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Contents

1. Introduction

This report discusses the compliance with international requirements for quality and safety of each of the ten traditional food products and production processes under study in the African Food Tradition rEvisited by Research (AFTER) project. The products and processes were evaluated for compliance with EU domestic quality and safety standards.

The study also aimed to identify the stage of product development from each raw material and to determine the amount and direction of research and optimisation work needed to facilitate commercialisation of products.

2. Determining the scope of benchmarking

2.1 Background:

All European Union (EU) food regulations and standards aim to protect European consumers and to prevent unsafe food from entering the EU market.

Currently none of the existing products (akpan, gowé, kenkey, kishk Sa'eedi, lanhouin, kitoza, kong, baobab, bissap or jaabi) investigated in the AFTER project are certified to meet recognised food safety standards like ISO 22000, Good Manufacturing Practice (GMP) or Hazard Analysis Critical Control Point (HACCP). The latter is not a formal requirement for export, but a voluntary certification system provided by a private company. If re-engineered AFTER products are to enter mainstream markets, food management certification (such as HACCP certification) may be necessary, because it is demanded by customers and importers.

Food quality and safety standards can be classified as (formal) mandatory public regulations and (informal) voluntary private standards. Formal public regulations usually describe legal and technical aspects and specifications whereas informal private standards also deal with market-related, environmental, social or logistical issues. Four levels of regulation setting organizations can be distinguished:

- multilateral standard ruling (e.g. World Trade Organisation - WTO) and multilateral standard setting organizations (Codex Alimentarius)

- supra-national standard setting organizations e.g. trading blocs such as the EU

- national standard setting organizations e.g. EU member states

- private industry and trade (corporate standards)

Mandatory regulations and voluntary standards are becoming increasingly interlinked with e.g. members of the WTO having to adapt their standardisation policies at the multilateral and national levels (Food Quality and Safety Standards, 2007) Voluntary standards increasingly become *de facto* requirements ("soft law") for producers, processors and distributors in their quest for competitiveness in international markets. The regulatory

environment, to which traditional products would have to conform for international market entry, is therefore becoming increasingly complicated.

Food related regulations and standards fall into one of 3 categories:

- Food quality standards such as International Organisation for Standardization (ISO) standards (ISO 22000)
- Food safety standards e.g. HACCP for safe production
- Social and ecological standards e.g. environmental labelling, organic farming

The principals of food safety deal with issues such as integration of 'farm to table' production, traceability, transparency and communication, risk analysis and adequate record keeping (Will & Guenther, 2007).

2.2 Scope of this study:

This report deals only with benchmarking of existing products and production processes against international safety standards as well as HACCP principals, which would be the minimum requirements for EU market entry. HACCP is a voluntary but useful certification system which is increasingly required by EU importers. Most of the traditional products studied in AFTER are produced by processes which have not been formally documented or described in terms of HACCP. Nevertheless, this report will also attempt to review the level of compliance with HACCP principals for each product.

The report should also assist in determining the developmental stage of the currently existing products and the nature (and extent) of re-engineering required for EU marketability. Re-engineering to overcome trade barriers other than food safety regulations (e.g. niche market certification, environmental impact and intellectual property status) will be discussed in more detail in reports by the respective workpackage leaders in the three product groups.

3. Compliance of traditional products/processes with international standards per product

The aim of EU import standards for foodstuffs is to protect the right of EU citizens to safe food and to prevent unsafe food imports from reaching consumers. While these standards could affect the economies of developing countries (Otsuki *et al*, 2001), the traditional products investigated in AFTER would have to comply with existing EU food legislation and market norms to enable export to the EU.

Criteria used as benchmark:

The production processes for each existing AFTER product have been surveyed and the current safety situation has been assessed by analyses. This information was used to benchmark or compare current processes and products against European safety and import standards. This data will be useful to characterise the developmental stage of the process as it provides information on how much research and optimisation work will be needed to export products to Europe or transfer the technology for its manufacturing to Europe.

- Applicable EU General Food Laws:

The Microbiological Criteria applicable to foodstuffs: EC Directive 2073/2005

and EU 178/2002 General principals of Food Law at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002R0178:EN:NOT

EU 852/2004 Hygiene of Foodstuffs at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:226:0003:0021:EN:PDF

EU 853/2004 Hygiene of Foodstuffs from animal origin (POAO) at:

http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2004:139:0055:0205:EN:PDF

EC 1881/2006 Maximum levels of certain contaminants in foodstuffs

- and HACCP: a voluntary certification system which is often required by EU importers. It could form part of the ISO 22000 food management system and certifies that the production process is executed according to well-documented food safety principals to eliminate food safety risks. Although most of the traditional products studied in AFTER are produced by processes which have historically integrated HACCP principals (by experience passed on over generations), these have mostly not been formally documented or described (except for kenkey).

GROUP 1 FERMENTED CEREAL PRODUCTS

3.1 Akpan:

Akpan is a ready-to-drink cereal-based beverage with a shelf-life of 2 days at ambient temperature or 8 days at 4°C (Madodé, 2003). It is traditionally produced in Bénin by women in home-based or small family enterprises. The variability in the raw materials and processing methods used can lead to high inconsistency in the nutritional, microbiological and sensory qualities of the products. The end products are therefore not standardised and could also have several end uses, for example as an ingredient for a beverage, a snack or porridge.

Not much research has been documented about the nutritional quality of akpan (especially after addition of flavourants and other additives). The microbiological profile of akpan is similar to that of ogi, an intermediate product. The low pH is crucial and prevents the growth of Enterobacteriaceae. As a fermented wet product, akpan becomes too sour during prolonged storage, leading to deterioration in sensory quality.

After 7 to 10 days of storage, some contaminants become visible on the surface of the product. At this stage, the majority of producers/sellers recount that they observe larvae and a layer of dirt on akpan. In addition, the products are sometimes contaminated by ants and flies, mainly from the concentrated sweet milk and sugar used as additives.

Due to the increasing EU consumer demand for non-dairy beverages, akpan, commonly known as “vegetal yoghurt”, could become of greater economic significance. Bénin will have a competitive advantage over other countries if it improves these products with specific sensory and safety attributes.

Akpan: Compliance with EU safety and quality standards:

- **EU General Food Law** EC 178/2002 and EC 2073/2005

Sensory, microbiological, chemical and nutritional analyses were performed on akpan and intermediary products and the results of the microbiological analyses are represented in Table 1.

The high lactic acid bacterial count (due to fermentation) is also reflected in the high total microbial count. The low count or absence of Enterobacteriaceae*, Escherichia coli* (*E. coli*) and food pathogens in the tested samples indicate that hygienic production practices were adequately implemented. The pH of the products was lowered by fermentation and this prevented the growth of Enterobacteriaceae and food pathogens and products therefore comply with EU regulatory requirements.

