

**DEVELOPMENT OF APPROPRIATE QUALITY ASSURANCE  
SYSTEM FOR SMALL AND MEDIUM SCALE ENTERPRISES**

**ELSA FOODS LIMITED,  
KPONE-TEMA, GHANA**

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## SUMMARY

The CASSVA SME's has been a collaboration involving partners in West Africa and Europe. In Ghana, the CSIR-Food Research Institute is the partner institution of the project. The overall objective of the project was to develop selected cassava-based foods to meet the changing and growing urban demand through the production of products that are convenient, of high quality and safe. It is in line with this overall objective that the development of appropriate quality assurance system for cassava based foods for Elsa Foods Limited, Kpone, Tema was undertaken in collaboration with a quality team from Elsa Foods Limited. This technical report is in eight parts. An overview of the FRI/EU Cassava SMEs Project is presented in Chapter 1. Cassava based products (*fufu* and *kokonte*) are presented in Chapters 2 and 3 whereas Chapters 4 and 5 highlights cassava/maize based products (*tuo zaafi*, *banku mix*). Chapters 6, 7 and 8 deals with maize/millet based products (fermented maize flour, *hausa koko* and fortified Tom Brown- popular as a weaning food). The product process flow diagram (PFD), worksheet on standard operating procedures (SOP's) for production and a worksheet on process step are included. Also included in each chapter is identifiable hazard, its source and their control measures for production, a Hazard Analysis Critical Control Point (HACCP) for production and a description and intended use of the product.

## CHAPTER 1 INTRODUCTION

The development of appropriate quality assurance system for small and medium scale enterprises was prepared under the Food Research Institute (FRI) /European Union (EU) Cassava SMEs project. Cassava SMEs is a multi-organisational, multidisciplinary approach to addressing the issue of SME development as the driving force for the commercialisation of cassava. The over-all purpose of the project is to develop selected cassava based foods (fermented *fufu*, pounded *fufu*, *kokonte*, cassava grits and local starch) to meet the changing and growing urban demand through the manufacture of products that are convenient, of high quality and safe. In Ghana the products are *fufu* (pounded), *kokonte* and cassava grits (to make cassava flour). In Nigeria the products are *fufu* (fermented) and *tapioca* (local starch product). Further, this project takes a holistic approach to provide “best practices” tools and technologies to develop the chain from production to consumption. The specific and technological objectives of the project are categorised into eight sections as follows:

1. To develop and promote best practice guidelines for the commercialisation of traditional food products using cassava products as a model.
2. To develop and test specific technologies for the commercialisation of cassava based products.
3. To understand and optimise the impacts of commercialisation, specifically that based on SMEs, on the livelihoods of traditional processors.
4. To assess the potential of traditional processors to produce high quality products that meet urban demand.
5. Development of appropriate quality assurance (QA) systems for SMEs engaged in commercial processing of traditional foods products.
6. To develop more cost-effective and environmentally sensitive process that will make commercial manufactured cassava products more affordable
7. To establish “best practices” for the establishment, support and promotion of SMEs producing traditional food products.
8. To examine and select marketing strategies and distribution systems which effectively target urban markets.

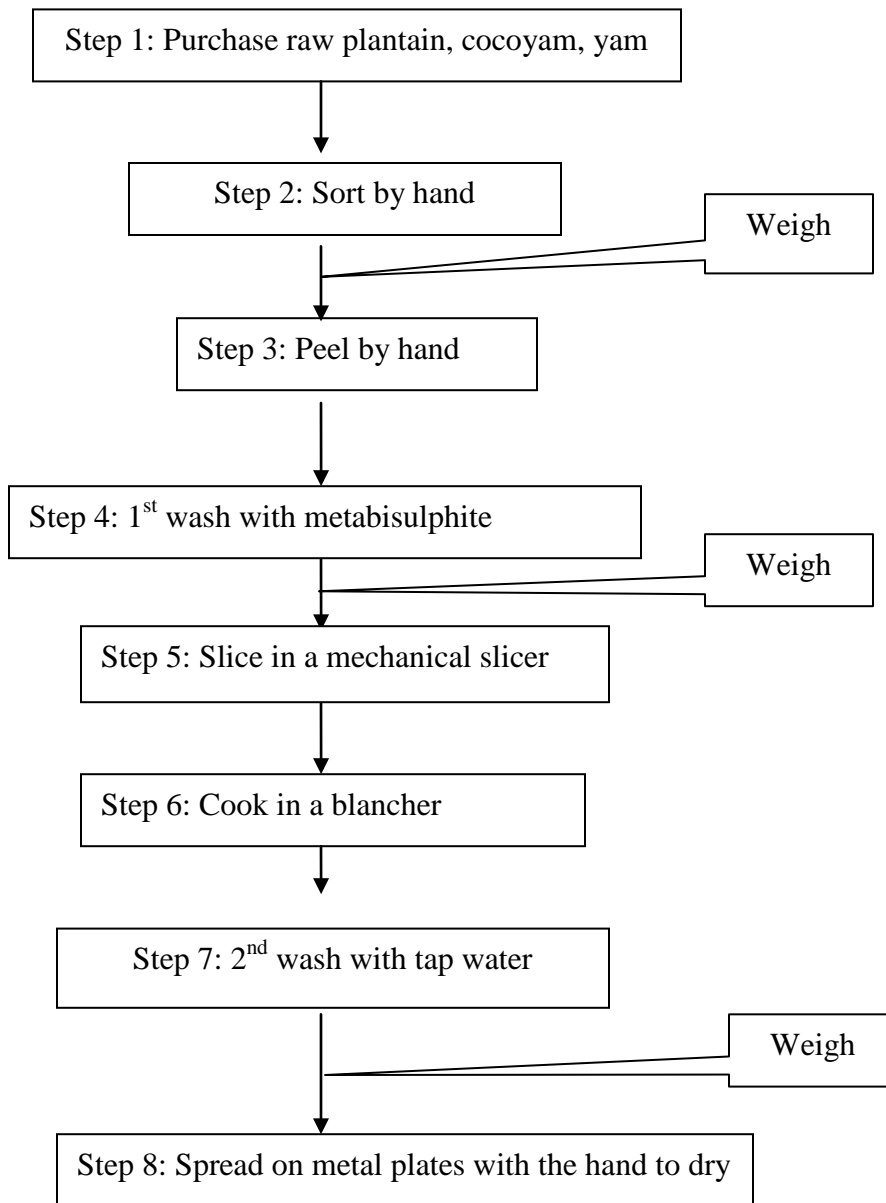
It is to address section 4, 5, 6 and 7 of the specific and technological objectives of the project that led to the development of appropriate quality assurance system for Elsa Foods Limited, a small scale enterprise based in Kpong-Tema, Ghana. Appropriate quality assurance system was developed for seven products for Elsa Foods Limited. These are cassava based products (*fufu* and *kokonte*), cassava/maize based products (*tuo zaafi*, *banku mix*) and maize/millet based products (fermented maize flour, *hausu koko* and fortified tom brown).

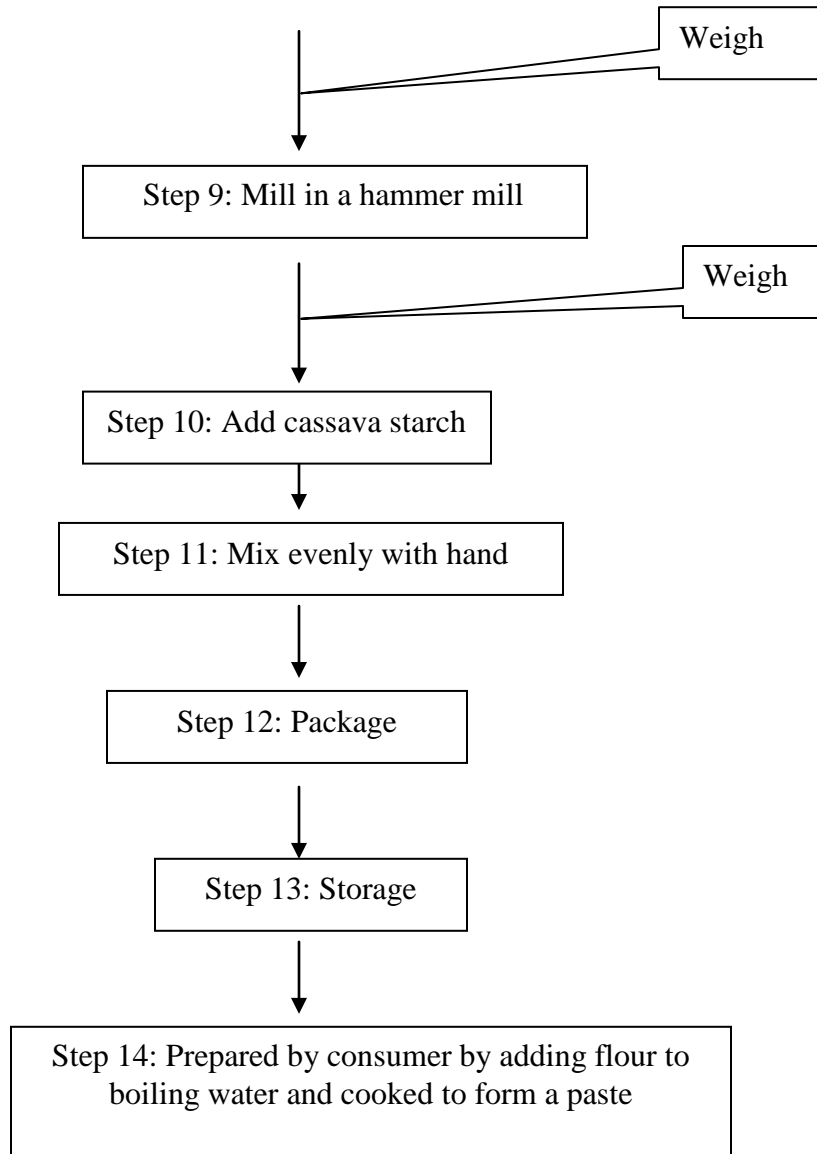
There are eight chapters in this technical report. Chapter 1 presents an overview of the FRI/EU Cassava SMEs Project. Chapters 2 and 3 deals with cassava based products (*fufu* and *kokonte*). Chapters 4 and 5 presents cassava/maize based products (*tuo zaafi*, *banku mix*) whereas chapters 6, 7 and 8 deals with maize/millet based products (fermented maize flour, *hausu koko* and fortified tom brown). The chapters presents a product and highlights a step-by step process flow diagram (PFD) for its production, a worksheet on standard operating procedures (SOP's) for production, a worksheet on process step, hazard and source and their control measures for production, a hazard analysis critical control point (HACCP) for production and a description and intended use of the product.



