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INTRODUCTION

The HACCP training was given at the first AFTER Project meeting in Cotonou, Benin (12-15 October 2010) and subsequently a report on the workshop and training support material on HACCP was produced (**D 1.1.1.1** and **D 1.3.1.1 respectively**), both of which are/will be available on the AFTER web site. This present document describes steps towards implementation of HACCP for the products in the 3 Groups (**Part A**: Group 1-Cereal-based; **Part B**: Group 2-Meat and fish products; **Part C** Group 3-Plant extracts as functional foods).

In brief, the role of HACCP is to provide continual self inspection, consequently, regulatory bodies have access to documentation that food safety is practiced at all times. This encourages a proactive attitude to food safety instead of reacting to out-of-control procedures. To recap, from the training materials, **the following are the general requirement/guidelines for the Hazard Analysis and Critical Control Points (HACCP) System**:

1. *Prior to the application of HACCP, the food sector should have prerequisite programmes in place such as GMP (Good Manufacturing Practice), or GHP (Good Hygienic Practice) according the CODE general principles of food hygiene, the appropriate code of practices and appropriate food safety requirements (legislation). The Prerequisite programs should be well established, fully operations and verified to facilitate successful application and implementation of HACCP*

2. *The intent of the HACCP system is to focus control at CCPs. Redesign of the operation should be considered if a hazard which must be controlled is identified but no CCPs are found*

3. *HACCP should be applied to each specific operation separately.*

4. *The HACCP plan should be reviewed and necessary changes made when a modification is made to a product, process or any step.*

5. *Management awareness and commitment is necessary for effective HACCP implementation*

6. *It has been recognized that when applying HACCP (especially for small and less developed businesses), flexibility appropriate to the business should be exercised but in either case all seven principles must be applied to the HACCP system*

The HACCP plans that are presented in this report (Table 1 to 10) are based on the survey and literature reports, especially where survey reports are not available.

A. HACCP plans for Group 1- Cereal-based products

Table 1: Hazard analysis critical control points (HACCP) for kenkey (adapted from Amoa-Awua et al., 1998)

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Maize	-Mycotoxins (aflatoxins, fumonisins, ochratoxin) -Foreign material (cob pieces, stones, glass, insects)	-Purchase good quality material	-Moisture content <13% -legislated levels of selected mycotoxins	-Visual inspection -Random sampling of batches and analysis for mycotoxins	-Reject raw material that is not up to standard -Inform supplier
Steeping	-Spoilage and pathogenic microorganisms	-Clean water -pH control to desired level	-Transparent, clear, odourless and colourless water -pH 4.2±0.1 -Keep hands off	-Visual inspection -Measure pH, or use pH strips	-Use boiled water for steeping -Educate the processors -Could use acidifying agents like sodium metabisulphite
Fermentation (paste, dough, mash)	-Mycotoxins -Spoilage and pathogenic microorganisms	-Adhere to fermentation time -Cover the dough	-pH must not be more than 3.9 -Titratable acidity-lactic acid 1.4-2% Acetic acid: 0.18-0.23%	-Visual inspection -Measure pH and use of pH strips	-Speed up fermentation process by back sloping, or inoculating with dough from a previous batch
Cooking	-Residual mycotoxins -Packaging material contamination	Adequate cooking for at least 3 hours	-not less than 3 hours cooking >10 parts per billion of aflatoxin	-Record time	-Heat for longer
Final Product			>100 cfu/g of foreign bacteria (non LAB) >100 cfu/g of moulds >10 parts		
Cleaning	-Contamination with spoilage and pathogenic microorganisms	-Good housekeeping and personal; hygiene -Maintenance of equipment	-Clean premises, processing equipment and vessels -trained processing staff	-Visual inspection -Swabbing	-Clean premises, equipment and vessels -Clean factory coats -Wash hands -Use gloves

Identifying Critical Control for each product Kenkey

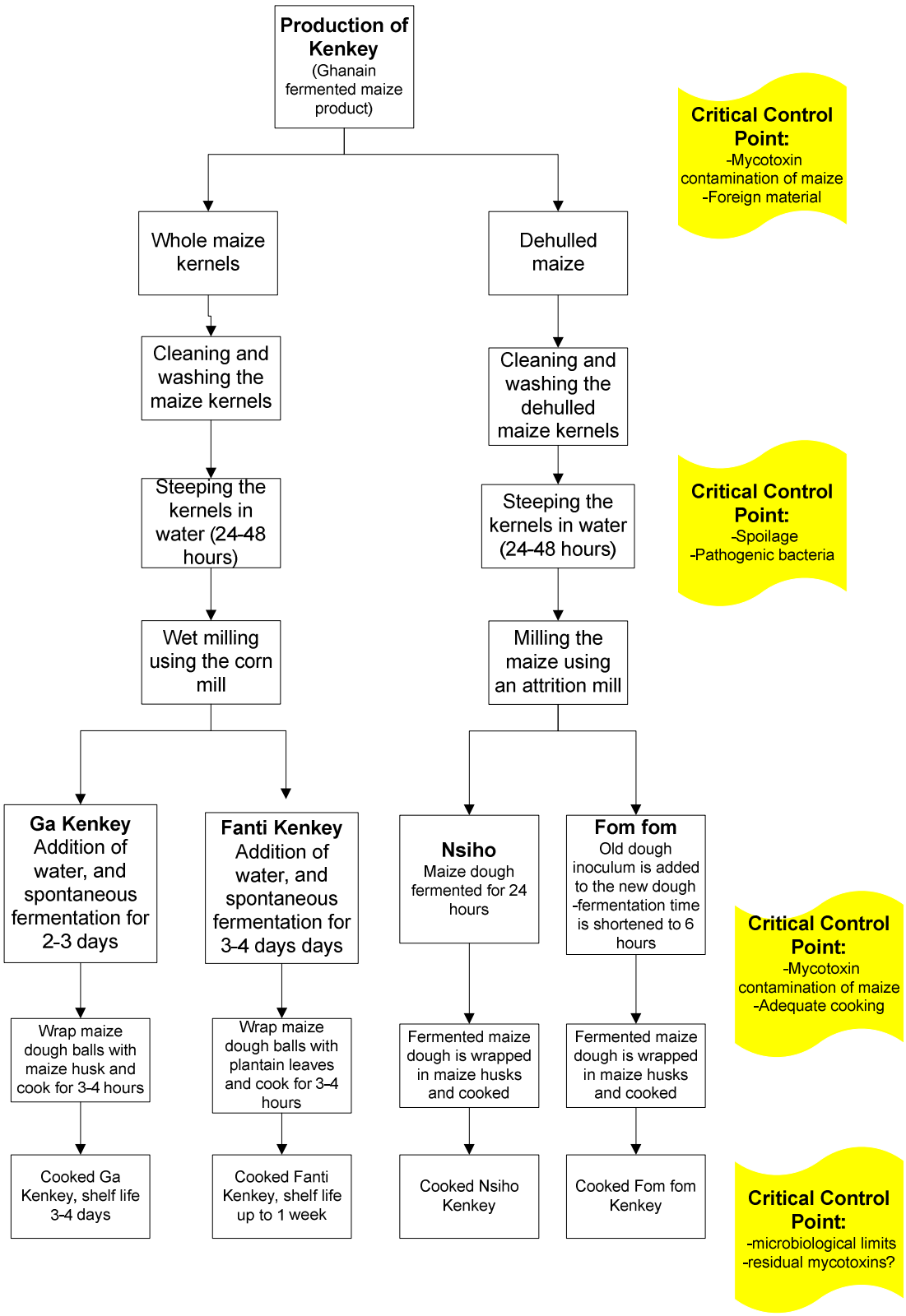

Fig 1: Flow diagram of Kenkey processing and suggested critical control points

Table 2: Hazard analysis critical control points (HACCP) for Gowe (Beninese fermented cereal paste)