The relatively high yeast and mould count is however cause for concern and the results of the mycotoxin tests (not all available yet) could affect the generally favourable benchmarking score of this product. In terms of food safety, mycotoxins could be considered as the major trade constraint for traditionally fermented cereal products. EC 1152/2009 and 165/2010 describe the maximum allowable levels for mycotoxins with e.g. total allowable aflatoxins at 4 ppb in cereals. The internal Beninese regulations (Departmental order

n°362/maep/d-cab/sgm/drh/dp/sa, October 30th, 2007) correspond to the EU regulations and also require a maximum of only 2 ppb aflatoxin B1 in cereal products. Four products out of seven did not comply with Codex level and five did not comply with EU standards according to Table 2. Aflatoxin level is thus a very important safety risk point for the reengineering of akpan.

In terms of physico-chemical quality, studies have been limited to pH (~4.4) and viscosity; further research is needed to identify dextrin profiles and aroma components. In addition data on particles size and degree of gelatinization are needed. To achieve reproducible quality it could be necessary to control the fermentation of the ogi by the use of a starter culture or combination of starter cultures.

Table 1. Inventory of the technological flora and pathogenic germs of akpan

Microorganisms $Log_{10}CFU/1\ g$	SOP number	Process and raw material used							
		Sorghum ogi		Sorghum dough		Maize ogi		Maize and sorghum mixed dough	
		Number of samples	Mean[a] +/-SD	Number of samples	Mean[a] +/-SD	Number of samples	Mean[a] +/-SD	Number of samples	Mean[a] +/-SD
Enumeration of microorganisms	Micro-01, ISO 4833	6	5.9 ± 1.7	6	7.0 ± 0.5	6	6.2 ± 1.1	6	6.5 ± 0.8
Enterobacteriaceae	Micro-02, ISO 21528-2	6	<1	6	<1	6	<1	6	<1
Escherichia coli	Micro-03, ISO 16649-2	6	<1	6	<1	6	<1	6	<1
Bacillus cereus	Micro-04, ISO 7932	6	<1	6	<1	6	<1	6	<1
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	6	Absence	6	Absence	6	Absence	6	Absence
Listeria monocytogenes	Micro-06, ISO 11290-1/A1:2004	6	Absence / 25 g	6	Absence / 25 g	6	Absence / 25 g	6	Absence / 25 g
Salmonella	Micro-07, ISO 6579:2002	6	Absence / 25 g	6	Absence / 25 g	6	Absence / 25 g	6	Absence / 25 g
Clostridium perfringens	Micro-08, ISO 7937	6	<1	6	<1	6	<1	6	<1
Yeasts and moulds	Micro-09, ISO 7954	6	5.4 ± 0.8	6	6.1 ± 5.6	6	5.2 ± 1.2	6	6.8 ± 0.5

Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	6	5.7 ± 0.8	6	6.5 ± 0.4	6	5.9 ± 1.0	6	6.7 ± 0.8
a = $\log_{10}$ colony forming units per g/ml									

Table 2. Results for chemical safety of akpan

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Process/Raw material used							
			Sorghum ogi		Sorghum dough		Maize ogi		Maize and sorghum mixed dough	
			Number of samples	Values	Number of samples	Values	Number of samples	Values	Number of samples	Values
Aflatoxins **(µg/kg)** B1 B1 +B2+G1+G2		UAC @ FRI	2	1.3/**8.8** 2.1/**12.0**	1	**11.2** **17.7**	2	0.4/**38.5** 0.7/**47.9**	2	**2.4**/**59.7** 3.1/**66.8**
Ochratoxin A		UAC @ FRI	NA							
Fumonisin		UAC @ FRI								

-HACCP for akpan

Microbiological safety of foodstuffs is best addressed by the implementation of a HACCP system. Akpan is not formally traded in the European Union (EU) at present so no market research is available. No HACCP study has been performed on the akpan production process to assess the compliance with safety standards. Fandohan et al. (2005) studied the fate of aflatoxins and fumonisins during the processing of maize into food products in Benin, among which ogi used to prepare akpan. According to these authors, on one hand, sorting, winnowing, washing, crushing combined with dehulling are unit operations that appeared to be effective in mycotoxins removal from the products. On the other hand, the use of ogi supernatant to prepare beverage like akpan can be harmful as mycotoxins can move from the ogi matrix into the supernatant. Overall, control points which should be considered in such a study would be:

- The quality of raw material (presence of mycotoxins, foreign materials in maize/sorghum)
- The hygienic conditions of the equipment (mill, vessels) and production environment.
- The quality of water added for preparation of the dough and fermentation
- The pH of the fermented product (critical)
- Quality of flavourants and other additives
- Storage time and temperature

The use of commercial starter cultures could standardize the fermentation process and lengthen the shelf-life period. This process has already been implemented with a similar product (mageu) in South Africa, which is commercially produced in compliance with HACCP conditions.

HACCP implementation would favourably influence the chances of akpan export to the EU especially in supplying documentation to support traceability required by the EU General Food Law EC 178/2002.

3.2 Gowé:

Gowé is a traditional Beninese beverage made by fermentation of a blend of malted and non-malted sorghum or maize flour. Gowé is a sour and sweet paste with a specific aroma consumed after dilution in water. Ingredients such as sugar, ice or milk are added according to taste. Gowé can be stored for 3 days at ambient temperature and up to 8 days refrigerated at 4°C (Vieira-Dalodé, 2008). The probiotic properties of the product (due to the lactic acid fermentation) have attracted interest with at least one patent registered.

Gowé: Compliance with EU safety and quality standards:

- **EU General Food Law** EC 178/2002 and EC 2073/2005

Sensory, microbiological, chemical and nutritional analyses were performed on gowé and intermediary products and the results of the microbiological analyses are represented in Table 3.

Table 3. Inventory of the technological flora and pathogenic germs of gowé

Microorganisms (Log10 CFU/1g)	SOP number	Process and raw material used							
		Malted and non-malted sorghum		Malted and non-malted maize		Malted and non-malted maize and steam cooking		Sorghum malted and non-malted maize mixed	
		Number of samples	Mean +/-SD	Number of samples	Mean +/-SD	Number of samples	Mean +/-SD	Number of samples	Mean +/-SD
Enumeration of microorganisms	Micro-01, ISO 4833	9	4.8 ±0.6	6	4.5 ±0.3	6	3.9 ±0.5	6	4.9 ±0.4
Enterobacteriaceae	Micro-02, ISO 21528-2	9	< 1	6	< 1	6	< 1	6	< 1
Escherichia coli	Micro-03, ISO 16649-2	9	< 1	6	< 1	6	< 1	6	< 1
Bacillus cereus	Micro-04, ISO 7932	9	Absence	6	Absence	6	Absence	6	Absence
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	9	Absence	6	Absence	6	Absence	6	Absence
Listeria monocytogenes	Micro-06, ISO 11290-1/A1:2004	9	Absence / 25g	6	Absence / 25g	6	Absence/ 25g	6	Absence/ 25g
Salmonella	Micro-07, ISO 6579:2002	9	Absence/ 25g	6	Absence / 25g	6	Absence/ 25g	6	Absence/ 25g
Clostridium perfringens	Micro-08, ISO 7937	9	Absence	6	Absence	6	Absence	6	Absence
Yeasts and moulds	Micro-09, ISO 7954	9	4.0 ±0.6	6	4.2 ±0.2	6	2.1 ±0.2	6	4.3 ±0.6
Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	9	4.8 ±0.2	6	4.3 ±0.5	6	2.4 ±0.4	6	4.8±0.4

The total microbial count, high lactic acid bacteria count and absence of Enterobacteriaceae and food pathogens indicate that the tested products were of acceptable hygienic standard in compliance with EU legislation. Some of the results of mycotoxin assays (ochratoxin A, fumonisin) were not yet available at the time of writing, but are of importance as the fungal and yeast counts were relatively high. Both the yeast and mould counts and the lactic acid counts were lower in samples which were processed by steam cooking. The results on aflatoxin are presented in Table 4 below.