## CHAPTER 2 FUFU FLOURS

*Fufu* flours are normally prepared from plantain, cocoyam and yam and can be enjoyed any time of the day. Plantain and yam *fufu* flours are often eaten with chicken light soup or pepper soup where as cocoyam *fufu* is often eaten with *kontomire* soup (cocoyam leaves: *Xanthosoma mafaffa*) popularly called *abunabun* or *green green* in Ghana.





**Figure 2.1**

Process flow diagram (PFD) for the production of *fufu* flours (plantain, cocoyam and yam)

**Table 2.1**

Worksheet-Standard operating procedures (SOP's) for the production of *fufu* flours  
(plantain, cocoyam and yam)

<b>Process step</b>	<b>Standard operating procedures</b>
4: 1 <sup>st</sup> wash with metabisulphite  7: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use prepared metabisulphite</li> <li>3. Wash bowls thoroughly</li> <li>4. Use clean water</li> </ol> <ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use prepared metabisulphite</li> <li>3. Wash bowls and sieves thoroughly</li> <li>4. Use clean water</li> </ol>
5: Slice	<ol style="list-style-type: none"> <li>1. Clean the slicer</li> <li>2. Remove the 3 components of slicer and clean</li> <li>3. Check sharpness of blade</li> <li>4. Fix back dismantled parts</li> <li>5. Check on movement of belt</li> <li>6. Power check</li> </ol>
6. Cook	<ol style="list-style-type: none"> <li>1. Clean blancher with clean water</li> <li>2. Fill blancher with clean water to the required level</li> <li>3. Introduce steam to 95°C</li> <li>4. Turn on the machine</li> <li>5. Feeding of product</li> <li>6. Regulation of speed -20 turns for 3 minutes</li> </ol>
8. Spread on metal plates (Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
10. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

**Table 2.2**

Worksheet-Process step, hazard and source and their control measures for the production of *fufu* flours (plantain, cocoyam and yam)

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw materials Plantain Cocoyam Yam	Vegetative pathogens  Fungi Diseased roots Heavy metals Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilizers Soil Soil Pesticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP GAP QA GAP, QA GAP, QA
2. Sort by hand	Vegetative pathogens	Processor	GPH GMP
3 Peel by hand	Vegetative pathogens	Processor Knife Working surface Dirty bowls	GPH, GMP
4. 1 <sup>st</sup> wash	Vegetative pathogens Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor	GHP, GPH
5. Slice	Vegetative pathogens	Unclean slicer Contaminated water for cleaning Operator	GHP, GPH
6. Cook (Blancher)	Vegetative pathogens	Contaminated water Improper cleaning of blancher	GHP, Use wholesome water
7. 2 <sup>nd</sup> wash	Vegetative pathogens	Contaminated water (tap, well, underground tank) Washing bowls	GHP, GPH

		Processor	
8. Spread on metal plates by hand	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP
9. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
10. Add cassava starch by hand	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
11. Mix evenly by hand	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
12. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
13. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
14. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP

**Table 2.3**

HACCP Plan for the production of *fufu* flours (plantain, cocoyam and yam)

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Diseased roots Heavy metals and pesticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
2	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
3	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
4	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
5	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i>	GMP, GHP	None				

6	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>	GMP, GHP, Cooking time, temperature, particle size cut material, wholesome water	Yes	Water boiling, cooking time > x min, material not thicker than X mm, chlorine -ted water if unsafe supply	Cooking temperature and time, slice thickness, water quality	Repeat cooking until critical limits are met and exceeded, reduce slice thickness if too thick.	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes If using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
8	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i>	GMP, GHP	None				
9	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Mycotoxin	GMP, GHP, Drying time, air temperature, particle size, thickness of layer for drying, moisture content	Yes	Temperature > °C Time > min Particle size > mm Layer thicknesses < mm	Temperature Time Particle size Layer thickness Moisture content	Re-dry if temp and time too low or particle size and layer thickness exceeded. Change particle size and adjust layer thickness	Keep records
10	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus</i>	GMP, GHP	None				

	<i>aureus</i> Fungal spores Oil/ grease Metal pieces						
11	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP	Yes	Quantity and quality of cassava to be added	Quantity within limits; Quality checked	Add cassava starch within approved limits	Keep records
12	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP	None				
13	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture	GMP, GHP	None				
14	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None				
15	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp > °C Time > min Use potable water	Water boiling, thickness of paste	Apply more heat, Cook for more time, Adjust water and flour ratio	Keep records

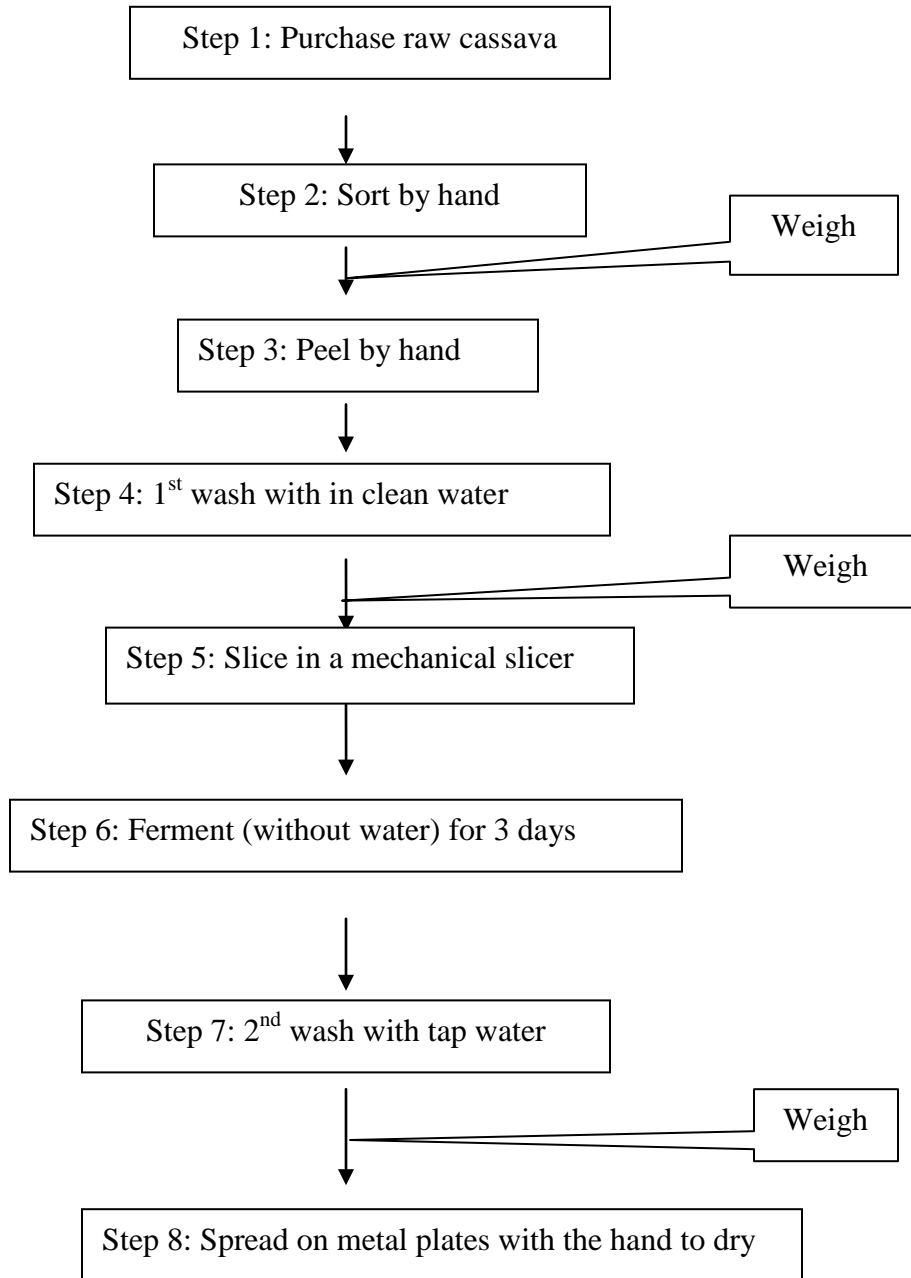


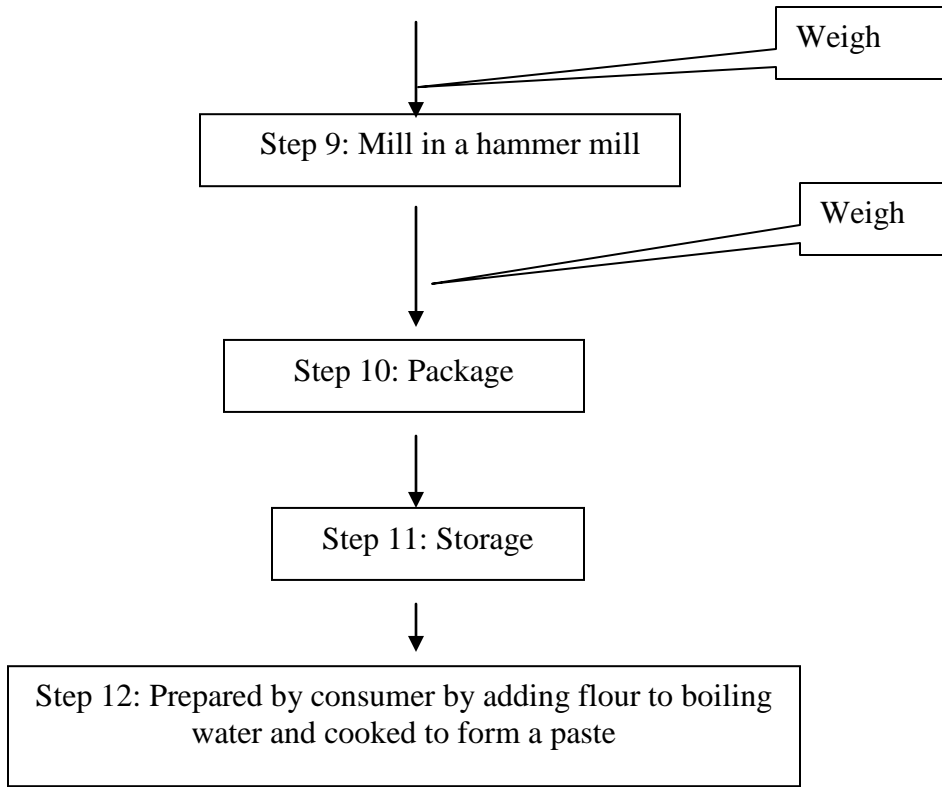
**Table 2.4**Product description and intended use for *fufu* flours (plantain, cocoyam and yam)