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Maize, Sorghum	-Mycotoxins (aflatoxins, fumonisins, ochratoxin) -Foreign material	-Purchase good quality material	-Moisture content <13% -legislated levels of selected mycotoxins	-Visual inspection -Random sampling of batches and analysis for mycotoxins	-Reject raw material that is not up to standard -Inform supplier
Steeping of sorghum and maize	-Spoilage and pathogenic microorganisms	-Clean water -pH control to desired level	- Transparent, clear, odourless and colourless water -pH 4.2±0.1 -Keep hands off	-Visual inspection -Measure pH, or use pH strips	-Use boiled water for steeping -Educate the processors -Could use acidifying agents like sodium metabisulphite
Germination of sorghum (Preparation of sorghum malt)	Mycotoxin due to mould growth	Purchase good quality sorghum	Mould growth observed	-Visual inspection	-Reject germinated seeds with mould growth -Treat grain with mould inhibitor (probably) -Wash the grain in sodium metabisulphite??
Fermentation (paste, mash)	-Mycotoxins -Spoilage and pathogenic microorganisms	-Adhere to fermentation time -Cover the dough	-pH must not be more than 3.9 -Titratable acidity-lactic acid 1.4-2% Acetic acid: 0.18-0.23%	-Visual inspection -Measure pH and use of pH strips	-Speed up fermentation process by backsloping, or inoculating with dough from a previous batch
Cooking	Residual mycotoxins -	Product normally cooked for a short time	>10 parts per billion of aflatoxin		Visual inspection
Sugar	Spoilage microorganisms, yeast or pathogens	Sugar from a reputable source (low microbial counts)		-Visual tests -Microbial examination	Reject suspect sugar, or dissolve in minimum water and preheat prior to use

Final Product			>100 cfu/g of foreign bacteria (non LAB) >100 cfu/g of moulds >10 parts		
Cleaning	-Contamination with spoilage and pathogenic microorganisms	-Good housekeeping and personal; hygiene -Maintenance of equipment	-Clean premises, processing equipment and vessels -trained processing staff	-Visual inspection -Swabbing	-Clean premise, equipment and vessels -Clean factory coats -Wash hands -Use gloves

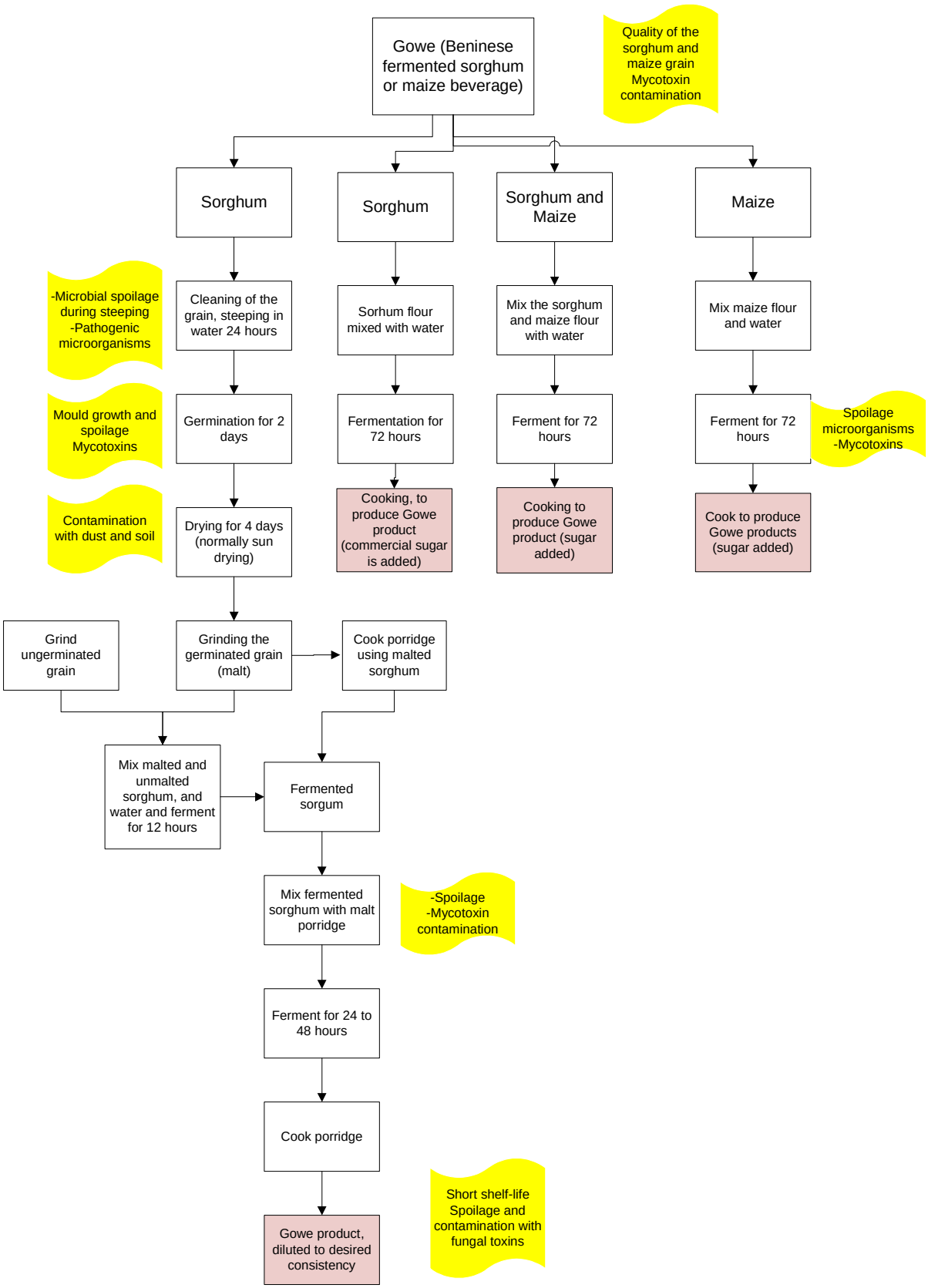

Fig 2: Flow diagram of gowe processing and suggested critical control points

Table 3: HACCP of Akpan (Beninise thirst quenching beverage)