Malted sorghum used in the production of one of the varieties of gowé had 10.7 ppb of aflatoxin B1 (exceeding the authorised EU limit of 2 ppb). Even though fermentation is expected to reduce this level, mycotoxins were still present in the final products above the allowable levels.

The Codex Alimentarius Commission (CAC, 1995) maximum permissible level of aflatoxins in ready to eat foods is 10 µg/kg (CAC, 1995). The permissible level is less than 4 µg/kg for total aflatoxin in Europe and less than 2 µg/kg for B1 for cereal products (CE 1181/2006). Irrespective of the gowé samples, aflatoxin B_1 was the main aflatoxin. Aflatoxin hazard was important for gowé prepared form maize with two samples (out of 5) presenting very high aflatoxin levels (13.4 and 34.5 µg/kg). For these samples, aflatoxins contamination was higher than maximum permissible level defined by the Codex Alimentarius Commission. In addition, three of these had aflatoxin levels higher than the recommended level for cereal products in Europe. Thus, consumption of gowé from maize in rural areas poses a risk of aflatoxin exposure and could not be exported to Europe. Re-engineering steps should therefore be taken to reduce this risk by e.g. ensuring that raw materials used (sorghum and maize) have low initial loads of mycotoxigenic fungi.

Table 4 : Mycotoxin content of gowé

Parameter and unit of measurement	Respon-sible partner and lab	Process/Raw material used							
		Malted and non-malted sorghum		Malted and non-malted maize		Malted and non-malted maize and steam cooking		Sorghum malted and non-malted maize mixed	
		Number of samples	Values	Number of samples	Values	Number of samples	Values	Number of samples	Values
Aflatoxins B1 B1+B2+G1+G2	UAC @ CIRAD	3	0.3/0.9/1.8 0.6/1.4/2.4	3	0.6/1.5/**28.6** 1.0/2.3/**34.5**	2	**7.8/15.7** **9.0**/**17.9**	0	
Ochratoxin A	UAC @ FRI	NA							
Fumonisin	UAC @ CIRAD								

-HACCP for gowé

HACCP assessment has not been performed on the gowé production process to assess the compliance with safety standards. Control points which should be considered in such a study would be:

- The quality of raw material (presence of mycotoxins, foreign materials in maize/sorghum)
- The quality of water added for preparation of the dough and fermentation
- The hygienic conditions of the equipment (mill, etc…) and production environment
- The pH of the fermented product (critical)
- Quality of flavourants and other additives
- Storage time and temperature

The use of commercial starter cultures could standardise the fermentation process and lengthen the shelf-life period.

As gowé is also a home-based/small scale product the implementation of HACCP would improve gowé export to the EU especially in supplying documentation to support traceability required by the EU General Food Law EC 178/2002

3.3 Kenkey:

In Ghana kenkey is a traditionally produced ready–to–eat staple food made from fermented maize. It consists of dumplings made from fermented maize dough which is wrapped in maize leaves and then boiled. It has a moisture content of about 62-68%, pH 3.7 and shelf-life of about 3 to 4 days without refrigeration.

Processing of maize into kenkey is an important activity in the food sector with substantial socio-economic impact. Kenkey is produced in home-based or small businesses of semi-commercial scale. Most of the producers work on their own while a few of them form small associations.

The substantial patent activity for kenkey (at least 11 patents) suggests that the product has properties which are commercially interesting. Re-engineering will have to take into account existing intellectual property rights and establish freedom to operate.

Kenkey: Compliance with EU safety and quality standards:

- **EU General Food Law** EC 178/2002, EC 1881/2006 and EC 2073/2005

Sensory, microbiological, chemical and nutritional analyses were performed on three types of kenkey and the results of the microbiological analyses indicated that the products conformed to EU safety regulations. The total microbial loads of the cooked products were very low (<10 colony forming units per gram) and levels of fungi and food pathogens were all well within EU allowable maximum limits. This indicates that sufficient process control is applied and that no post-processing contamination occurred.

Results of the mycotoxin analyses of kenkey are presented in Table 5. In line with the observed yeast and mould counts (only white kenkey supported the growth of a few fungal colonies) the mycotoxin levels were also low and mostly within EU allowable limits (below 2 ppb aflatoxin B1 and 4 ppb total aflatoxins). The Ga kenkey exceeded the levels of B1 aflatoxins, while low levels were measured in Fanti kenkey. No aflatoxin was detected in white kenkey and ochratoxin A was not detected in any of the tested varieties.

Of the three varieties it would appear that white kenkey is the safest in terms of mycotoxins. It is also the only variety which could be suitable as infant food with levels around 0.1 ppb.

Table 5. Results for chemical safety of kenkey

Parameter and unit of measurement	Process/Raw material used								
	Fanti-Kenkey			Ga-Kenkey			White-Kenkey		
	Number of Samples	Mean	SD	Number of Samples	Mean	SD	Number of Samples	Mean	SD
Aflatoxins (ug/kg)	5	0.48	0.59	5	2.83	1.32	5	0.11	0.05
Ochratoxin A (ug/kg)	5	Not detected		5	Not detected		6	Not detected	
Fumonisin									

-HACCP for kenkey

A HACCP system has been designed and implemented in a semi-commercial kenkey production process to assess the effect on product quality and safety (Amoa-Awua *et al*. 2006). Critical control points considered in the study were:

- The quality of raw material (presence of aflatoxins in maize kernels)
- The quality of water added for preparation of the dough and fermentation (enterotoxins from faecal contamination)
- The pH of the fermented product (faecal pathogens producing enterotoxins)
- Packaging (presence of aflatoxins)
- Cooking time and temperature (faecal pathogens)

During the study of HACCP implementation (Amoa-Awua *et al*. 2006), Good Manufacturing Practice (GMP) was first implemented as a prerequisite programme in the traditional operations to ensure the effectiveness of the quality system. The system was simplified to be conveniently integrated into the processing systems employed by traditional processors and relied on practical techniques such as visual examination, use of pH strips, and timing of operations to assure the safety of the product. Such a system is sustainable, but its effectiveness will depend on strict supervision and managerial commitment.

The study on the implementation of the combined GMP and HACCP system at minimal cost demonstrated that hazards which may be associated with the traditional practices can be effectively managed or controlled. Aflatoxin levels in the end products were significantly reduced. This demonstrates developmental progress in kenkey production and will facilitate commercialisation of the product in general. Re-engineering with the aim of exporting to the EU should definitely include the implementation of the HACCP system.