1. Product name(s)	Plantain, cocoyam and yam <i>fufu</i> flour
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a thick paste by adding boiling water and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Take 2 cups of water and 1 cup of <i>fufu</i> flour. Boil water and add <i>fufu</i> flour slowing to the boiled water as you stir with a wooden ladle. Continue stirring on low heat into a thick smooth paste (5-10 minutes). Add more water if desired. Mould into balls and served with traditional west African soups or any other soups.
9. Special distribution control	Store in dry place

### CHAPTER 3 SNOW -WHITE KOKONTE

Snow-white *kokonte* is fermented cassava flour prepared from high yielding cassava. In Ghana it is locally called 'Face the Wall'. It is often eaten with chicken, goat light soup or pepper soup.





**Figure 3.1**

Process flow diagram (PFD) for the production of snow- white *kokonte*

**Table 3.1**

Worksheet-Standard operating procedures (SOP's) for the production of *snow white kokonte*

<b>Process step</b>	<b>Standard operating procedures</b>
4: 1 <sup>st</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls thoroughly</li> <li>3. Use clean water</li> </ol>
7: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls and sieves thoroughly</li> <li>3. Use clean water</li> </ol>
5: Slice	<ol style="list-style-type: none"> <li>1. Clean the slicer</li> <li>2. Remove the 3 components of slicer and clean</li> <li>3. Check sharpness of blade</li> <li>4. Fix back dismantled parts</li> <li>5. Check on movement of belt</li> <li>6. Power check</li> <li>7. Introduce product</li> </ol>
6. Ferment for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Cover bowl with nets</li> <li>4. Check daily.</li> </ol>
8. Spread on metal plates (Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
10. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

**Table 3.2**

Worksheet-Process step, hazard and source and their control measures for the production of *snow white kokonte*

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw cassava	Vegetative pathogens  Fungi Diseased roots Heavy metals Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilizers Soil Soil Pesticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP GAP QA GAP, QA GAP, QA
2. Sort by hand	Vegetative pathogens	Processor	GPH GMP
3 Peel by hand	Vegetative pathogens	Processor Knife Working surface Dirty bowls	GPH, GMP
4. 1 <sup>st</sup> wash	Vegetative pathogens Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor	GHP, GPH
5. Slice	Vegetative pathogens	Unclean slicer Contaminated water for cleaning Operator	GHP, GPH
6. Ferment (3days)	Vegetative pathogens	Contaminated surrounding	GMP
7. 2 <sup>nd</sup> wash	Vegetative pathogens	Contaminated water (tap, well, underground tank) Washing bowls Processor	GHP, GPH
8. Spread on metal plates by hand	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP

9. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
13. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
14. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
15. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP

**Table 3.3**

HACCP Plan for the production of *snow white kokonte*

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Diseased roots Heavy metals and pesticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
2	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
3	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
4	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
5	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i>	GMP, GHP	None				

6	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>  Fungal spores	GMP, GHP,	Yes	Availability of fermented microbes,	Fermentation odour	1.Cleaning of cassava chips 2.Clean water 3. Clean bowls 3.Appropriate for 3days. 4.Expose product	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes If using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
8	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Mycotoxin	GMP, GHP, Drying time, air temperature, particle size, thickens of layer for drying, moisture content	Yes	Temperature > °C Time > min Particle size > mm Layer thickness < mm	Temperature Time Particle size Layer thickens Moisture content	Re-dry if temp and time too low or particle size and layer thickness exceeded. Change particle size and adjust layer thickness	Keep records
9	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Oil/ grease Metal pieces	GMP, GHP	None				
10	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> ,	GMP, GHP	None				



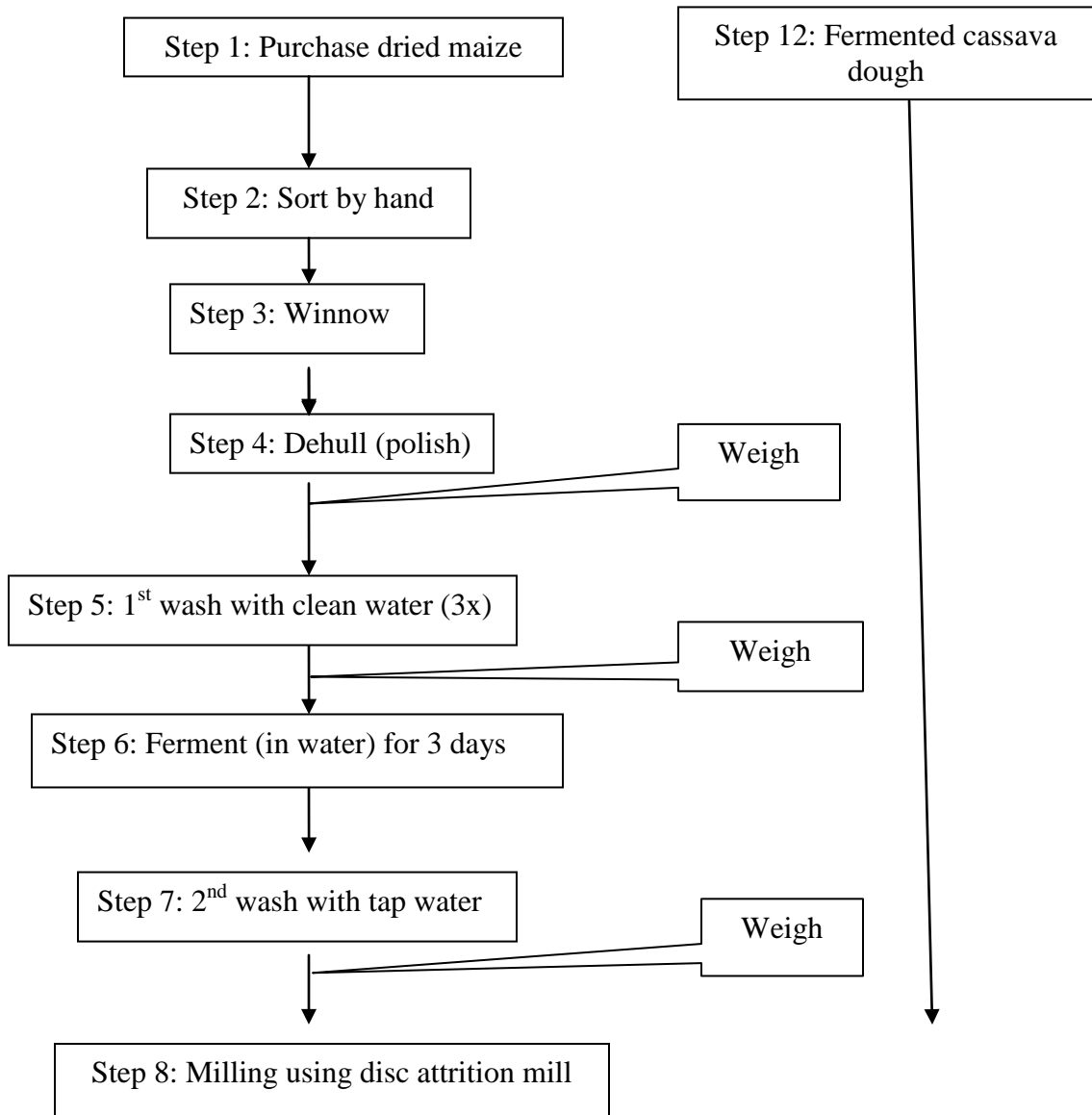
	<i>Staphylococcus aureus</i> Fungal spores Moisture						
11	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None				
12	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp > °C Time > min Use potable water	Water boiling, thickness of paste	Apply more heat, Cook for more time, Adjust water and flour ratio	Keep records

