelf life (year)
Plum jam	52	2
Yellow plum jam (ringló)	40	1.5
Apricot jam	40	1.5
Blackcurrant jam	40	1.5
Morello cherry jam	40	1.5

Table 13. The minimum refraction index and shelf life duration according to the Codex Alimentrius Hungaricus 2-33/1/03 Directive.

<u>Microbiological hazards:</u>

Moulds, mycotoxins, *Salmonella* spp., *E. coli, S. aureus*

<u>Chemical hazards:</u>

Pesticide and herbicide residues, residues of cleaning and disinfecting agents

<u>Physical hazards:</u>

Glass, sharp plastic, stone, metal, wood, paint, rust

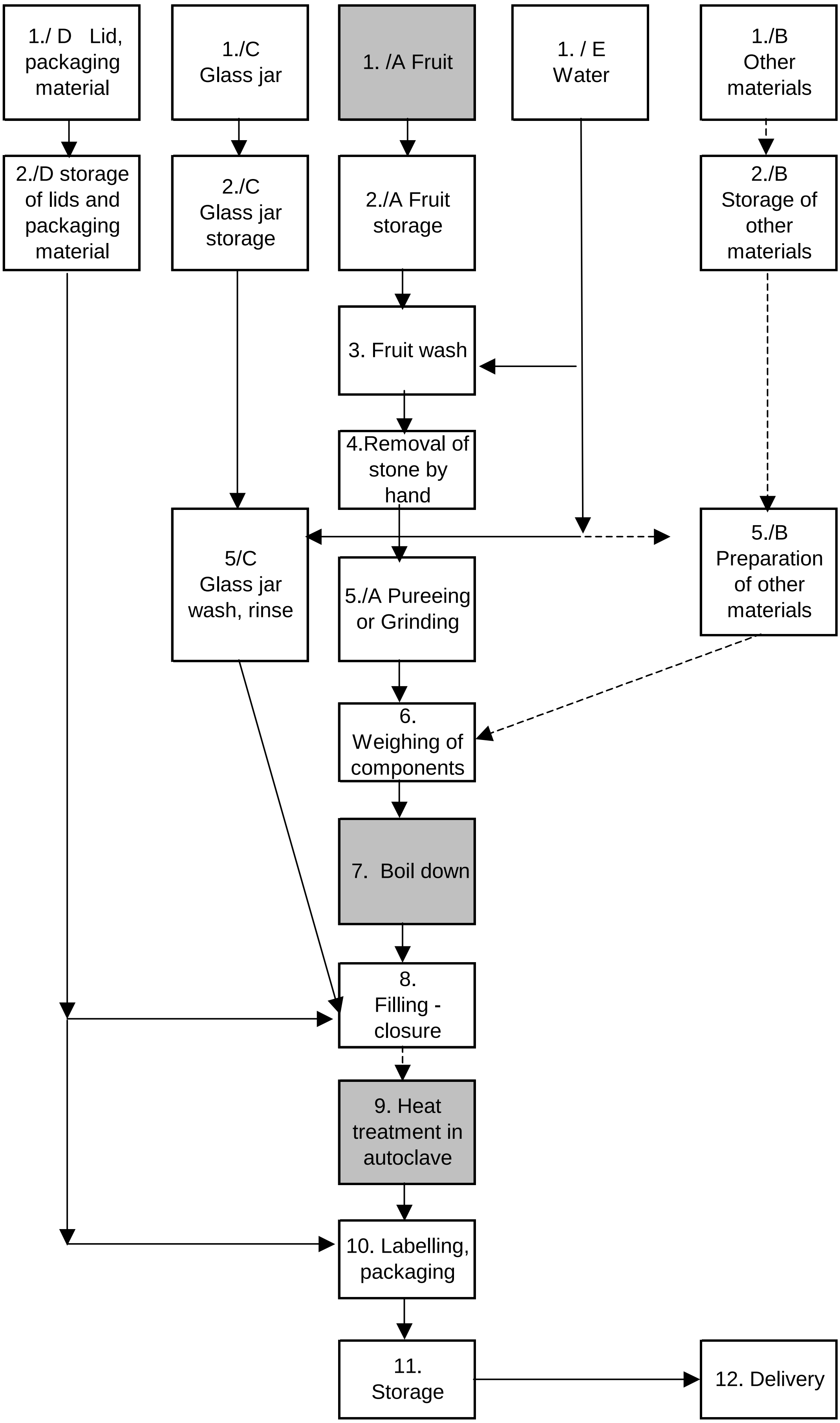

Figure 15. Typical flowchart of jam production chain

No.	Operation	Hazards	CCP
1. A	**Fruit**	Presence of foreign material Presence of mycotoxins due to mouldy raw material Pesticide residue	GHP CCP
1. B.	**Other material**		
1.C.	**Glass jars**	Broken, cracked glass jars Contaminated glass jars	GHP
1.D.	**Lids, packaging material**	Growth of vegetative microbes during shelf life due to inadequate closure of low quality lids	
1.E	**Water**	Presence of microbes in the water	GHP
2.A,	**Fruit storage**	Cross-contamination from foreign material (glass, stone, metal, plastic) Microbial spoilage due to inadequate storage	GHP
2.B.	**Storage of other materials**	Cross-contamination from foreign material (glass, stone, metal, plastic) Vegetative microbes and sporeformer contamination from rodents Residue of pest control	GHP GHP
2.C.	**Glass jar storage**	Cross-contamination from foreign material (glass, stone, metal, plastic) Contamination of jars	GHP
2.D.	**Storage of lids and packaging material**	Cross-contamination from foreign material (glass, stone, metal, plastic) Contamination of lids	GHP
3.	**Fruit wash**	Insufficient removal of physical hazard Cross-contamination and insufficient washing	GHP
4.	**Removal of stone by hand**	Insufficient removal of stone Cross-contamination from personnel	GHP