3.4 Kishk Sa'eedi:

Kishk Sa'eedi (KS) is an Egyptian homemade fermented food prepared from fermented buttermilk mixed with freshly harvested parboiled wheat. The mixture is again fermented and then cut up into small balls or unshaped nuggets and sun dried. It is sometimes eaten in the dry state, but often reconstituted in a little water to be consumed as a drink, or cooked in a variety of recipes.

KS is a (rural) home product, produced and principally consumed by the family and extended family; hence there is limited market distribution or information for KS.

KS: Compliance with EU safety and quality standards:

- **EU General Food Laws** EC 178/2002, EC 2073/2005 and POAO EC 853/2004 would apply.

As KS is a home-produced foodstuff proving compliance with hygiene regulations on e.g. premises, equipment, source of raw materials (such as milk from animal origin), water supply, transport etc. could be difficult. It could be somewhat more practical to provide a dossier documenting a history of safe use and consumption. Products would however still have to comply with EU regulations and current results indicate that some of the products do not meet these standards. Sensory, microbiological, chemical and nutritional analyses were performed on two types of KS and the results of the microbiological analyses are presented in Table 6.

Table 6. Results for inventory of the technological flora and pathogenic germs of kishk Sa'eedi (KS)

Microorganismes	SOP number	Responsible partner and lab	Process/Raw material used					
			Laban Zeeir			Kishk Sa'eedi		
			Number of Samples	Mean Log_{10}	SD	Number of Samples	Mean Log_{10}	SD
Enumeration of microorganisms	Micro-01, ISO 4833	FAAU@FAAU	41	5.0	0.99	14	6.83	0.50
Enterobacteriaceae	Micro-02, ISO 21528-2	FAAU@FAAU	41	2.15	0.71	14		1.4
Escherichia coli	Micro-03, ISO 16649-2	FAAU@FAAU	41	0	0	14	0	-
Bacillus cereus	Micro-04, ISO 7932	FAAU@FAAU	41	0	0	14	0	-
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	FAAU@FAAU	41	One sample positive	0	14	0	-
Listeria monocytogenes	Micro-06, ISO 11290-1/A1:2004	FAAU@FAAU	41	0	0	14	0	-
Salmonella	Micro-07, ISO 6579:2002	FAAU@FAAU	41	0	0	14	0	-
Clostridium perfringens	Micro-08, ISO 7937	FAAU@FAAU	41	0	0	14	0	-
Yeasts and moulds	Micro-09, ISO 7954	FAAU@FAAU	41	5.30	0.93	14	5.17	1.35
Lactic acid bacteria (LAB)	Micro-10,M-METH-MO-13	FAAU@FAAU	41	4.85	1.6	14	6.27	0.85

High levels of lactic acid bacteria (technological organisms resulting from the fermentation processes) are reflected in the high total aerobic count. However, some pathogenic germs (*Escherichia coli*, *Listeria sp., Clostridium sp.*, and *Salmonella sp.*) were encountered in KS, particularly in the first set of samples collected from street vendors. This also pointed out that handling and storage conditions is a critical point for this product that should be addressed during re-engineering.

The high levels of lactic acid bacteria in the products could represent a marketing opportunity based on its potential probiotic properties. For new dietary supplements regulatory EU approval must be sought for food supplements and food additives. This would apply to new probiotics for example, especially if functional claims are to be made (Traditional Herbal Remedy Directive and Dietary Supplements 2004/24/EC).

In spite of the high fungal load of kishk Sa'eedi, results of mycotoxin analyses showed that none of the seven samples tested had more than 10 ppb dry sample weight of either aflatoxins, ochratoxin A or fumonisins. It is possible that the prolonged fermentation stages removed or bound the mycotoxins. The levels of mycotoxins should be determined more accurately as low levels would improve the export potential of this product. In terms of food safety, mycotoxins could be considered as the major trade constraint for traditionally fermented cereal products. EC 1152/2009 and 165/2010 describe the maximum allowable levels for mycotoxins with e.g. total allowable aflatoxins at 4 ppb and 2 ppb for aflatoxin B1 in cereal products.

-HACCP for KS

As KS is strictly a home-produced product, HACCP assessment has not been performed on the production process, making it difficult to assess the compliance with safety standards. A HACCP study of KS production should investigate control points such as:

- The quality of raw material (hygienic quality of milk, presence of mycotoxins, foreign materials in wheat)
- The quality of water to wash wheat
- The pH of the fermented products – both the milk and the mixed product (critical)
- Sun-drying process (prevent dust, microbial or insect contamination)
- Storage time and temperature

The use of commercial starter cultures could standardise the fermentation process and lengthen the shelf-life period.

Due to the non-standardised nature of materials and processes used for the production of most home-based products, the implementation of HACCP would improve the likelihood of

export to the EU by enforcing a documented system to comply with traceability, transparency, labelling etc. requirements by the EU General Food Law EC 178/2002. Potential certification as Slow Food, functional (novel) food (containing probiotics) and intellectual property issues should be carefully considered before re-engineering of KS.

GROUP 2 MEAT AND FISH PRODUCTS

3.5 Lanhouin:

Lanhouin is a traditionally processed fermented fish product, widely used as a food condiment/taste enhancer in urban and rural areas in Southern Benin and in the neighbouring countries of Togo and Ghana. Lanhouin is processed by spontaneous fermentation causing degradative changes in the fish through microbiological and enzymatic activities and its production is largely artisanal.

Lanhouin: Compliance with EU safety and quality standards:

- **EU General Food Laws** EC 178/2002, EC 2073/2005 and POAO EC 853/2004

Lanhouin has market access to the EU, but food safety and contamination issues exist for this product. Also, traceability (to the fishing vessel) and managing fish harvesting could present a problem in the future.

According to the EC directives regarding **Products of Animal Origin (EC 853/2004**) and the **OIE Terrestrial Code**, meat products, fish, poultry and dairy products require prior approval of the public health condition applicable in the country before import into the EU. To export these products to the EU a country must be on the EU positive list. Benin is on the positive list for fisheries products and has 3 approved establishments.
(see https://webgate.ec.europa.eu/sanco/traces/output/FFP_BJ_en.pdf)

Environmental sustainability is increasingly becoming important in the EU and for fisheries products, proving that sustainable harvesting regimes are in place is increasingly required. To produce lanhouin the majority (95.0 %) of processors claimed that they mostly used Cassava croaker (*Pseudotolithus senegalensis*) followed by Lesser African threadfin (*Galeoides decadactylus*) (claimed by 88.6 %), Atlantic bumper (*Chloroscombrus chrysurus*) (claimed by 87.9 %), kingfish/Spanish mackerel (*Scomberomorus tritor*) (claimed by 81.4 %) and Crevalle jack (*Caranx hyppos*) (claimed by 77.1 %).