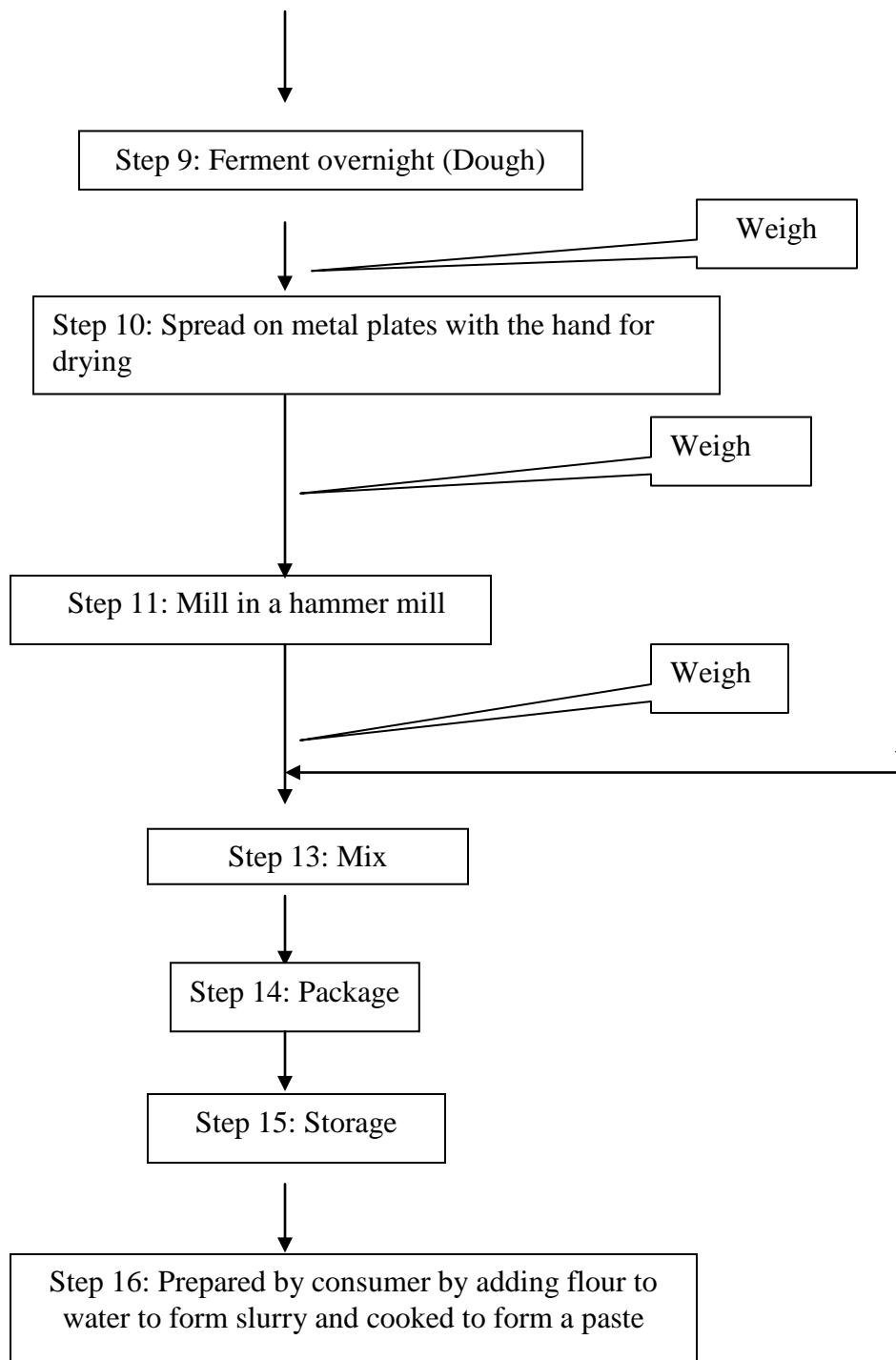
**Table 3.4**Product description and intended use for *snow white kokonte*

1. Product name(s)	Snow white <i>Kokonte</i>
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a thick paste by adding boiling water and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Add 1.5 cups of water and 1 cup of flour to boiling water and stir constantly with a wooden ladle until cooked (10-15 minutes). Turn on to a plate and form a smooth ball of <i>kokonte</i> .
9. Special distribution control	Store in dry place

## CHAPTER 4 TUO ZAAFI

*Tuo zaafi* popularly called ‘TZ’ in Ghana is prepared from high quality maize and cassava flour. This meal is mainly a northern Ghanaian dish which is enjoyed by all Ghanaians. It is often eaten with special ‘dawadawa’ (*Parkia clappertoniana*) soup and other soups.





**Figure 4.1**

Process flow diagram (PFD) for the production of *Tuo zaafi*

**Table 4.1**Worksheet-Standard operating procedures (SOP's) for the production of *Tuo zaafi*

<b>Process step</b>	<b>Standard operating procedures</b>
5: 1 <sup>st</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Pour maize into water and stir to wash</li> </ol>
7: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls and sieves thoroughly</li> <li>3. Use clean water</li> <li>4. Pour maize into water and stir to wash</li> <li>5. Drain maize in clean water</li> </ol>
6. Steep in water for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Steep maize in water</li> <li>4. Cover bowl with nets</li> <li>5. Check daily</li> </ol>
8: Mill using a disc attrition mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean the receptacle</li> <li>3. Clean discs</li> <li>4. Test-run machine</li> <li>5. Introduce product.</li> </ol>
9. Ferment overnight	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Mix dough thoroughly</li> <li>4. Cover bowl with nets</li> </ol>
10. Spread on metal plates(Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
11. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

**Table 4.2**

Worksheet-Process step, hazard and source and their control measures for the production of *Tuo zaafi*

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw materials dried maize	Vegetative pathogens  Fungi Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilizers Insecticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP QA GAP, QA GAP, QA
2. Sort by hand	Vegetative pathogens	Processor	GPH GMP
5. 1 <sup>st</sup> wash	Vegetative pathogens Fungal spores  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
6. Steep in water for 3 days	Vegetative pathogens	Unclean water Contaminated water for fermentation Processor	GHP, GPH, GMP
7. 2 <sup>nd</sup> wash	Vegetative pathogens  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
8. Mill using disc attrition mill	Vegetative pathogens  Oil/grease Metal fragments  Fungal spores	Mill  Mill Mill/teething chipping off  Surrounding air	GMP  GMP GMP GMP

9. Ferment over night	Vegetative pathogens  Fungal spores	Contaminated water for fermentation Contaminated bowls Processor  Surrounding air	GMP  GHP  GMP
10. Spread on metal plates by hand (Drying)	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP
11. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
12. Add fermented cassava dough	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
13. Mix	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
14. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
15. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
16. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP

**Table 4.3**

HACCP Plan for the production of *Tuo zaafi*

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Heavy metals and pesticides/insecticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
2	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
5	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
8	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> Fungal spores Metal pieces Oil/grease	GMP	None				
9	Vegetative	GMP, GHP,	Yes	Availab	Fermentatio	1.Cleanin	Keep



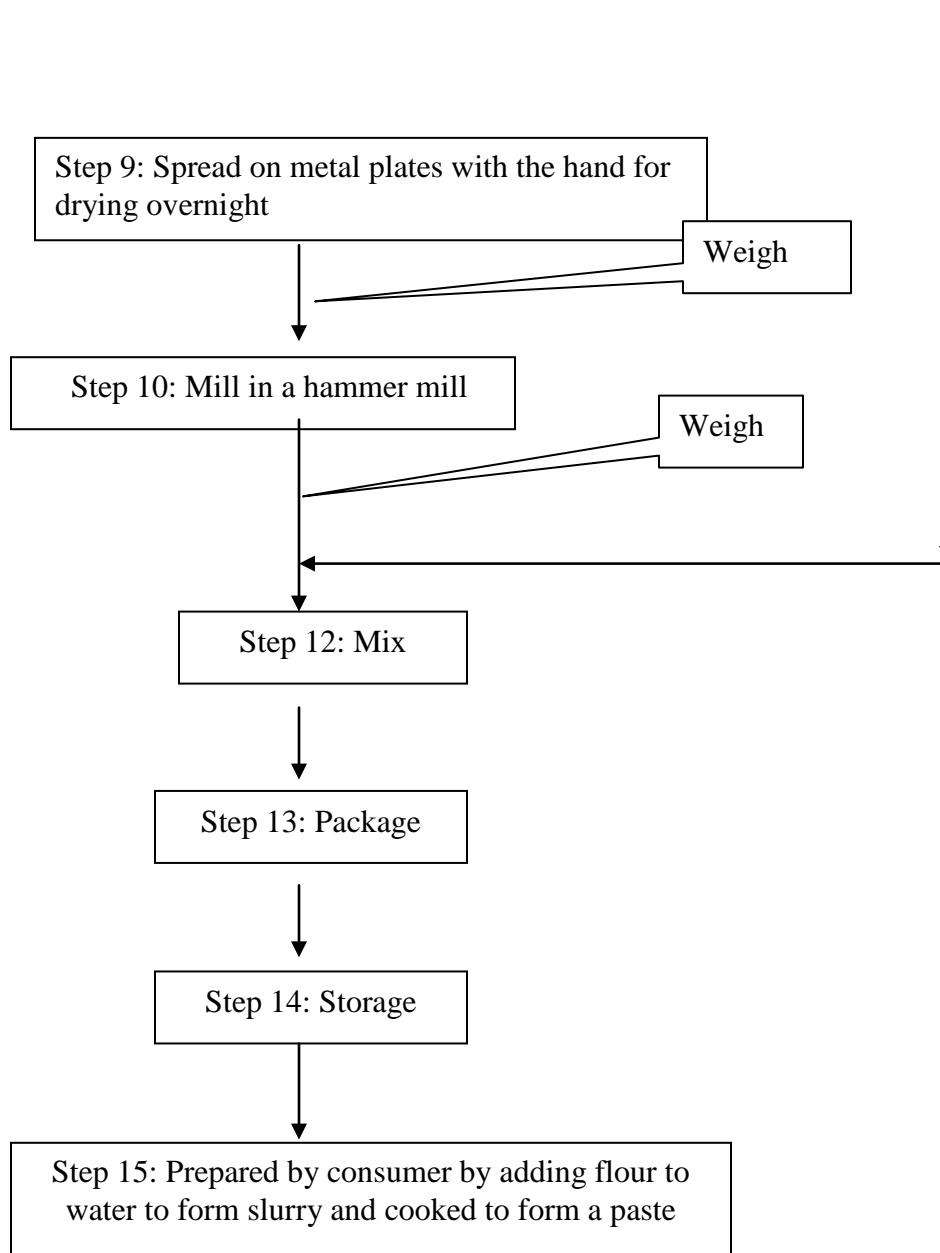
	<p>pathogens such as <i>E. coli</i>, <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i></p> <p>Fungal spores</p>			<p>ility of fermented microbes,</p>	<p>n odour</p>	<p>g of grains</p> <p>2.Clean water</p> <p>3. Clean bowls</p> <p>3.Appropriate for 3days.</p> <p>4.Expose product</p>	<p>records</p>
10	<p>Vegetative pathogens such as <i>E. coli</i>, <i>Vibrio Cholerae</i>, <i>Salmonella spp.</i>, <i>Staphylococcus aureus</i></p> <p>Fungal spores</p> <p>Mycotoxin</p>	<p>GMP, GHP, Drying time, air temperature, particle size, thickens of layer for drying, moisture content</p>	<p>Yes</p>	<p>Temperature 60-70 °C</p> <p>Time 7-9 hours</p> <p>Particle size &gt; mm</p> <p>Layer thickness &lt; mm</p>	<p>Temperature</p> <p>Time</p> <p>Particle size</p> <p>Layer thickens</p> <p>Moisture content</p>	<p>Re-dry if temp and time too low or particle size and layer thickness exceeded. Change particle size and adjust layer thickness</p>	<p>Keep records</p>
11.	<p>Vegetative pathogens such as <i>E. coli</i>, <i>Salmonella spp.</i>, <i>Vibrio cholerae</i>, <i>Staphylococcus aureus</i></p> <p>Fungal spores</p> <p>Moisture</p>	<p>GMP, GHP</p>	<p>None</p>				
12, 13, 14, 15	<p>Vegetative pathogens such as <i>E. coli</i>, <i>Salmonella spp.</i>, <i>Vibrio cholerae</i>, <i>Staphylococcus aureus</i></p> <p>Fungal spores</p> <p>Moisture</p> <p>Insects, pests</p> <p>Rodents</p>	<p>GMP, GHP</p>	<p>None</p>				
16	<p>Vegetative pathogens such as <i>E. coli</i>, <i>Salmonella spp.</i>, <i>Vibrio cholerae</i>, <i>Staphylococcus aureus</i></p> <p>Fungal spores</p>	<p>GMP, GHP, cooking temperature, time</p> <p>Use potable water for cooking</p>	<p>Yes</p>	<p>Coking temp 90-100°C</p> <p>Time 20-30 min</p> <p>Use potable water</p>	<p>Portable Water , thickness of paste</p>	<p>Apply more heat, Cook for more time, Adjust water and flour ratio</p>	<p>Keep records</p>