5.A.	**Pureeing or Grinding**	Stone contamination due to insufficient sieving Cross-contamination from equipment, personnel	GHP
5.B.	**Preparation of other materials**	Cross-contamination from foreign material (glass, stone, metal, plastic) Cross-contamination from equipment, personnel	GHP
5.C.	**Glass jar wash, rinse**	Insufficient removal of possible physical hazard (e.g. glass) Cross-contamination from personnel	GHP
6.	**Weighing of components**	Residue of cleaning and disinfecting agent	GHP
7.	**Boil down**	Cross-contamination from the environment (paint, rust)	

No.	Operation	Hazards	CCP
		Moulds due to insufficient temperature	CCP
8.	**Filling – closure**	Cross-contamination from the environment (paint, rust) Microbial contamination due to insufficient sealing	GHP
9.	**Heat treatment in autoclave**	Insufficient heat treatment	CCP
10.	**Labelling, packaging**	Microbial spoilage due to misdating of the shelf life	GHP
11.	**Storage**	Growth of microorganisms due wrong handling of finished products	GHP
12.	**Delivery**	Growth of microorganisms due wrong transportation of finished products	GHP

Table 14. Typical CCPs and GHPs in the production chain of fruit jams

11 Production chain of honey

Honey is a sweet and viscous fluid produced by honey bees (*Apis mellifera*), and derived from the nectar of flowers. Honey as it exists in the beehive or as obtained by extraction, settling or straining without adding heat is considered a low risk product in terms of bacteriological hazards (due to the very high sugar content). However, chemical and physical hazards must be taken into account as well as general hygiene standards.

Hazards

Physical	Foreign matter, splinter of wood, bee fragments, glass splinter,
Chemical	Cleaning and disinfecting agent Heavy metals Nitrite, nitrate Pesticides Lubricants
Microbiological	Pathogens, toxins