Certain species of fish are prone to **histamine** build-up during their post-harvest decomposition. This is dangerous to human health and the EU regulates it under EU 853/2004 (Table 7). The key species implicated in histamine contamination are: Scombridae

(mackerel, tuna, and bonito), Clupeidae (herring, sardine), Engraulidae (anchovy), Coryphaenidae (mahi mahi), Pomatomidae (bluefish) and Scomberesosidae (saury).

Table 7 EU histamine regulations

Food category	Maximum permitted level of histamine
Fishery products from fish species associated with a high amount of histidine	Nine samples to be taken, of which: the average histamine content must be 100mg/kg or less; no more than 2 samples may have levels between 100mg and 200mg/kg; and no sample may have a level above 200mg/kg.
Fishery products which have undergone enzyme maturation treatment in brine, manufactured from fish species associated with a high amount of histidine	Nine samples to be taken, of which: the average histamine content must be 200mg/kg or less; no more than 2 samples may have levels between 200mg and 400mg/kg; and no sample may have a level above 400mg/kg.

Source: http://www.seafish.org

Various biogenic amines including histamine, putrescine, cadaverine and spermidine were detected in variable amounts in the lanhouin samples analysed (Table 8). Independently to the variants of technology used for the processing, histamine content of less than 200 mg/kg was obtained in 87.0% of lanhouin samples made from from cassava fish (*Pseudotolothus* sp.) while 3% and 10% of samples showed histamine levels ranging between 200-400 mg/kg and exceeding 400 mg/kg respectively. Regarding lanhouin samples obtained from king fish (*Scomberomorus tritor*), 67% of them contained histamine levels less than 200 mg/kg, 3% of them had histamine contents of 200 mg/kg, and 13% had histamine contents ranging between 200-400 mg/kg while 17% showed histamine levels higher than 400 mg/kg. These results showed that the type of fish can impair the production of histamine.

In a previous study where lanhouin samples were purchased from processors, the histamine contents in most of the samples (75%) mainly obtained from king fish (*Scomberomorus tritor*), exceeded the recommended level of 200 mg/kg. In addition, the levels of putrescine, cadaverine and spermidine found in the lanhouin samples were high. This may increase the toxic effects of histamine as both putrescine, and cadaverine have been shown to potentiate histamine toxicity (Eitenmiller, 1980). However, no safe levels have been set for putrescine and cadaverine for human consumption. To achieve reproducible quality and to reduce the prouduction of histamine it could be necessary to control the fermentation by the use of single or mixed starter cultures, since microorganisme such as *Staphylococcus xylosus* can be use to control histamine production in meat product such as sausages. In this respect, some strains of technological microorganisms isolated from lanhouin can be used to develop starter culture.

Table 8: Results for chemical safety of Lanhouin

Parameter and unit of measurement	SOP number	Location and raw material used (Mean +/- SD)											
		Comé market						Djoda market					
		Cassava fish n= 12			King fish n =12			Cassava fish n =12			King fish n=12		
		Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD
Histamine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	0	40,49	11.3±15.0	0	153,00	38.8±61.7	0	19,88	8.9 ± 8.5	0	28,19	8.6±10.6
Cadaverine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	18,93	304,79	146.2±109.6	32,71	265,04	110.4±79.9	44,17	336,67	194.7±111.5	4,05	274,43	98.7±93.8
Putrescine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	1,68	47,73	20.5±16.6	4,16	22,96	13.9±8.74	4,58	69,66	37.7 ± 23.6	4,84	60,97	18.3±21.1
Spermidine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	34,45	114,09	64.4±38.5	13,74	102,77	35.0±34.3	9,75	341,29	89.9±125.7	8,73	461,44	104.1±178.3

Table 8: Results for chemical safety of Lanhouin (continued)

Parameter and unit of measurement	SOP number	Process and raw material used (Mean +/- SD)																	
		Aerobic fermentation						Semi aerobic fermentation						Anaerobic fermentation					
		Cassava fish (n=12)			King fish (n=12)			Cassava fish (n=12)			King fish(n=12)			Cassava fish (n=12)			King fish (n=12)		
		Min	Max	Mean ±SD	Min	Max	Mean±SD	Min	Max	Mean± SD	Min	Max	Mean± SD	Min	Max	Mean ±SD	Min	Max	Mean ±SD
Histamine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	0	67,86	13.7± 26.8	14,33	266,74	73.5± 96.9	0	431,88	76.6± 174.0	0	40,47	10.1± 15.2	1,29	22,66	8.6± 7.5	0	30,85	9.9± 12.6
Cadaverine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	22,02	301,72	108.3 ±112.9	208,11	2679,28	684.3± 978.1	106,97	324,01	213.0± 75.5	8,56	354,02	128.8 ±120.2	9,57	298,31	174.0 ± 114.6	44,43	394,42	158.4 ±123.9
Putrescine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	8,34	81,46	26.1± 28.3	25,92	63,51	44.3± 13.3	17,67	101,10	41.0± 31.1	8,39	80,73	37.0± 28.0	2,49	55,88	34.4± 18.0	5,87	102,83	30.1± 36.0
Spermidine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	9,68	59,86	25.0± 19.5	28,21	123,75	62.2± 34.7	26,11	101,24	47.8± 28.7	10,53	68,03	32.7± 26.9	5,66	438,75	96.7± 168.2	11,15	139,34	47.0± 46.9

Infestation with insects is a problem and to prevent it products such as petroleum, insecticides and peel of lemon are used by some of the processors to protect the product from flies and maggots during the drying step and storage periods. Products could also be contaminated with **chemicals or pesticides** if fish is stored near households subject to anti-malarial spraying programmes or by the re-use of bags/sacks for packaging. These levels are regulated by harmonized regulation EC 396/2005.

The thiobarbituric acid (TBA) number provides an indication of the onset of lipid oxidation. There are no set standards in literature as far as we know that indicate acceptable levels of TBA in fermented fish products. However, for meat products, the TBA level should be lower than 5 mg malonaldehyde/kg (Gigaud, 2006).

During analyses of lanhouin samples the thiobarbituric acid (TBA) contents varied from 10.9 ± 2.1 to 12.5 ± 0.4 malonaldehyde/kg for all lanhouin samples. No significant difference ($p>0.05$) was observed in the thiobarbituric acid content of lanhouin samples.

The total volatile nitrogen (TVN) levels in tested lanhouin samples were also high and this together with high TBA numbers, serve as a reflection of some forms of spoilage. The re-engineering of the processing method could assist to improve the quality of lanhouin regarding the TBA, TVN, microbiological profile, histamine levels and other quality parameters.

In terms of the EU General Food Law (EC 178/2002) for **safe and hygienic food production**: sensory, microbiological, chemical and nutritional analyses were performed on lanhouin and results of the microbiological analyses are presented in Table 9. The microbial loads were generally towards the higher end of the acceptable range (5 log cfu.g^{-1}). The presence of *Clostridium perfringens* (in some semi-aerobic samples) and high levels of *Staphylococcus aureus* constitutes non-compliance with acceptable EU standards. It indicates inadequate process control or also the use of poor quality ingredients (e.g. salt). This corresponds to previous findings of a “lack of proper hygienic practices during processing, rudimentary packaging, contamination of product, the re-use of salt for subsequent fermentation, insect infestation" and susceptibility to larvae infestation, mould growth and bacterial spoilage during storage (Anihouvi *et al*, 2006). In the current study mould growth was absent from most of the samples analysed. Lactic acid bacteria (which could have antimicrobial properties) occurred in anaerobically fermented cassava and kingfish. The presence of these organisms did not seem to affect the microbial quality of the lanhouin.