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Maize, Sorghum (mostly maize)	-Mycotoxins (aflatoxins, fumonisins, ochratoxin) -Foreign material	-Purchase good quality material	-Moisture content <13% -legislated levels of selected mycotoxins	-Visual inspection -Random sampling of batches and analysis for mycotoxins	-Reject raw material that is not up to standard -Inform supplier
Steeping	-Spoilage and pathogenic microorganisms	-Clean water -pH control to desired level	-Transparent, clear, odourless and colourless water -pH 4.2±0.1 -Keep hands off	-Visual inspection -Measure pH, or use pH strips	-Use boiled water for steeping -Educate the processors -Could use acidifying agents like sodium metabisulphite
Fermentation (paste, mash, dough)	-Mycotoxins -Spoilage and pathogenic microorganisms	-Adhere to fermentation time -Cover the dough	-pH must not be more than 3.9 -Titratable acidity-lactic acid 1.4-2% Acetic acid: 0.18-0.23%	-Visual inspection -Measure pH and use of pH strips	-Speed up fermentation process by back sloping, or inoculating with dough from a previous batch
Cooking	Residual mycotoxins	Adequate cooking	-not less than 3 hours cooking >10 parts per billion of aflatoxin	-Record time	-Heat for longer
Sugar, milk, ice	Spoilage and pathogenic microorganisms, yeast	-Reputable source of sugar -Milk must be pasteurised -Ice must be from good quality water		Good quality products	
Final Product			>100 cfu/g of foreng bacteria (non LAB) >100 cfu/g of moulds >10 parts		
Cleaning	-Contamination	-Good	-Clean	-Visual	-Clean

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
	with spoilage and pathogenic microorganisms	housekeeping and personal; hygiene -Maintenance of equipment	premises, processing equipment and vessels -trained processing staff	inspection -Swabbing	premise, equipment and vessels -Clean factory coats -Wash hands -Use gloves

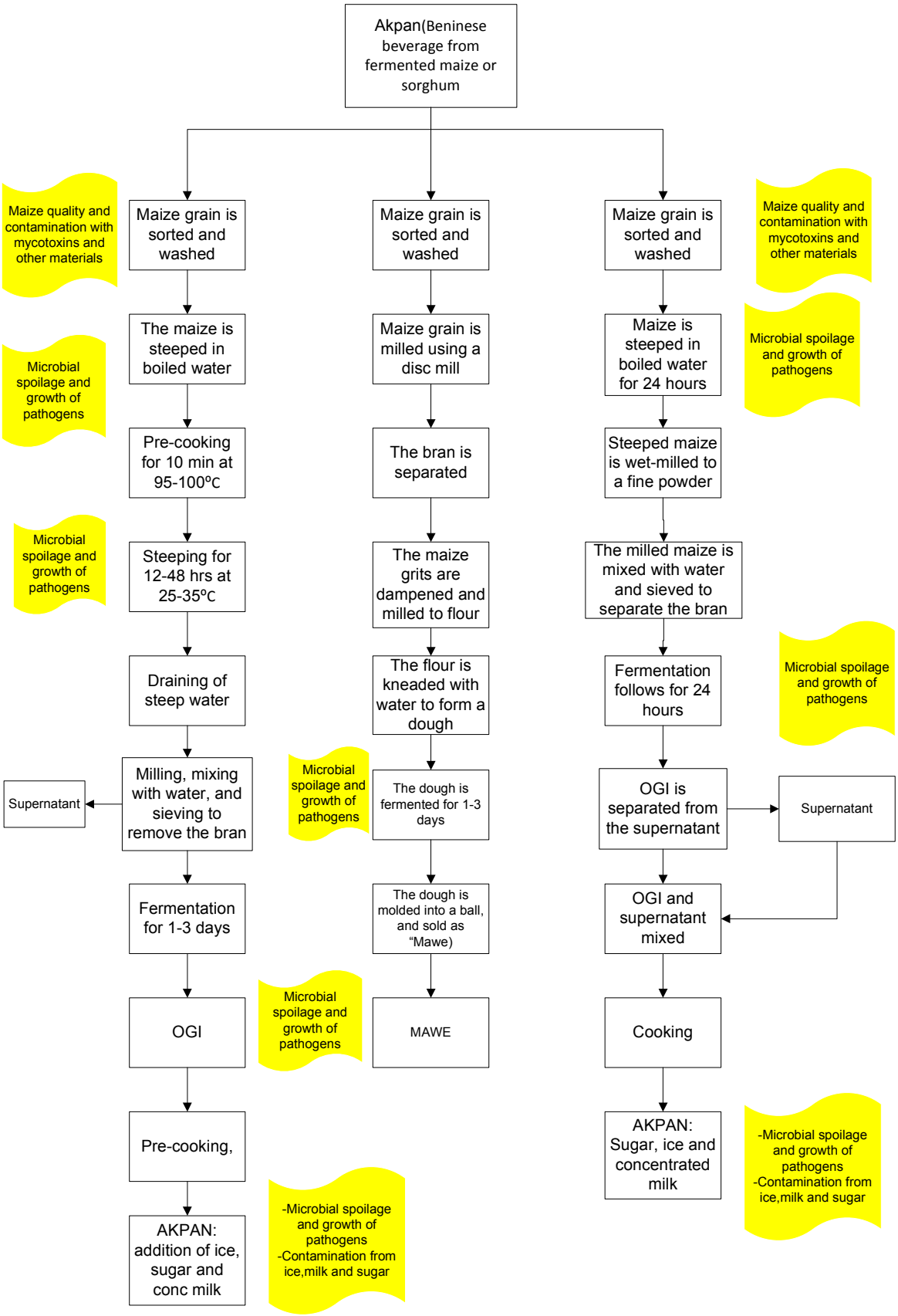

Fig 3: Flow diagram of akpan processing and suggested critical control points

Table 4: HACCP for Kishk

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Wheat	-Mycotoxins (aflatoxins, fumonisins, ochratoxin) -Foreign material	-Purchase good quality material	-Moisture content <13% -legislated levels selected mycotoxins	-Visual inspection -Random sampling of batches and analysis for mycotoxins	-Reject raw material that is not up to standard -Inform supplier
Par boiling the wheat	-Residual mycotoxins	-Adequate cooking step	-Boil for at least for 4 hours	-Record cooking time	-Heat for longer
Fermented milk	-Spoilage and pathogenic microorganisms	-Adhere to fermentation time	-pH limit -Titratable acidity, minimum	-Measure pH and use of pH strips	-Speed up fermentation process by backsloping, or inoculating with milk from a previous batch
Other ingredients: Salt, cumin seeds	Spoilage and pathogenic microorganisms	Good quality ingredients	Low microbial counts >--- cfu/g	Microbial counts done for each batch	Reject suspect batches of ingredients
Fermentation	Spoilage and pathogenic microorganisms	Adequate reduction of pH	pH below 4.2	pH strips, pH measurements	Speed up fermentation use back sloping methods
Sun drying	Dust as source of moulds and other microorganisms	Cover and protect from dust		Visual inspection	Use drying ovens
Final Product			>100 cfu/g of foreign bacteria (non LAB) >100 cfu/g of moulds >10 parts		
Cleaning	-Contamination with spoilage and pathogenic microorganisms	-Good housekeeping and personal; hygiene -Maintenance of equipment	-Clean premises, processing equipment and vessels -trained processing staff	-Visual inspection -Swabbing	-Clean premise, equipment and vessels -Clean factory coats -Wash hands -Use gloves