**Table 4.4**

Product description and intended use

1. Product name(s)	<i>Tuo zaafi</i>
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a slurry by adding water and cooked to form a paste and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Take 4 parts of cold water and 2 parts of flour. Mix the flour with 2 parts of water and boil the remaining 2 parts and add salt to taste. Fold the mix dough into the boiling water and stir with a wooden ladle on low heat until well blended and cooked to desired consistency (10-12 minutes). Add more water if preferred. Mould cooked <i>Tuo zaafi</i> meal into balls and serve with any stew of your choice.
9. Special distribution control	Store in dry place





**Figure 5.1**

Process flow diagram (PFD) for the production of *banku mix*.

**Table 5.1**Worksheet-Standard operating procedures (SOP's) for the production of *banku mix*

<b>Process step</b>	<b>Standard operating procedures</b>
4: 1 <sup>st</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Pour maize into water and stir to wash</li> </ol>
6: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls and sieves thoroughly</li> <li>3. Use clean water</li> <li>4. Pour maize into water and stir to wash</li> <li>5. Drain maize in clean water</li> </ol>
5. Steep in water for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Steep maize in water</li> <li>4. Cover bowl with nets</li> <li>5. Check daily</li> </ol>
7: Mill using a disc attrition mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean the receptacle</li> <li>3. Clean discs</li> <li>4. Test-run machine</li> <li>5. Introduce product.</li> </ol>
8. Ferment for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Mix dough thoroughly</li> <li>4. Cover bowl with nets</li> <li>5. Check daily.</li> </ol>
9. Spread on metal plates(Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
10. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

**Table 5.2**

Worksheet-Process step, hazard and source and their control measures for the production of *banku mix*

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw materials Dried maize	Vegetative pathogens  Fungi Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilisers Insecticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP QA GAP, QA GAP, QA
2. Sort by hand	Vegetative pathogens	Processor	GPH GMP
4. 1 <sup>st</sup> wash	Vegetative pathogens Fungal spores  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
5. Steep in water for 3 days	Vegetative pathogens	Unclean water Contaminated water for fermentation Processor	GHP, GPH, GMP
6. 2 <sup>nd</sup> wash	Vegetative pathogens  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
7. Mill using disc attrition mill	Vegetative pathogens  Oil/grease Metal fragments	Mill  Mill Mill/teething chipping off	GMP  GMP GMP

	Fungal spores	Surrounding air	GMP
8. Ferment in water for 3 days	Vegetative pathogens  Fungal spores	Contaminated water for fermentation Contaminated bowls Processor  Surrounding air	GMP  GHP GMP
9. Spread on metal plates by hand (Drying)	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP
10. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
11. Add fermented cassava dough	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
12. Mix	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
13. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
14. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
15. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP

**Table 5.3**

HACCP Plan for the production of *banku mix*

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Heavy metals and pesticides/insecticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
2	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
4	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
6	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> Fungal spores Metal pieces Oil/grease	GMP	None				



5	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>  Fungal spores	GMP, GHP,	Yes	Availability of fermented microbes,	Fermentation odour	1.Cleaning of grains 2.Clean water 3. Clean bowls 3.Appropriate for 3days. 4.Expose product	Keep records
8	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>  Fungal spores	GMP, GHP,	Yes	Availability of fermented microbes,	Fermentation odour	1.Cleaning of grains 2.Clean water 3. Clean bowls 3.Appropriate for 3days. 4.Expose product	Keep records
9	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Mycotoxin	GMP, GHP, Drying time, air temperature, particle size, thickens of layer for drying, moisture content	Yes	Temperature 60-70 °C Time 7-9 hours Particle size > mm Layer thickness < mm	Temperature Time Particle size Layer thickens Moisture content	Re-dry if temp and time too low or particle size and layer thickness exceeded. Change particle size and adjust layer thickness	Keep records
10.	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Oil/grease Metal pieces	GMP, GHP	None				
11.	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus</i>	GMP, GHP	None				

	<i>aureus</i> Fungal spores Moisture						
12, 13, 14	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None				
15	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp 90-100°C Time 20-30 min Use potable water	Portable Water, thickness of paste	Apply more heat, Cook for more time, Adjust water and flour ratio	Keep records