Table 9. Results for inventory of the technological flora and pathogenic germs of lanhouin

Microorganisms (Log CFU/g)	SOP number	Responsible partner and lab	Location (Mean +/- SD)					
			Comé market			Djoda market		
			Number of Samples	Cassava fish	King fish	Number of Samples	Cassava fish	King fish
Enumeration of microorganisms	Micro-01, ISO 4833	UAC @ UAC	12	3.60±0.58	4.13±0.30	12	4.52±0.33	4.17±0.12
Enterobacteriaceae	Micro-02, ISO 21528-2	UAC @ UAC	12	2.54±0.80	<1	12	<1	<1
Escherichia coli	Micro-03, ISO 16649-2	UAC@ UAC	12	<1	<1	12	<1	<1
Bacillus cereus	Micro-04, ISO 7932	UAC @ UAC	12	<1	<1	12	1.02±0.26	1.20±0.19
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	UAC @ UAC	12	1.85±0.17	1.60±0.26	12	2.10±0.20	1.34±0.28
Listeria monocytogenes (search in 25g of samples)	Micro-06, ISO 11290-1/A1:2004	UAC@ UAC	12	Absent	Absent	12	Absent	Absent
Salmonella (search in 25g of samples)	Micro-07, ISO 6579:2002	UAC@ UAC	12	Absent	Absent	12	Absent	Absent
Clostridium perfringens	Micro-08, ISO 7937	UAC @ UAC	12	<1	<1	12	1.16±0.52	2.12±0.08
Yeasts and moulds	Micro-09, ISO 7954	UAC @ UAC	12	2.32±0.26	2.35±0.41	12	<1	<1
Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	UAC @ UAC	12	<1	<1	12	2.23±0.22	1.13±0.05
Coagulase Negative Staphylococci (CNS)	Micro-05, ISO 6888-1	UAC @ UAC	12	2.61±0.41	2.94±0.39	12	3.15±0.64	3.46±0.69

Table 9. Results for inventory of the technological flora and pathogenic germs of lanhouin (continued)

Microorganisms (Log CFU/g)	SOP number	Process used (Mean +/- SD)								
		Aerobic fermentation			Semi-aerobic fermentation			Anaerobic fermentation		
		Number of Samples	Cassava fish	King fish	Number of Samples	Cassava fish	King fish	Number of Samples	Cassava fish	King fish
Enumeration of microorganisms	Micro-01, ISO 4833	12	3.65±0.6	3.60±0.6	12	3.93±0.4	3.63±0.6	12	3.44±0.7	3.45±0.3
Enterobacteriaceae	Micro-02, ISO 21528-2	12	<1	<1	12	<1	<1	12	<1	<1
Escherichia coli	Micro-03, ISO 16649-2	12	<1	<1	12	<1	<1	12	<1	<1
Bacillus cereus	Micro-04, ISO 7932	12	1.75±0.3	1.22±0.0	12	2.15±0.40	1.37±0.3	12	<1	1.3±0.2
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	12	1.14±0.39	2.0±0.9	12	2.05±0.6	1.32±0.33	12	1.64±0.22	1.30±0.28
Listeria monocytogenes (search in 25g of samples)	Micro-06, ISO 11290-1/A1:2004	12	Absent	Absent	12	Absent	Absent	12	Absent	Absent
Salmonella (search in 25g of samples)	Micro-07, ISO 6579:2002	12	Absent	Absent	12	Absent	Absent	12	Absent	Absent
Clostridium perfringens	Micro-08, ISO 7937	12	<1	<1	12	1.13±0.1	1.30±0.4	12	<1	<1
Yeasts and moulds	Micro-09, ISO 7954	12	1.72±0.6	<1	12	<1	<1	12	<1	<1
Lactic acid bacteria (LAB)	Micro-10,M-METH-MO-13	12	<1	<1	12	<1	<1	12	1.19±0.2	1.60±0.1

CFU/g: Colony Forming Unit per gram.

-HACCP for lanhouin

No record of a formal HACCP assessment on lanhouin could be found. The microbial loads and histamine levels of the analysed products indicate that such an assessment and the implementation of HACCP would be essential and possible control points would be:

- Control of type and quality fish used for fermentation (some species more prone to high histamine levels) - critical
- Control of the quality of water used during processing and hygiene of materials
- Control of ingredients used (salt should be tested for microbiological quality)
- Control of the processing (time before gutting, type of ripening, type of fermentation, salting, drying operations) - critical
- Packaging and storage (products should be protected from insect infestation in a safe way e.g. covering) - critical

The implementation of HACCP would enforce a documentation system to improve traceability (to vessel and producer) and product quality in general.

3.6 Kitoza:

Kitoza is a traditional Malagasy dish consisting of strips of dried or smoked pork or beef meat. The maximum duration of preservation is one week, but most producers sell their products within one day.

Production volumes vary from small home-based (for own consumption) to small commercial enterprises producing between 4 and 20 kg per week. Kitoza mainly retails at the local markets and is considered to be a delicacy in Madagascar, often eaten as a snack and associated with important occasions or celebrations (it is regarded as a 'treat'). Demand usually outstrips production so that it is often sold out on the day of production.

Kitoza: Compliance with EU safety and quality standards:

- EU General Food law EC 178/2002, EC 2073/2005 and POAO EC 853/2004

The Department of Trade and export in Madagascar regulates all export of kitoza and aims to promote trade at an international level.

However to import meat products into the EU, freedom from key transboundary diseases of the area of production has to be proven before exports can start and achieving this requires a veterinary management regime. According to the EC directives regarding Products of Animal Origin and the OIE Terrestrial Code, meat products, fish, poultry and dairy products require prior approval of the public health condition applicable in the country before import into the EU. To export these products to the EU a country must be on the EU positive list and Madagascar is not on the positive list for meat.

Other EU legislation also applicable to kitoza would be Animal Welfare legislation: EU legislation aiming to prevent pain or suffering to animals and therefore keepers of animals must meet minimum standards of housing, transportation and slaughter of live animals.

It is therefore unlikely that re-engineering would enable kitoza export to the EU and efforts should rather be focussed on improving production processes and volumes for the expanding local market. Kitoza could be pre-packaged (Packaging EC 1935/2004) and marketed as a high value protein rich nutritional snack food. Existing Malagasy snack food markets are under-supplied so this presents a good opportunity. Sales in delicatessens, supermarkets, fast food shops and taxi and bus stations show particular promise.

In terms of compliance with EU General Food Safety Laws, four types of kitoza products were subjected to sensory, microbiological, chemical and nutritional analyses. The results of the microbiological and polycyclic aromatic hydrocarbon analyses are presented in Tables 10 and 11.