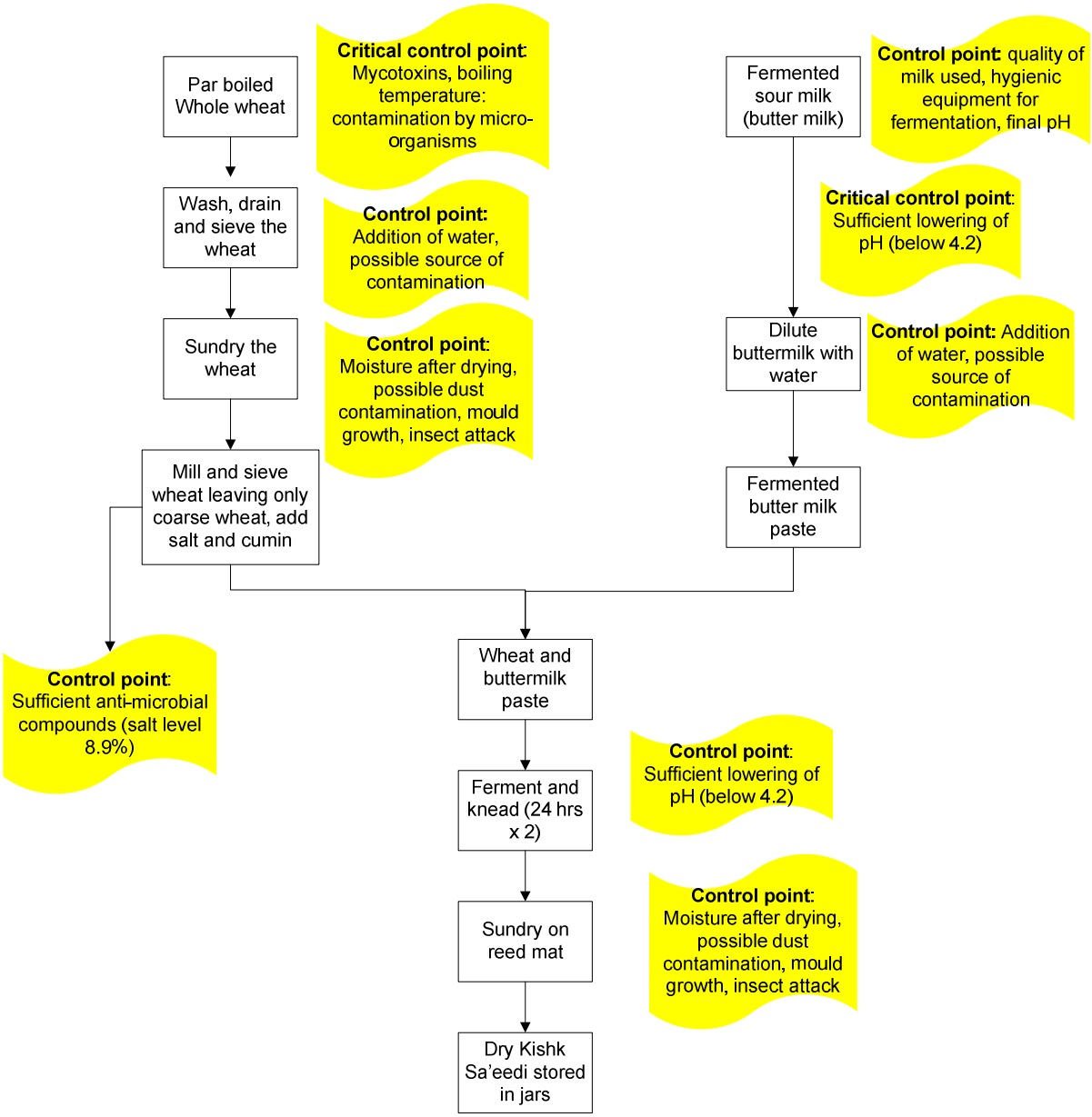

Fig 4: Flow diagram of Kishk processing and suggested critical control points

B. HACCP studies for meat and fish products

Table 5: HACCP plan for Kitoza

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Pork or Beef meat	-Contaminated meat, parasites found in beef and pork meat -Spoilage and pathogenic microorganisms -animal parasites that can infect humans (tape worm etc	-Select good quality meat that is not spoiled or smelly -Purchase meat from reputable sources or registered butchers that have meat inspectors, -Animals must be slaughtered after veterinary inspection	-Microbial limits of raw meat, and type of bacteria -presence of parasites or signs of disease	-Visual inspection -Purchase meat from reputable butchers -Inspection reports	-Reject meat from animals that are not examined by veterinarian, or animals that are sick -Reject suspect meat
Slicing and cutting into strips	-Spoilage and pathogenic microorganisms	-Use clean utensils -Clean processing environment -Examination of animals by veterinary department, and the meat by health inspector	-healthy animals -Meat must not show signs of deterioration or have an odour	-Visual inspection -Traceability, -Certificate of animal and meat inspection	-Reject meat from suspicious sources -Reject bad quality meat
Marinating, spicing and salting	-Contamination from spices and salts -Spoilage and pathogenic microorganisms	-Use clean spices, hygienically produced or decontaminated	Microbial levels	-Visual inspection -Microbial populations in the spices	-Reject dirty spices, or those with high microbial and pathogenic microbial counts
Smoking	-Spoilage and pathogenic organisms -Benzopyrene	-Adequate smoking time -Avoid burning	-Levels of benzopyrene	Visual inspection-visible burning -monitor smoking times	-Reject off flavour meat, that is over smoked