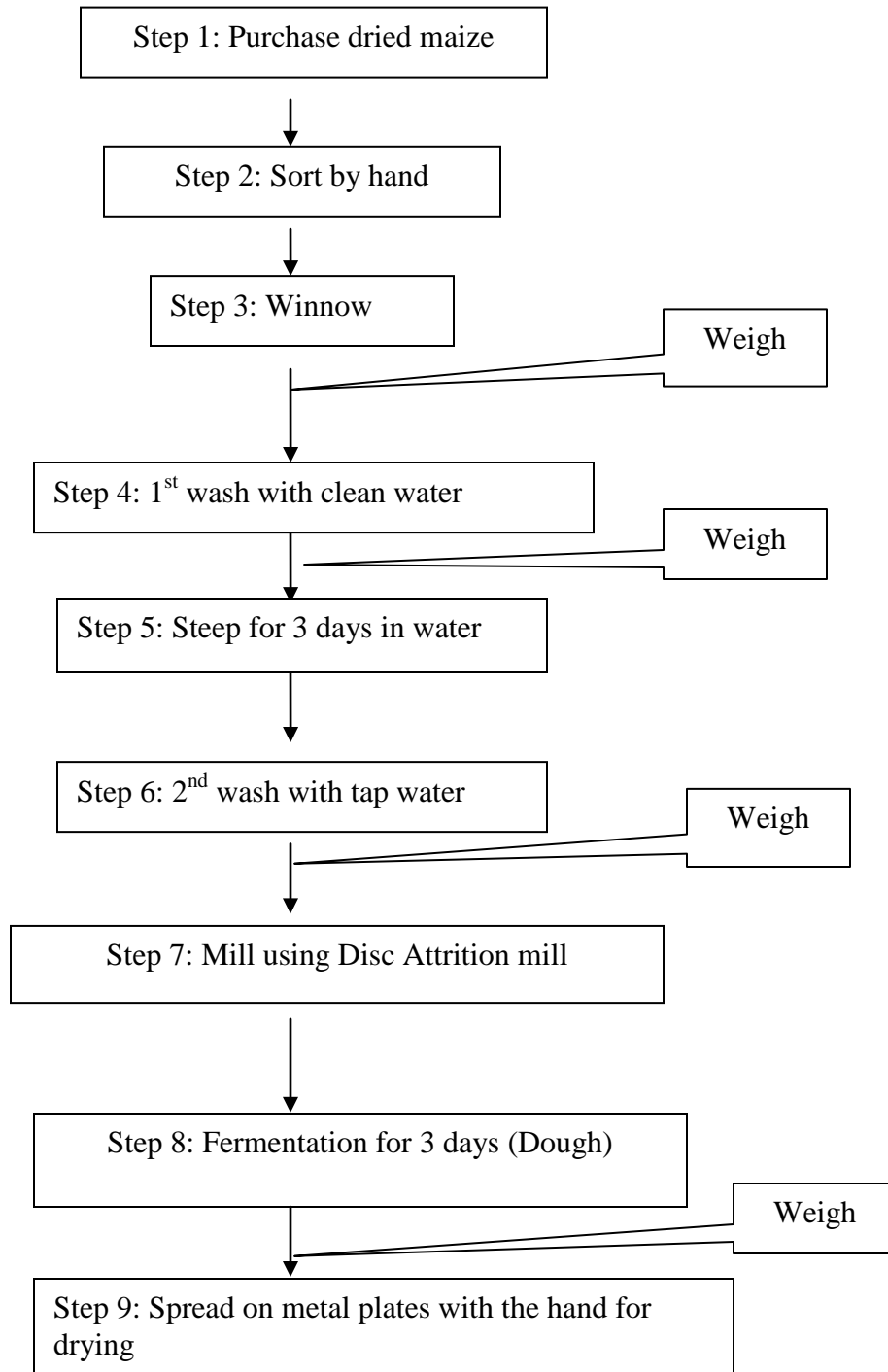
**Table 5.4**

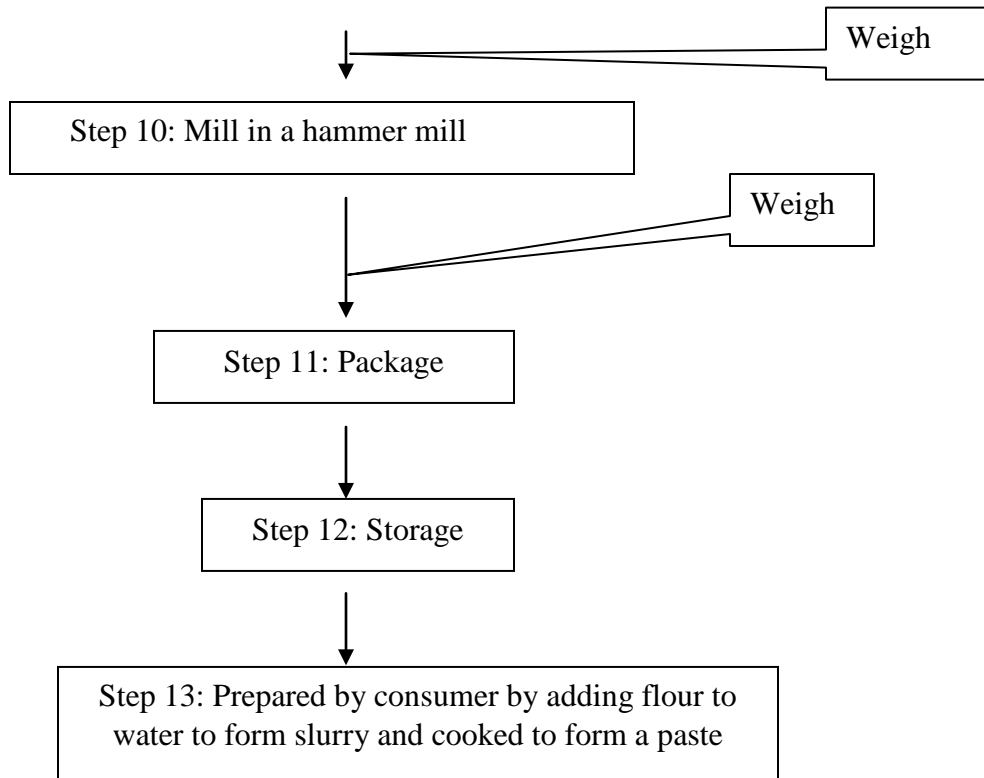
Product description and intended use

1. Product name(s)	<i>Banku</i> mix
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a slurry by adding water and cooked to form a paste and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Add 200g of flour to 6dl cold water, mix the flour with 3dl water, boil the rest (3 dl water), add salt to taste. Fold the mix dough into the boiled water and stir with a wooden ladle on low heat till well blended and cooked to desired consistency (10-12 minutes). Add more water if preferred. Mould cooked <i>banku</i> meal into ball and serve with any stew or soup of your choice.
9. Special distribution control	Store in dry place

## CHAPTER 6 FERMENTED MAIZE FLOUR

This flour is prepared from selected maize of high quality. Fermented maize flour is use in preparing porridge, *banku*, *kenkey* and *akple*.





**Figure 6.1**

Process flow diagram (PFD) for the production of fermented maize meal

**Table 6.1**

Worksheet-Standard operating procedures (SOP's) for the production of fermented maize meal

<b>Process step</b>	<b>Standard operating procedures</b>
4: 1 <sup>st</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Pour maize into water and stir to wash</li> </ol>
6: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls and sieves thoroughly</li> <li>3. Use clean water</li> <li>4. Pour maize into water and stir to wash</li> <li>5. Drain maize in clean water</li> </ol>
5. Steep in water for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Steep maize in water</li> <li>4. Cover bowl with nets</li> <li>5. Check daily</li> </ol>
7: Mill using a disc attrition mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean the receptacle</li> <li>3. Clean discs</li> <li>4. Test-run machine</li> <li>5. Introduce product.</li> </ol>
8. Fermentation for 3days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Mix dough thoroughly</li> <li>4. Cover bowl with nets</li> <li>5. Check daily.</li> </ol>
9. Spread on metal plates(Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
10. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

**Table 6.2**

Worksheet-Process step, hazard and source and their control measures for the production of fermented maize meal

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw materials Dried maize	Vegetative pathogens  Fungi Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilizers Insecticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP QA GAP, QA GAP, QA
2. Sort by hand	Vegetative pathogens	Processor	GPH GMP
4. 1 <sup>st</sup> wash	Vegetative pathogens Fungal spores  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
5. Steep in water for 3 days	Vegetative pathogens	Unclean water Contaminated water for fermentation Processor	GHP, GPH, GMP
6. 2 <sup>nd</sup> wash	Vegetative pathogens  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
7. Mill using disc attrition mill	Vegetative pathogens  Oil/grease Metal fragments	Mill  Mill Mill/teething chipping off	GMP  GMP GMP

	Fungal spores	Surrounding air	GMP
8. Ferment in water for 3 days	Vegetative pathogens  Fungal spores	Contaminated water for fermentation Contaminated bowls Processor  Surrounding air	GMP  GHP  GMP
9. Spread on metal plates by hand (Drying)	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP
10. Milling in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
11. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
12. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
13. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP



**Table 6.3**

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Heavy metals and pesticides/insecticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
2	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
4	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
6	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> Fungal spores Metal pieces Oil/grease	GMP	None				

5	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>  Fungal spores	GMP, GHP,	Yes	Availability of fermented microbes,	Fermentation odour	1.Cleaning of grains 2.Clean water 3. Clean bowls 3.Appropriate for 3days. 4.Expose product	Keep records
8	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and Spores <i>Bacillus cereus</i> <i>Clostridium spp.</i>  Fungal spores	GMP, GHP,	Yes	Availability of fermented microbes,	Fermentation odour	1.Cleaning of grains 2.Clean water 3. Clean bowls 3.Appropriate for 3days. 4.Expose product	Keep records
9	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Mycotoxin	GMP, GHP, Drying time, air temperature, particle size, thickens of layer for drying, moisture content	Yes	Temperature 60-70 °C Time 7-9 hours Particle size > mm Layer thicknesses < mm	Temperature Time Particle size Layer thickens Moisture content	Re-dry if temp and time too low or particle size and layer thickness exceeded. Change particle size and adjust layer thickness	Keep records
10.	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Oil/grease Metal pieces	GMP, GHP	None				
11.	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus</i>	GMP, GHP	None				

	<i>aureus</i> Fungal spores Moisture						
12	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None		14		
13	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp 90-100°C Time 20-30 min Use potable water	Portable Water , thickness of paste	Apply more heat, Cook for more time, Adjust water and flour ratio	Keep records