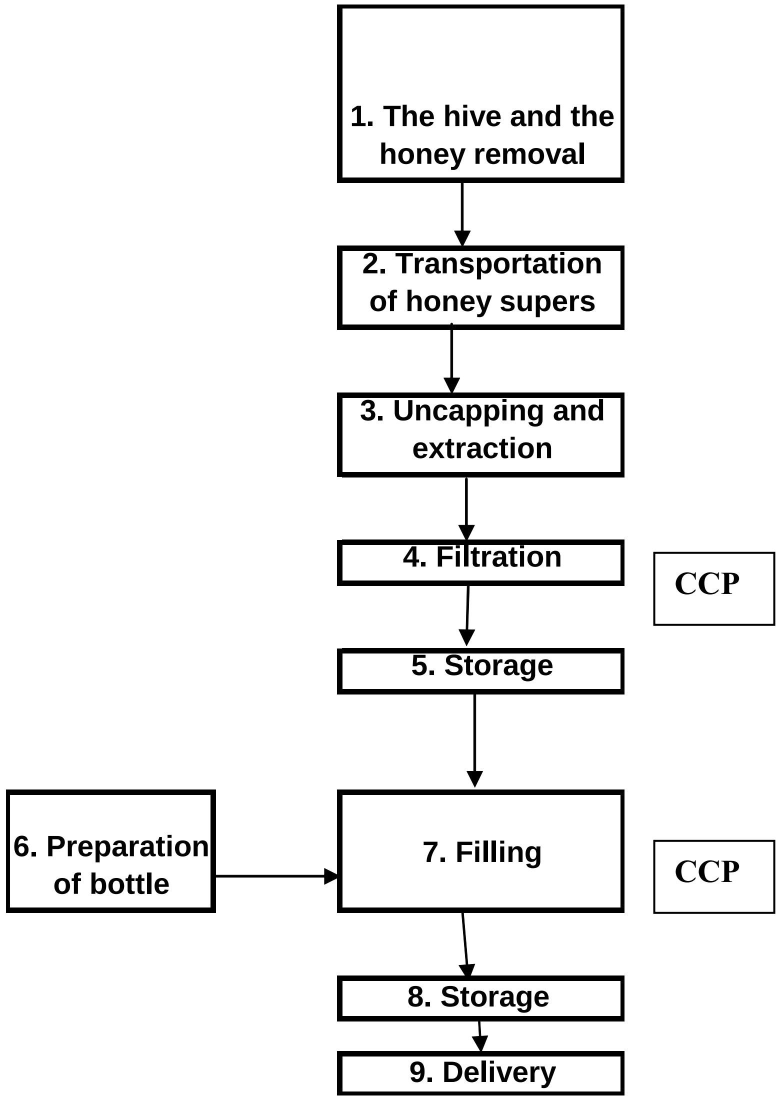

Figure 16. Typical flowchart of honey production chain

No.	Operation	Hazard	CCP
1	**The hive and the honey removal**	**Physical**: soil, wire, wood, varnish particles, rust etc.	**GAP**
		• **Chemical**: - medicines: pest., antibiotics, - plant toxins (e.g. pontic honey, tutin) - paints, preservatives	**GAP**
		• **Biological**: - Bacterial spores e.g. Clostridium	**GAP**
2	**Transportation of honey supers**	**Physical, microbiological and chemical contamination from**: - Transportation - Animals - Rain water	**GAP**
3	**Uncapping and extraction**	**Physical**: soil, wire, wood, paint or other contaminants from personnel, equipment and environment	**GHP**
		• **Chemical**: - residue of pest control, residue of cleaning and disinfecting agents, paints, lubricants	**GHP**
		• **Biological**: - microbiological contamination from personnel, equipment and environment	**GHP**
4	**Filtration**	Failure to remove physical contaminants: • wax with residues • foreign matter (e.g. bee fragments, wood)	**CCP**
5	**Storage**	**Physical** contamination from - container - surroundings - pests	**GHP**
		Chemical deterioration due to • high temperatures (HMF) • moisture increase on surface • residue of cleaning and disinfecting agents	**GHP**
		Microbiological contamination from environment	**GHP**
6	**Preparation of bottle**	• **Foreign matter** due to contamination from: - lids - environment - glass breakage	**GHP**

		Chemical - residue of cleaning and disinfecting agents	**GHP**
		Microbiological: Survival of spoilage organisms due to inadequate washing	**GHP**
7	**Filling**	**Chemical**: residue of cleaning and disinfecting agents, lubricants	**CCP**
8	**Storage**	**Microbiological** spoilage due to insufficient storage time and temperature **Labelling** should inform consumers about infant botulism.	**GHP**
9	**Delivery**	**Chemical** hazards due to moisture absorption because: - damaged seals, jars - poor handling - poor packaging	**GHP**
		Microbiological cross-contamination due to damaged seals and over-storage	**GHP**

Table 15. Typical CCPs and GHPs in the production chain of honey

Concluding remarks

Under this task of the project several production chains of different traditional European food products have been mapped and the critical control points (CCPs) as well as the critical hygiene points (CHPs) have been defined. Special flowcharts have been produced for the production chain of each examined commodity, as well as tables with the CCPs and GHPs. Special focus was given not only on the determination of critical points affecting microbial safety but also on the physical/chemical points that may affect the safety of the final commodity. The information provided in this report could become an important source of information for European food industries to increase the efficiency of the overall management of the food safety of traditional foods.

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