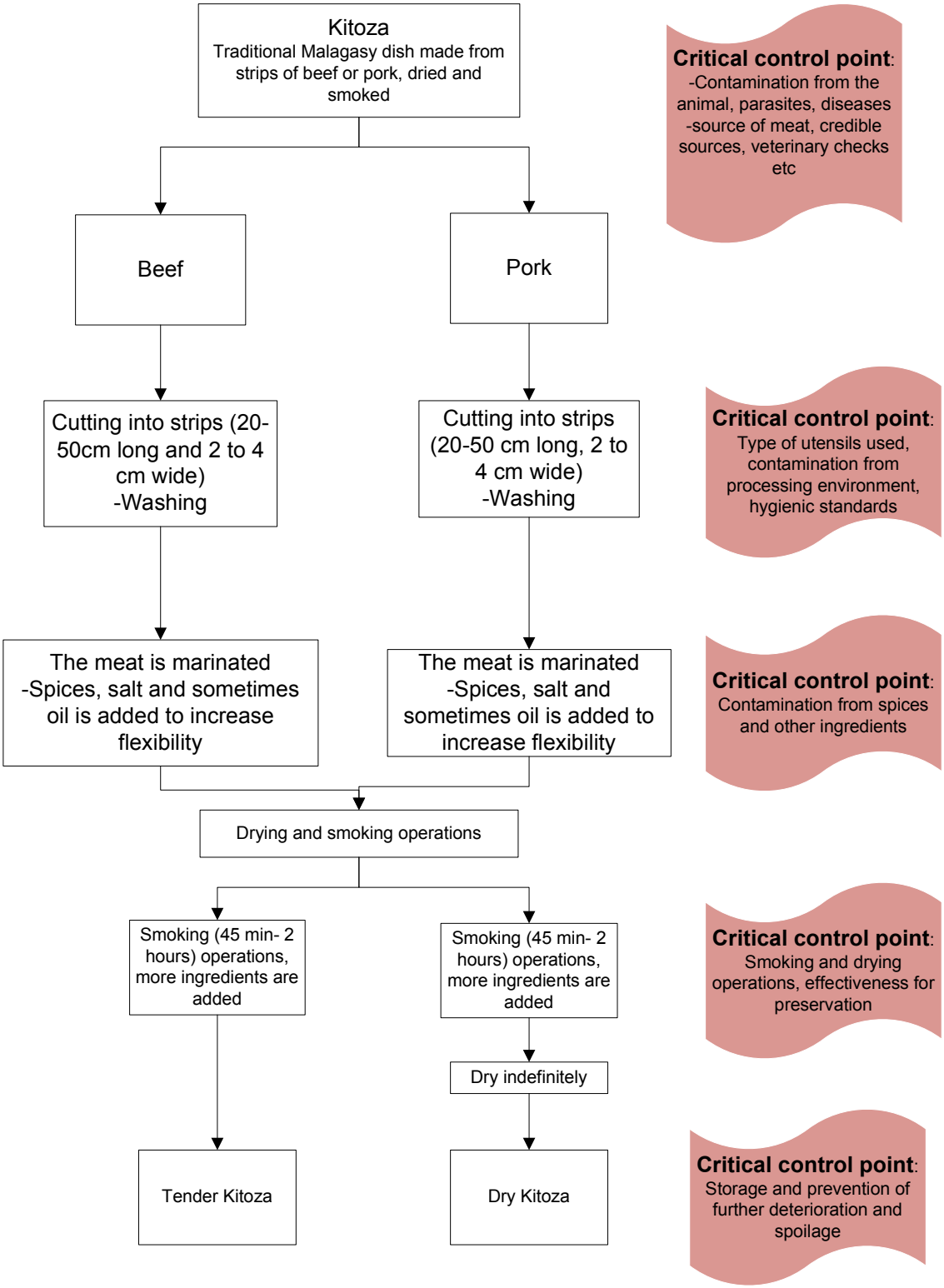

Fig 5: Flow diagram of kitoza processing and suggested critical control points

Table 6: HACCP plan for kong

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Fish:	-Contamination with environmental contaminants like toxic waste, heavy metals, spoilage and pathogenic microorganisms -Contamination of the fish flesh with microorganisms and pathogens from the fish gut	-Examine fish and determine levels of heavy metals -Use clean water	-Sign of disease -Sign of spoilage ----> heavy metals	-Visual inspection -Analysis of flesh -microbial analysis	-Use clean utensils and water (preferable running water) -wash the eviscerated fish, and place in separate container
Evisceration	-Spoilage and pathogenic microorganisms -Contamination by dust -Wet kong microbial and pathogenic microorganism -Maggots	-Hygienic practices, cleaning and washing the fish -Cover the fish	-microbial levels -	-Visual -Microbial levels evaluated	-Cover during drying -Cover smoked product, ensure that the fish is of good quality
Wet smoked kong	-Spoilage and pathogenic microorganism -Maggots	Source of fish, cleaning, salting	Pathogenic microorganisms	Microbial load Visual-signs of spoilage	-Select good quality fish use -Reject poor quality fish -reject spoilt fish and with maggot infestation
Dry smoked kong	-Pathogenic microorganism -Benzopyrene -Moulds may produce toxins	-Hygienic processing -Storage -levels of salting	>--% Moisture	-Visual inspection -Microbial levels -determine levels of benzopyrene	-Reject suspect fish that has become mouldy - Cover, and dry in a controlled environment -Use fly repellants (natural

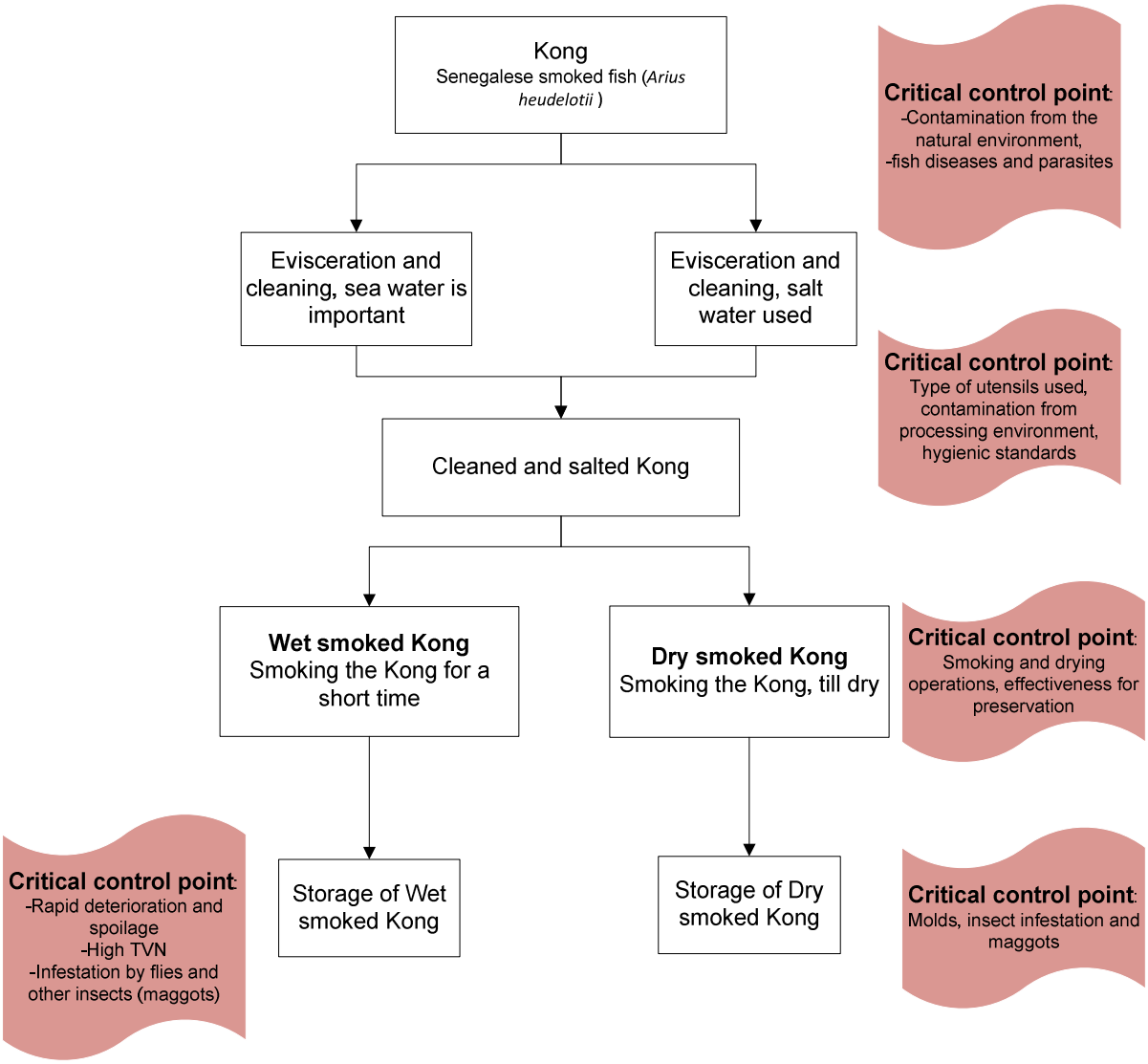

Fig 6: Flow diagram of kong processing and suggested critical control points

Table 7: HACCP study for Lanhouin (Beninese fermented fish)