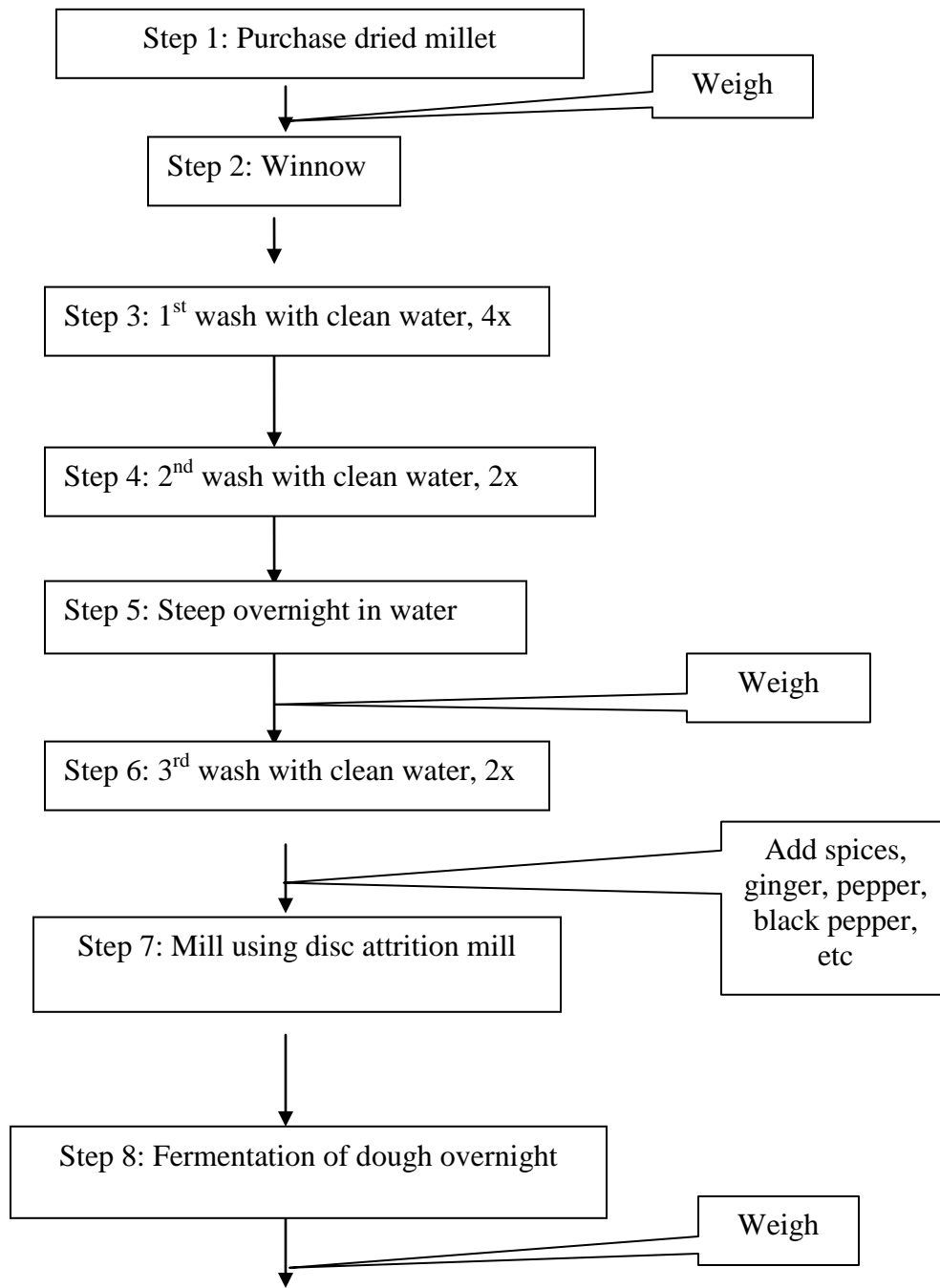
**Table 6.4**

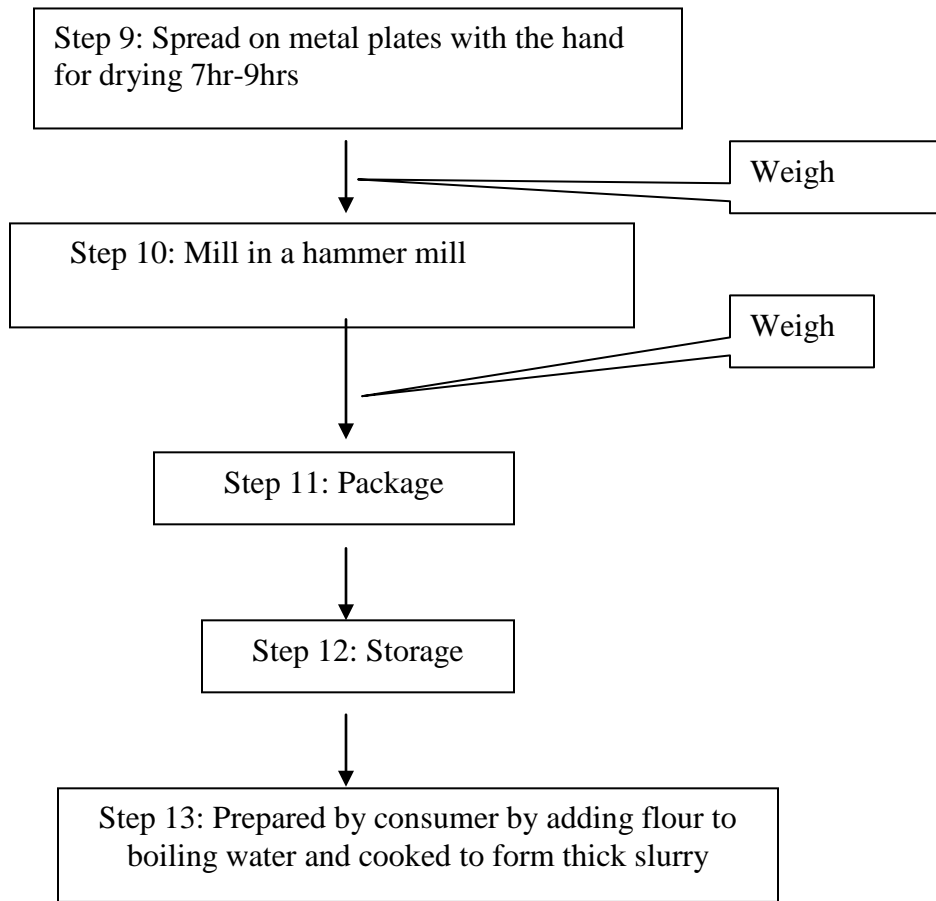
Product description and intended use

1. Product name(s)	Fermented Maize meal
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a slurry by adding water and cooked to form a paste and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Take 2 parts of water, 1 part of flour and boil in a saucepan. Add the flour to boiling and stir with a wooden ladle till cooked between 10-15 minutes. Add or reduce water according to required consistency. Serve with any stew or soup of your choice.
9. Special distribution control	Store in dry place

## CHAPTER 7 HAUSA KOKO

This is a specialty breakfast drink or porridge enjoyed by a majority of people. *Hausa koko* is prepared from millet and spices which depends on the choice of the processor.





**Figure 7.1**

Process flow diagram (PFD) for the production of *Hausa koko*

**Table 7.1**Worksheet-Standard operating procedures (SOP's) for the production of *Hausa koko*

<b>Process step</b>	<b>Standard operating procedures</b>
3: 1 <sup>st</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Pour maize into water and stir to wash</li> </ol>
4: 2 <sup>nd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Pour maize into water and stir to wash</li> </ol>
6: 3 <sup>rd</sup> wash with clean water	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Wash bowls and sieves thoroughly</li> <li>3. Use clean water</li> <li>4. Pour maize into water and stir to wash</li> <li>5. Drain maize in clean water</li> </ol>
5. Steep in water overnight	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Steep maize in water</li> <li>4. Cover bowl with nets</li> <li>5. Check daily</li> </ol>
7: Mill using a disc attrition mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean the receptacle</li> <li>3. Clean discs</li> <li>4. Test-run machine</li> <li>5. Introduce product.</li> </ol>
8. Fermentation for 3 days	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Use clean water and bowls</li> <li>3. Mix dough thoroughly</li> <li>4. Cover bowl with nets</li> <li>5. Check daily.</li> </ol>
9. Spread on metal plates(Drying)	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and head gear</li> <li>2. Clean trays (clean water/ metabisulphite)</li> <li>3. Allow trays to dry</li> <li>4. Put trays into dryers</li> <li>5. Set into 70°C</li> <li>6. Check after 7 hours</li> </ol>
10. Mill in a hammer mill	<ol style="list-style-type: none"> <li>1. Wear gloves, nose musk and headgear</li> <li>2. Clean filters before and after milling</li> <li>3. Clean the receptacle</li> <li>4. Clean sifters, blades and hammers</li> <li>5. Test-run machine</li> <li>6. Replace filters</li> <li>7. Introduce product.</li> </ol>

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**Table 7.2**

Worksheet-Process step, hazard and source and their control measures for the production of *Hausa koko*

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1. Raw materials: Dried millet	Vegetative pathogens  Fungi spores Heavy metals  Insects and pests Sand	Faecal contamination on the farm, transport, human carriers,  Soil and air Pesticides/insecticides used  Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP QA GAP, QA GAP, QA GAP, QA
2. Winnow	Vegetative pathogens	Processor	GPH GMP
3: 1 <sup>st</sup> wash 4: 2 <sup>nd</sup> wash 6: 3 <sup>rd</sup> wash	Vegetative pathogens Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor	GHP, GPH
5: Steep 8: Ferment	Vegetative pathogens	Unclean slicer Contaminated water for cleaning Operator	GHP, GPH
7. Mill with disc attrition mill	Vegetative pathogens Fungal spores Oil/grease Metal pieces	Air and improper cleaning of mill Chipping off occurring in mill teeth, Processor	GHP, GMP,
9. Spread on metal plates by hand for drying	Vegetative pathogens Fungal spores	Processor Trays Contaminated air	GPH, GHP
10. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil/grease Metal fragments	Processor Surrounding air, Mill	GPH,GHP,GMP
11. Package(	Vegetative	Processor	GPH, GHP



hand, double bags and double seal)	pathogens Fungal spores	Surrounding air, Containers	
12. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
13. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP

**Table 7.3**

HACCP Plan for the production of *Hausa koko*

<i>List</i>							
Step	Hazard (s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Diseased roots Heavy metals and pesticides Insects and pests	Inspection Supplier accreditation, GAP, GMP, GHP	None				
3, 4 and 6	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using water from storage tank	Treat storage water with chlorine	Use appropriate chlorine levels	Discard water if too high or low levels of chlorine are used	Keep records
5 and 8	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i>	GMP, GHP	Yes	Availability of fermenting microbes	Fermentation odour	Clean grains properly, Use clean water and bowls, ferment for one day, Expose product	Keep records
7	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i>	GMP, GHP	None				
9	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Mycotoxin	GMP, GHP, Drying time, air temperature, particle size, thickens of layer for drying, moisture	Yes	Temperature > °C Time > min Particle size > mm Layer	Temperature Time Particle size Layer thickens Moisture content	Re-dry if temp and time too low or particle size and layer thickness exceeded.	Keep records

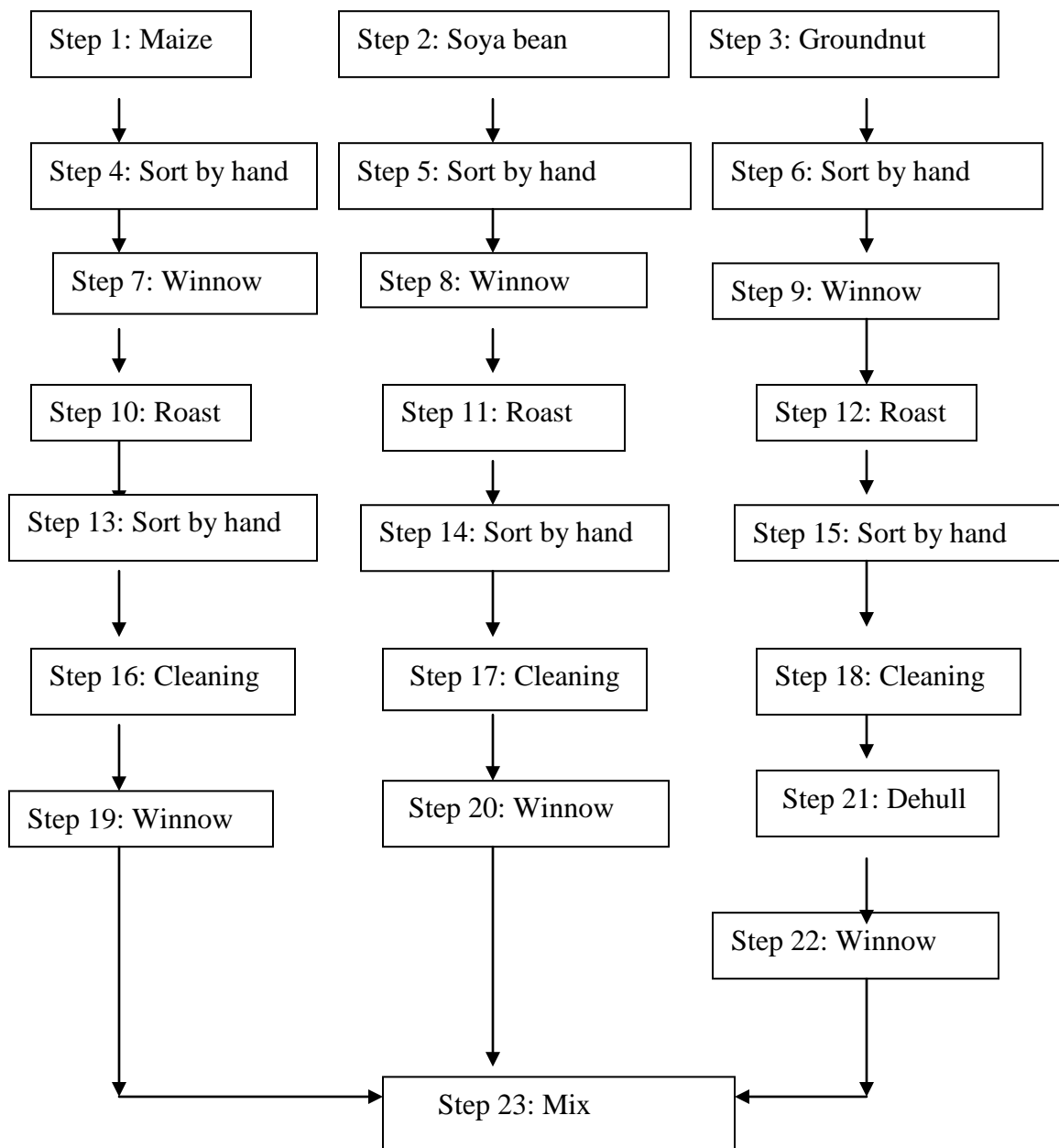
		content		thickness < mm		Change particle size and adjust layer thickness	
10	Vegetative pathogens such as <i>E. coli</i> , <i>Vibrio Cholerae</i> , <i>Salmonella spp.</i> , <i>Staphylococcus aureus</i> Fungal spores Oil/ grease Metal pieces	GMP, GHP	None				
11	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture	GMP, GHP	None				
12	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None				
13	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp > 90-100°C Time > 10-15 min Use potable water	Potable water cooked to thick slurry	Apply more heat, Cook for more time, Adjust water and flour ratio	