The tested samples contained levels near or above the authorised upper EU limits of total, Staphylococcus and fungal counts. Enterobacteriaceae (*E. coli*) counts, an indicator of hygienic practices, were below the authorised EU limit of 4 log cfu/g but 42% of the kitoza from dried salted pork did not match this criterion. Smoking generally appeared to improve the microbial quality, but smoked samples had higher levels of PAH.

http://www.efsa.europa.eu/en/focusfood/docs/focusfood01.pdf

The results of **polycyclic aromatic hydrocarbon** (PAH) assays (Table 10) showed dried smoked kitoza from beef did not comply with EU regulations of <5 ppb benzo[*a*]pyrene. This presents a safety issue which should be addressed by selection of combustible materials, smoker design or process modification during re-engineering. The levels of PAH in dried smoked kitoza from pork bordered on allowable levels while the dried non-smoked kitoza complied with EU regulations.

A number of PAH compounds are genotoxic carcinogens. It is recommended that exposure to PAHs should be as low as reasonably achievable. In a study published in *The EFSA Journal* the median dietary exposure across European countries was calculated both for mean and high dietary consumers and varied between 235 ng/day (3.9 ng/kg b.w. per day) and 389 ng/day (6.5 ng/kg b.w. per day) respectively for benzo[*a*]pyrene alone. The BMDL10 value was calculated from the statistical models at 0.07mg/kg b.w. per day. The two highest contributors to the dietary exposure were cereal (products), and sea food (products). To

protect public health from such compounds, EU Maximum Levels have been introduced for some foods using benzo[a]pyrene as a marker for the group of chemical compounds.
http://www.efsa.europa.eu/en/focusfood/docs/focusfood01.pdf

Table 10. Results for inventory of the technological flora and pathogenic germs of kitoza

Microorganisms *LogCFU/g sample	Kitoza manufactured with pork (20 samples)						Kitoza manufactured with beef (20 samples)					
	Smoked, 13 samples			Dried, 7 samples			Smoked, 12 samples			Dried, 8 samples		
	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min	Mean	Max	Min
*Total count 30°C	7.2/1.1			7.5/0.5			6.1/1.7	8.4	4.1	7.2/0.9	8.2	5.9
**Enterobacteriaceae*	2.3/1.1 (n=3)	3.3	<1	3.7/1.2 (n=6)	8.3	6.9	2.6/1.8 (n=4)	5.0	<1	3.0/1.1 (n=7)	3.8	<1
**Escherichia coli*	1.5/.01 (n=2)	1.6	<1	3.8/1.0 (n=6)	4.7	<1	1.3/0.4 (n=2)	1.6	<1	2.7/1.2 (n=5)	4.1	<1
**Bacillus cereus*	<2	<2	<2	<2	5.2	<1	3.0 (n=1)	3.0	<2	<2	<2	<2
**Staphylococcus aureus* and CPS	2.7/0.7 (n=5)	3.6	<2	3.1/0.5 (n=6)	<2	<2	3.4/1.2 (n=4)	4.6	<2	3.5/1.1 (n=5)	4.7	<2
**Listeria monocytogenes*	P (n=1)			A	3.5	<2	A	A	A	A	A	A
**Salmonella spp*	A	A	A	A	A	A	A	A	A	A	A	A
**Clostridium perfringens*	<1	<1	<1	<1	A	A	<1	<1	<1	<1	<1	<1

*Yeast and mould	3.8/1.3 (n=11)	6.1	<1	4.8/0.9	<1	<1	4.4/2.9 (n=8)	4.4	<1	3.4/1.2	5.0	1.6
*Lactic acid bacteria	7.3/1.1	8.3	4,9	7.1/0.9	6.5	3.6	5.9/1.7	8.2	3.5	7.1/1.0	8.3	5.9
*Coagulase Negative Staphylococci	6.3/1.4	8.1	4.0	6.8/0.9	8.1	5,5	5.3/1.9	8.1	3.0	6.9/0.9	8.1	5.5

Table 11. Results of polycyclic aromatic hydrocarbons analyses of kitoza

Parameter and unit of measurement	SOP number	Responsible partner and lab	Kitoza manufactured with beef (Mean +/- SD)					
			Smoked samples (n=14)			Dried samples (n=14)		
			Mean+/- SD	Min	Max	Mean+/- SD	Min	Max
PAH - B(a)P (ppb)	AntiNutri-MeatFish-001-fr	CIRAD-R	10.74 +/- 17.63 (n=7 > 5ppb)	0.00	59.06	0.00+/- 0.00	0.00	0.02
Parameter and unit of measurement	**SOP number**	**Responsible partner and lab**	**Kitoza manufactured with pork (Mean +/- SD)**					
			Smoked samples (n=14)			**Dried samples (n=14)**		
			Mean+/- SD	**Min**	**Max**	**Mean+/- SD**	**Min**	**Max**
PAH - B(a)P (ppb)	AntiNutri-MeatFish-001-fr	CIRAD-R	4.94 +/- 8.24 (n=3 >5ppb)	0.20	24.81	0.09 +/- 0.34 (n=1 >5 ppb*)	0.00	1.21

-HACCP for kitoza

No record of a formal HACCP assessment on kitoza could be found. The microbial loads and PAH levels of the analysed products indicate that such an assessment and the implementation of HACCP would greatly benefit the product quality. To proceed to a more commercial scale of production by re-engineering, HACCP implementation would be essential and possible control points would be:

- Control of meat used (buy from reputable source with veterinary inspection for microbial or parasite infections and zoonoses) - critical
- Hygienic utensils, equipment and processing methods
- Control of spice and other ingredient quality (supplier quality assurance)
- Smoking and drying process adequate to improve microbial quality but not increase level of PAH (check benzopyrene levels) – critical
- Storage and distribution (prevent contamination and deterioration)

The implementation of HACCP would encourage a documentation system to improve traceability, transparency, labelling and product quality in general.

3.7 Kong:

Kong is traditionally prepared by smoking (and in some cases drying) fresh *Arius heudelotii* fish in Senegal. Wet kong (which is not dried) is only sold in markets nearest to production zones, because the moisture content could lead to bacterial contamination within days. For export in the region, dried kong is promoted for food. Over the three years 2006 to 2008 the quantity of fresh fished kong produced per year was about 12,500 tons (DPM, 2007, 2008, 2009).

Kong: Compliance with EU safety and quality standards:

- EU General Food Law EC 178/2002, EC 2073/2005 and POAO EC 853/2004

The formal export market of kong from Senegal to Europe ceased to exist in 2006 because of European's standards and regulations.

The EU requires that fisheries products exported to the EU come from specific approved premises as well as complying with OIE public health conditions. Exports to the EU are only allowed from approved vessels and establishments therefore abattoirs, fish processing plants and transport has to be prior inspected and approved by the Competent Authority and confirmed by the EU Food and Veterinary Office (FVO) (EU undated). This also means that fisheries vessels must comply with **EU hygiene standards** and have **traceability** to the individual fishing vessel.