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Fish:	-Spoilage and pathogenic microorganisms from the environment Environmental toxic contaminants (heavy metals and other toxins) -Contamination of the fish flesh with microorganisms and pathogens from the fish gut	-Assess environment where the fish is sourced	-Sign of disease -Sign of spoilage -Levels of heavy metals	-Visual inspection -Determine levels of heavy metals -Microbial levels	-Use clean utensils and water (preferable running water) -wash the eviscerated fish, and place in separate container
Cleaning and evisceration of fish	Toxins and spoilage and pathogenic microorganisms from the fish intestine	-Separate fish gut contents, and wash the fish using clean water	-Level of specific pathogenic microorganisms	Microbial examination and identification of microorganisms	Reject batches with high levels of contamination
Ripening of the eviscerated fish	Pathogenic and spoilage bacteria	Control process promote fermentative microorganisms	Levels of pathogens		Reject fish with high pathogen counts
Fish Salting	Contamination from salt	Use clean salt	Microbial levels -other minerals and impurities	-Visual -monitor contamination with halophiles, moulds, yeast	-Reject dirty salt, or clean the salt dy dissolving in hot water and allowing particles to settle
Fish: Ripening of whole fish (lanhouin)	-Type of fish -Spoilage and pathogenic microorganisms	-Fish species must be correct-not histamine producers -Clean water, salt levels-for whole fermented fish -	-Fish identified -Histamine levels monitored -Presence of pathogens -Clean water	-Visual inspection -	-Reject suspicious fish -Reject fish that is visibly rotten
Fermentation	Spoilage and	-Clean fish and	- levels of	-Visual	-Reject spoilt

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
fish	pathogenic microorganisms -Histamine	utensils -Control the fermentation	pathogens, non fermenters -Histamine, max permitted is 25ppm	inspection -Plate counts and isolation of pathogenic microorganism use selective microbial media	fish -use clean equipment and water -use adequate levels of salt
Sundrying	-Contamination by spoilage and pathogenic microorganisms (flies----Larvae and maggots) -Dust	-Cover the drying product	Microbial levels	-Visual inspection	Cover, and dry in a controlled environment -Use fly repellants (natural)

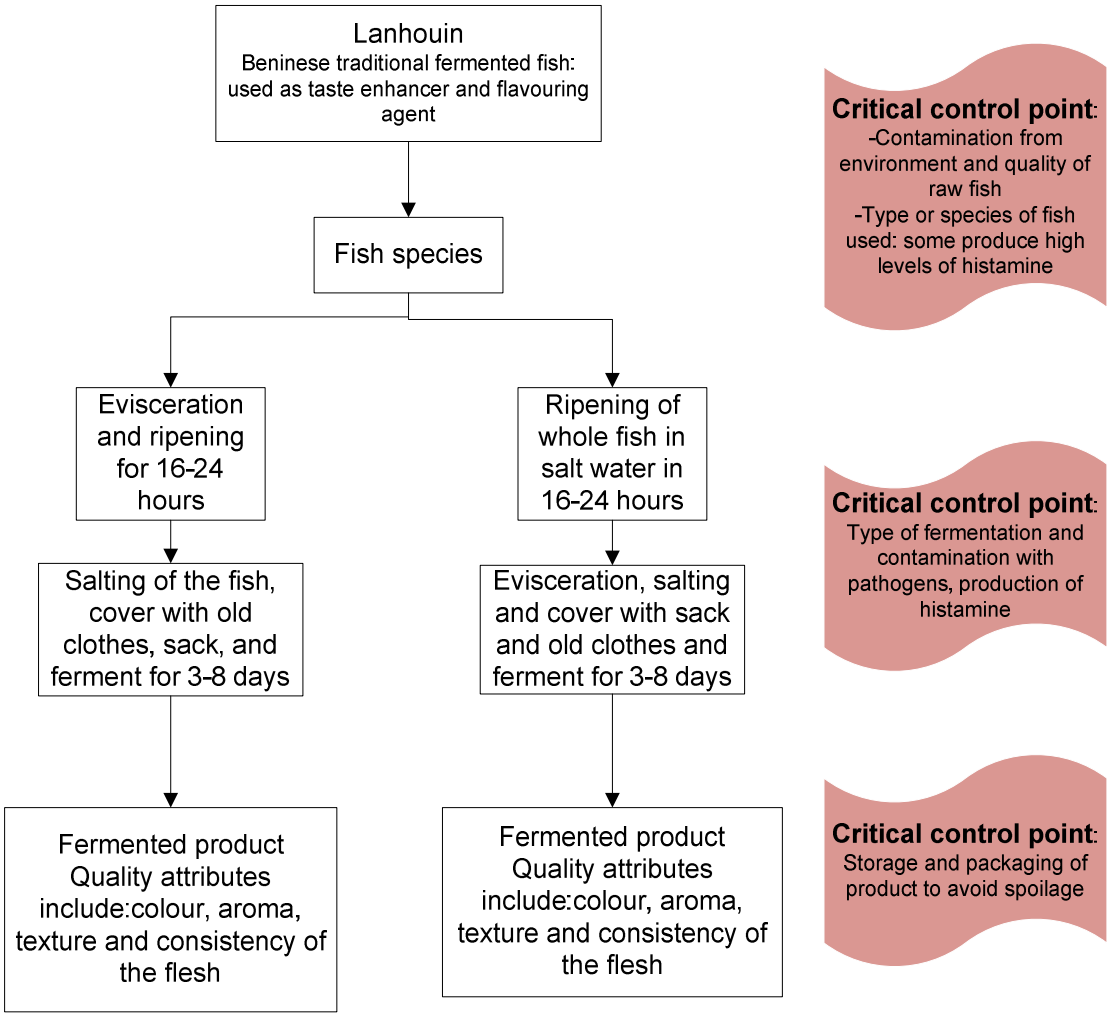

Fig 7: Flow diagram of lanhouin processing and suggested critical control points

C. HACCP for plant extracts as functional foods

Table 8: HACCP for baobab

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Baobab (Buy)	Spoilage and pathogenic microorganisms	Quality of raw material, dryness or extent of maturity		Visual	Reject bad fruits
Dried pulp-separation from the seed	-Spoilage and pathogenic microorganisms -Mould growth during storage	-Storage conditions -Control moisture levels	Microbial count	Visual inspection Measure moisture levels Monitor microbial content	-Reject or further dry the pulp if moisture too high -reject spoilt pulp showing visible mould growth
Juice preparation (water)	Microbial contaminants-Yeasts, lactic acid bacteria	Good quality water must be used -Clean utenils	-- cfu/g	-Monitor levels in the juice preparation	-Boil water -Clean utensils