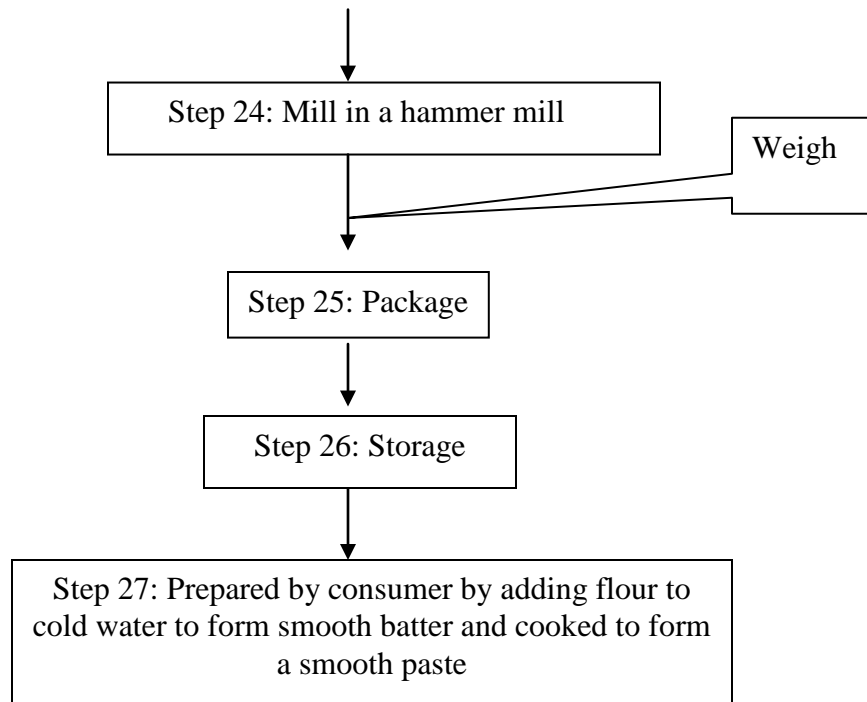
**Table 7.4**Product description and intended use of *Hausa koko*

1. Product name(s)	<i>Hausa koko</i>
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a thick slurry by cooking with water and eaten
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Add 100g flour to 5 dl of cold water (salt optional) and blend flour with 2 dl water to a smooth batter. Boil rest of water (3 dl), add salt if used. Pour the batter into the boiled water stirring gently with a wooden ladle on low heat till smooth and cooked (4-5 minutes).
9. Special distribution control	Store in dry place

## CHAPTER 8 FORTIFIED TOM BROWN

This is a winimix ideal for weaning infants and serves as a morning breakfast for the family. It is prepared from a blend of high quality maize, soya beans and groundnuts. Fortified Tom Brown is ideal food for malnutrition in vulnerable groups like refugees and school children as well as protein-deficient infants and good for recuperating patients.





**Figure 8.1**

Process flow diagram (PFD) for the production of *fortified Tom Brown*

**Table 8.1**

Worksheet-Standard operating procedures (SOP's) for the production of *fortified Tom Brown*

<b>Process step</b>	<b>Standard operating procedures</b>
1- 22: Sort, winnow, roast and clean grains	1. Wear gloves, nose musk and head gear 2. Sort grains properly
24. Mill in a hammer mill	1. Wear gloves, nose musk and headgear 2. Clean filters before and after milling 3. Clean the receptacle 4. Clean sifters, blades and hammers 5. Test-run machine 6. Replace filters 7. Introduce product.

**Table 8.2**

Worksheet-Process step, hazard and source and their control measures for the production of *fortified Tom Brown*

<b>Process step</b>	<b>Hazard</b>	<b>Source</b>	<b>Control measures</b>
1, 2 and 3. Raw materials dried maize, soyabean and groundnut	Vegetative pathogens  Fungi Insects and pests Sand	Faecal contamination on the farm, transport, human carriers, fertilizers Insecticides used Soil and air Soil	GAP, GHP, Supplier assurance.  GAP(sorting) GAP QA GAP, QA GAP, QA
4, 5, 6 and 13, 14 15: Sort by hand	Vegetative pathogens Fungal spores	Processor Surrounding air	GPH GMP
7, 8, 9 and 19, 20 and 22: Winnow	Vegetative pathogens Fungal spores  Fungal spores	Contaminated water (tap, well, underground tank) Washing bowls Processor Surrounding air	GHP, GPH
23. Mix	Vegetative pathogens Fungal spores	Processor Surrounding	GPH, GHP

		air, Containers	
24. Mill in a hammer mill	Vegetative pathogens Fungal spores Oil grease Metal fragments	Processor Surrounding air, Miller Mill	GPH,GHP,GMP
25. Package (hand, double bags and double seal)	Vegetative pathogens Fungal spores	Processor Surrounding air, Containers	GPH, GHP
26. Storage	Vegetative pathogens Fungal spores Insects, pests and Rodents	Unclean surroundings, Surrounding air	GMP
27. Prepared by consumer	Vegetative pathogens Fungal spores	Consumer, Surrounding air Water supply, Unclean bowl and stirrer	GPH, GHP



**Table 8.3**

HACCP Plan for the production of *fortified Tom Brown*

<i>List</i>							
Step	Hazard(s)	Control measure(s)	CCPs	Critical limits	Monitoring procedure(s)	Corrective action(s)	Record (s)
1-6	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> , Fungi Heavy metals and pesticides/insecticides Insects and pests	Inspection Supplier accreditation, Sorting, GAP, GMP, GHP	None				
13-22	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> , <i>Salmonella</i> , <i>Listeria</i> , <i>Shigella</i> , <i>Bacillus cereus</i> , <i>Clostridium spp.</i> Fungal spores	GMP, GHP	None				
23	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> , <i>Vibrio cholerae</i> , Fungal spores	GMP, GHP	Yes Using appropriate proportions	Use scales for measuring proportions	Use appropriate of the 3 materials	Re mix with appropriate proportions	Keep records
24	Vegetative pathogens such as <i>E. coli</i> , <i>Staphylococcus aureus</i> and <i>Bacillus cereus</i> Fungal spores Metal pieces Oil/grease	GMP	None				
25.	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella spp.</i> , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture	GMP, GHP	None				

26	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> spp. , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores Moisture Insects, pests Rodents	GMP, GHP	None				
27	Vegetative pathogens such as <i>E. coli</i> , <i>Salmonella</i> spp. , <i>Vibrio cholerae</i> , <i>Staphylococcus aureus</i> Fungal spores	GMP, GHP, cooking temperature, time Use potable water for cooking	Yes	Coking temp 90-100°C Time 20-30 min Use potable water	Portable Water , thickness of paste	Apply more heat, Cook for more time, Adjust water and flour ratio	Keep records

**Table 8.4**

Product description and intended use

1. Product name(s)	Tom Brown (Winimix)
2. Important product characteristics of end product (eg. $A_w$ , pH, etc.)	Moisture content of 6% (w/w)
3. How the product is to be used	Made into a slurry by adding water and cooked to form a paste and eaten immediately
4. Packaging	Double wrapped plastic bags in fibre board box or only in double wrapped plastic bags
5. Shelf-life	1.5 to 2 years
6. Where the product will be sold	Shops in Ghana and export
7. Users	Everyone including children, elderly and the sick
8. Labelling instructions	Boil 3 cups of water, mix 1 cup winimix with 1 cup cold water to a smooth batter. Pour the batter into the boiling water and stir to a smooth paste, sweeten to taste and serve.
9. Special distribution control	Store in dry place

## GLOSSARY

FRI.....	Food Research Institute
EU.....	European Union
SMEs.....	Small and Medium Scale Enterprises
SOP.....	Standard Process Flow
QA.....	Quality Assurance
HACCP.....	Hazard Analysis Critical Control Point
CCPs.....	Critical Control Points
PFD.....	Process Flow Diagram
SOP.....	Standard Operating Procedures
GAP.....	Good Agriculture Practices
GMP.....	Good Manufacture Practices
GPH.....	Good Personal Hygiene
GHP.....	Good Hygienic Practices