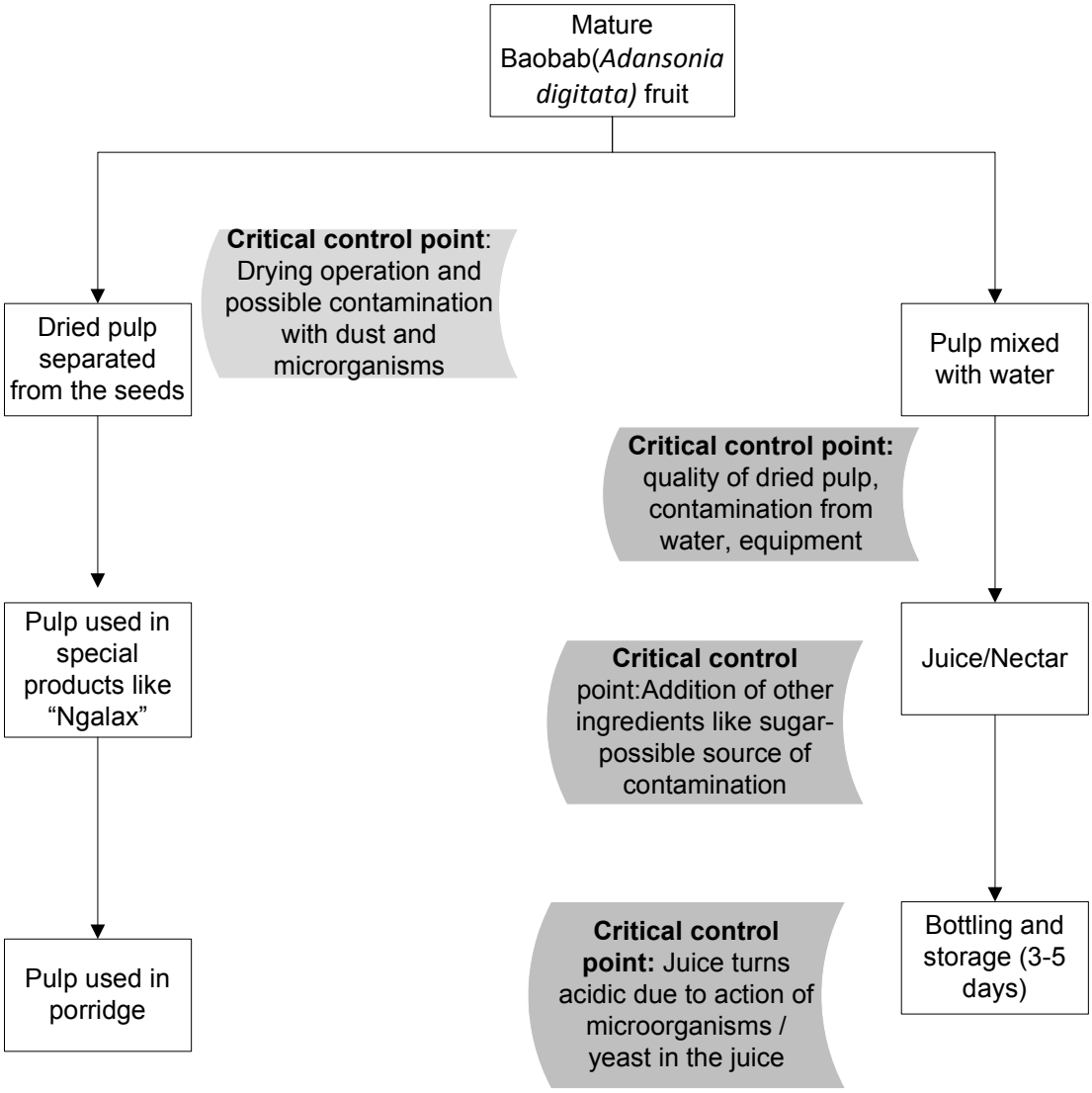

Fig 8: Flow diagram of baobab processing and suggested critical control points

Table 9: HACCP Plan for Bissap

Process step	Hazard	Control measure	Critical limits	Monitoring procedure	Corrective action
Hibiscus (Bissap)	-Contamination from environment	-Cleaning and washing before processing to juice	-Dust and microbial contamination		-Reject poor quality materials -Hygienic processing -Washing -Clean or boiled water -Sugar and other ingredients must be cleaned and tested
Juice preparation (water)	Microbial contaminants-Yeasts, lactic acid bacteria	Good quality water must be used -Clean utenils	-- cfu/g	-Monitor levels in the juice preparation	-Boil water -Clean utensils

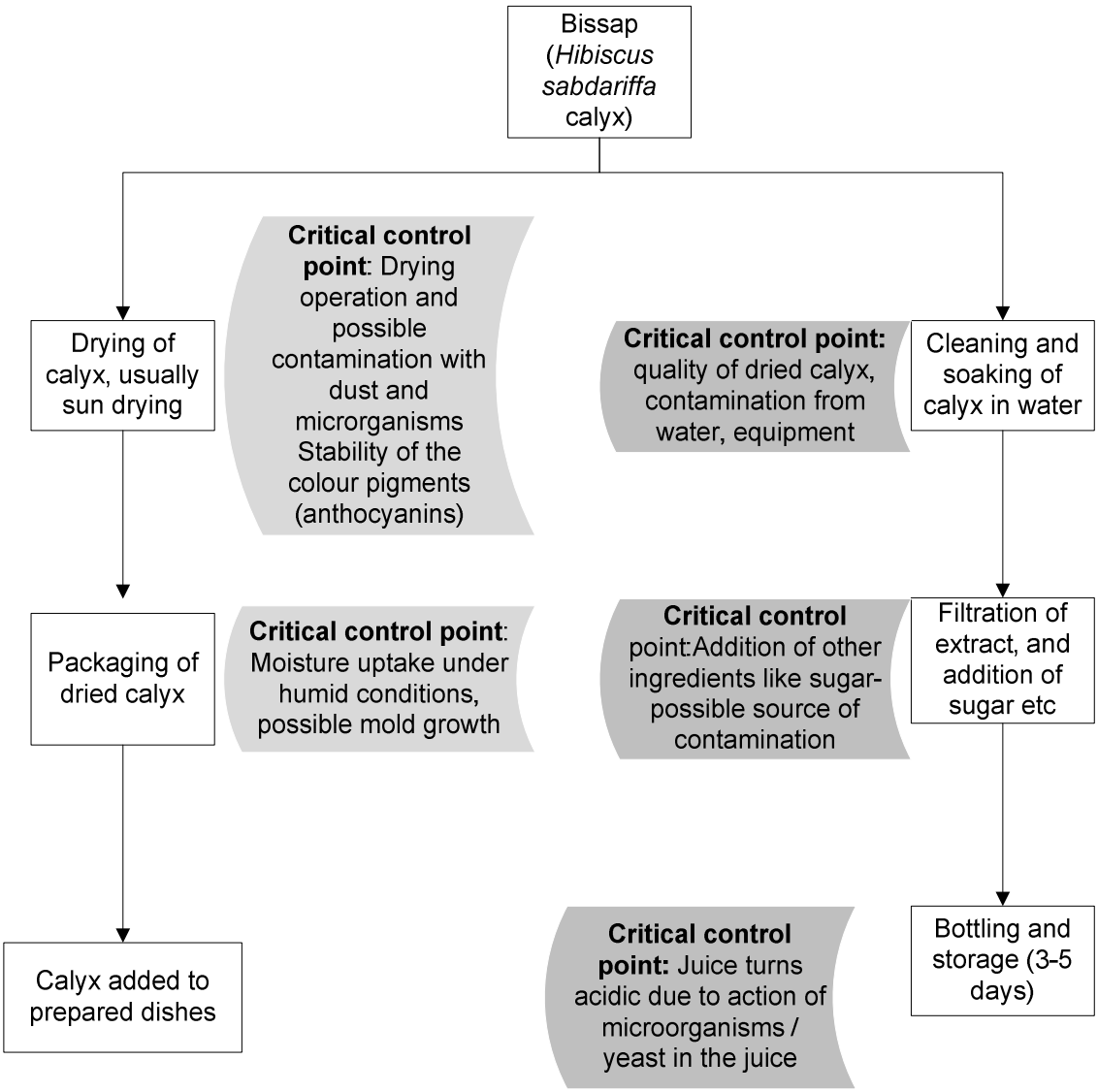

Fig 9: Flow diagram of bissap (*Hibiscus sabdariffa*) processing and suggested critical control points

Table 10: HACCP plan for Jaabi

Process step	**Hazard**	**Control measure**	**Critical limits**	**Monitoring procedure**	**Corrective action**
Jaabi fruit	-Contamination from environment	-Cleaning processing to juice	-Dust and microbial contamination	Visual for blemishes, spoilage -Microbial counts	-Reject poor quality materials -Hygienic processing -Washing -Clean or boiled water -Sugar and other ingredients must be cleaned and tested
Fruit grinding	-Microbial contaminants	Good quality fruits and clean utensils	-- cfu/g	-Monitor levels in the fruit	-clean fruits -Clean utensils
Moulding of the flour	Water added to flour, and it moulded - Staphylococcus from the hands -Other spoilage moulds	-Good hygiene -Boil water	---cfu/g	Monitor levels, wash hands	
Steaming, roasting or drying of the jaabi cake	-Spoilage and pathogenic microorganisms -Contaminants from the environment -Benzopyrene fromrasting				

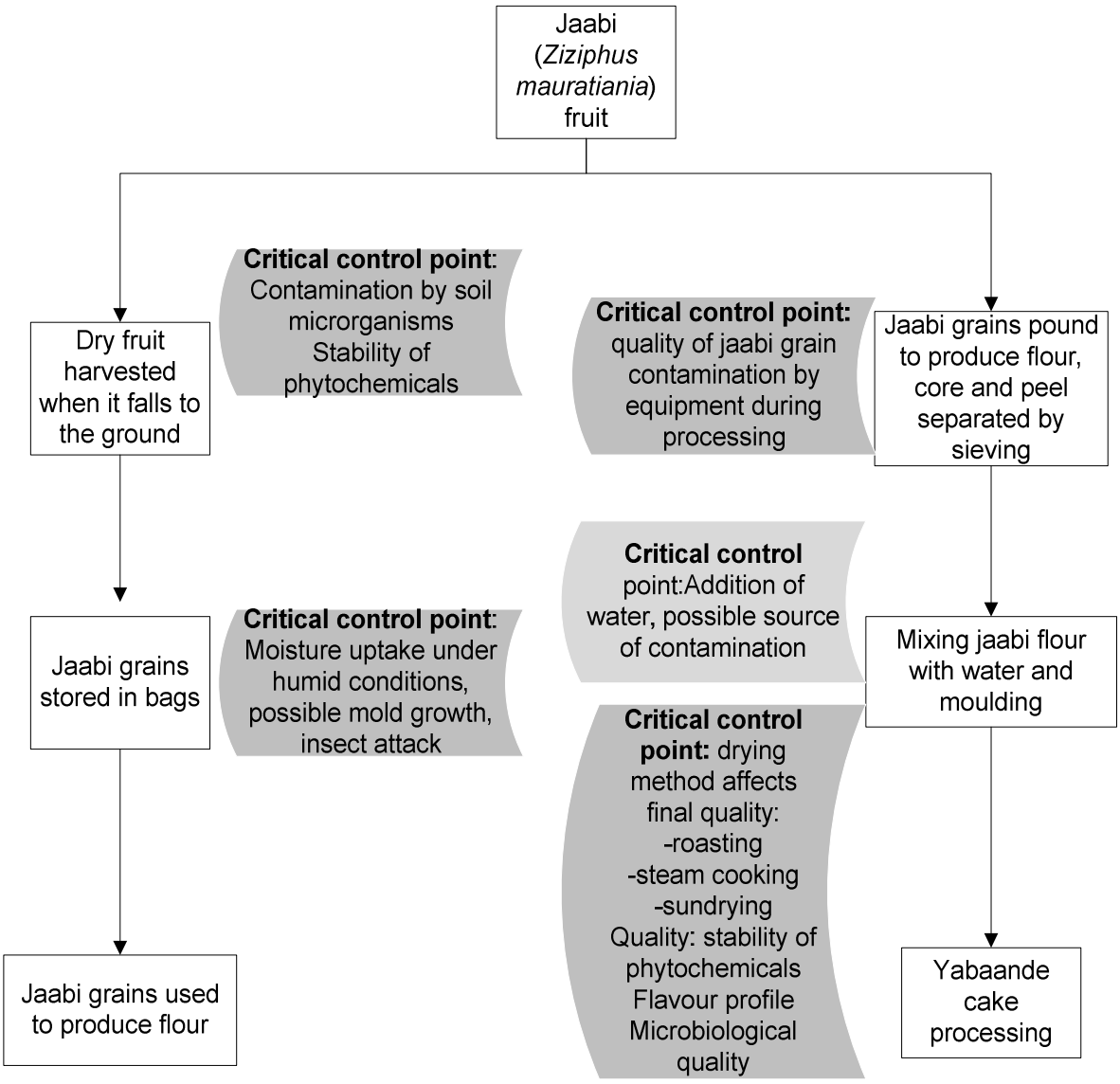

Fig 10: Flow diagram of jaabi processing and suggested critical control points

D. Summary of microbial and other hazards associated with the products per group

- **Group 1 (Cereal-based Products)**

Biological hazards

Microorganisms: *Bacillus cereus*, mycotoxigenic fungi, microorganisms from the workers (viruses, *E. Coli, Shigella, S. aureus)*

Other hazards: Aflaxoxin, environmental contaminants such as insecticides, pesticides

- **Group 2 (Meat and fish products)**

Biological hazards associated with meat

Pathogenic microorganisms: *Bacillus cereus, Clostridium perfringens, Clostridium botulinum, Listeria monocytogens, Escherichia coli* O157:H7, *Salmonella, Shigella, Staphylococcus aureus*
(the preformed heat stable toxin), viruses
Control measure: For bacteria, the control is mainly heat treat, which can also inactivate some toxins they produce

Parasites: *Taenia* spp (beef and pork), *Trichinella spiralis (pork);* Control is cooking, or avoid contaminated meat.

Other hazards: nitrates and nitrites in smoked meat, banzapyrene

Biological hazards associated with Fish

Pathogenic organisms: same as for meat, and in addition, *Vibrio, viruses,* and contamination from the workers

Toxins and toxic elements: scrombotoxin, mercury, PCB

- **Group 3 (Plant extracts as functional foods)**

Contamination from the environment and processors: *Staphylococcus aureus* (may not grow because of low pH), Bacillus spp, viruses,

Toxins: Mycotoxins, insecticides, pesticides