According to the EC directives regarding **Products of Animal Origin (EC 853/2004**) and the **OIE Terrestrial Code**, meat products, fish, poultry and dairy products require prior approval of the public health condition applicable in the country before import into the EU. To export these products to the EU a country must be on the EU positive list. Senegal is on the positive list for fisheries products and has 114 approved establishments (see list at https://webgate.ec.europa.eu/sanco/traces/output/FFP_SN_en.pdf)

In terms of the EU General Food Law (EC 178/2002) for **safe and hygienic food production**: sensory, microbiological, chemical and nutritional analyses were performed on kong and results of the microbiological analyses are presented in Table 12. The microbial loads and coliform levels in the samples were generally high (above the acceptable level of 5 log cfu.g^{-1}), indicating inadequate hygiene during processing. The microbiological profile of wet kong appeared slightly better than that of older dried kong. This could be due in part to the higher levels of lactic acid bacteria (with possible antimicrobial properties) present in the wet kong. The presence of *Clostridium perfringens* in some of the products is cause for concern. During the survey of operators in the kong industry, inadequate packaging and labelling were mentioned as marketing constraints by retailers.

Environmental sustainability is increasingly becoming important in the EU and for fisheries products, proving that sustainable harvesting regimes are in place is increasingly required. The species used for kong production could easily be produced by aquaculture.

Certain species of fish develop high levels of **histamine** during their decomposition post-harvest. This is dangerous to human health and the EU regulates it under EU 853/2004. *Arius heudelotii* used for the production of kong is not one of the species usually implicated in histamine contamination.

The results of **polycyclic aromatic hydrocarbon** (PAH) assays (Table 13) showed higher levels of PAH in the dried than in wet kong. Dried smoked kong did not comply with EU regulations of <5 ppb benzo[*a*]pyrene. This presents a safety issue and therefore the process of smoking should be optimised during re-engineering.

Products could also be contaminated with other **chemicals or pesticides** if fish is stored near households subject to anti-malarial spraying programmes or by the re-use of bags/sacks for packaging. These levels are regulated by harmonized regulation EC 396/2005.

Table 12. Results for inventory of the technological flora and pathogenic germs of kong

Microorganisms *LogCFU/g sample	SOP number	Zone and Process used (Mean +/- SD)					
		Zone 1: Ziguinchor			Zone 2 : Dakar		
		Number of Samples	Well dried smoked	Wet smoked	Number of Samples	Well dried smoked	Wet smoked
*Enumeration of microorganisms	Micro-01, ISO 4833	22	7,15 ± 7,1 (n=13)	5,37 ± 5,64 (n=7)	15	-	6,90 ± 7,20 (n=15)
**Enterobacteriaceae*	Micro-02, ISO 21528-2	22	4,22 ± 4,21 (n= 5)	1,48 ± 0 (n= 1)	15	-	4,18 ± 4,35 (n=12)
**Escherichia coli*	Micro-03, ISO 16649-2	22	3 ± 0 (n=1)	A	15	-	2,18 ± 1,70 (n= 2)
**Bacillus cereus*	Micro-04, ISO 7932	22	A	A	15	-	A
**Staphylococcus aureus* and CPS	Micro-05, ISO 6888-1	22	A	A	15	-	A
**Listeria monocytogenes*	Micro-06, ISO 11290-1/A1:2004	22	A	A	15	-	A
**Salmonella*	Micro-07, ISO 6579:2002	22	A	A	15	-	A
**Clostridium perfringens*	Micro-08, ISO 7937	22	1,84 ± 1,71 (n= 3)	1 ± 0 (n= 3)	15	-	1,85 ± 1,63 (n=11)
*Yeasts and moulds	Micro-09, ISO 7954	22	3,61 ± 3,96 (n= 5)	3,38 ± 3,73 (n= 5)	15	-	2,73 ± 2,66 (n= 2)
*Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	22	7,80 ± 7,96 (n= 11)	9,75 ± 9,75 (n= 7)	15	-	8,54 ± 8,58 (n= 15)

Table 13. Results of polycyclic aromatic hydrocarbon analyses of kong

Parameter and unit of measurement	SOP number	Respon-sible partner and lab	Zone and Process used					
			Zone 1 : Ziguinchor			Zone 2 : Dakar		
			Number of Samples	Well dried smoked	Wet smoked	Number of Samples	Well dried smoked	Wet smoked
Polycyclic Aromatic Hydrocarbon B(a)P ppb	Anti-Nutri-MeatFish-001-fr	CIRAD	12	9,50 /5,84 (n= 9)	1,15/ 0,88 (n= 3)	2	-	1,66/ 0,85

HACCP and re-engineering of kong

A formal HACCP assessment should be performed to identify the hazards in the production process so that these can be addressed by re-engineering. This information is needed to guide the efforts to re-engineer kong in a way that conforms to market entry rules of food hygiene and safety. The process re-engineering of smoked kong should improve the products' quality attributes such as chemical components (lower values of PAH, TVN) and microbiology quality. Packaging innovation, good labelling and better product presentation can be used to add value. Apart from the product quality, the re-engineering should alleviate environmental impact (diversification and rational combustibles management, better performance during the smoking). Furthermore, new presentations of the smoked kong in fillets or slices can be tested by consumers to add value to the final products.

HACCP control points to consider for re-engineering are:

- Control on raw material quality (inspect fish free from disease, heavy metals, parasites; clean water and salt used)
- Hygienic practices during processing (evisceration, cleaning, cover to prevent fly infestation)
- Smoking and drying (adequate process to optimise preservation but prevent high levels of PAH) – critical
- Storage and distribution (prevent infestation with insects, moulds) – critical

In summary, kong has market access to the EU, but food safety and contamination issues exist for this product. Also, traceability (to the vessel) and managing fish harvesting could present a problem in future.

GROUP 3 PLANT-BASED EXTRACTS FOR FUNCTIONAL FOODS

3.8 Baobab:

The baobab tree *Adansonia digitata L*. grows in many parts of Senegal, but fruit are wild harvested mostly around Dakar and near villages. The fruit, seeds and leaves of this plant are common ingredients in traditional dishes in rural and urban areas. The pulp of the fruit is probably the most important form of consumption.

After breaking the capsule of baobab fruit, the separation from fibrous strands gives yellowish-white pulp which is very popular for some culinary use, sauces and food additive. Baobab fruit juice (which is often bottled) is usually prepared by mixing baobab fruit pulp powder to water and adding sugar, milk, vanilla extract and fruit juice. Baobab fruit extracts are concentrated to produce products such as juice concentrate and jam. Dried fruit pulp is also mixed with nuts and millet flour and consumed as a popular food dish ("ngalax") after the addition of sugar and other ingredients.

Baobab is an important source of income for Senegalese people and solely valorised in the traditional way (Diop *et al*, 2005). At the Dakar market, the price of the baobab fruit pulp without the capsule (pulp, seeds and fibres) varies between 300 and 400 FCFA.kg^{-1} according to the seasonal abundance and the processors of baobab pulp can be divided into small-scale processors and industrial operators. Small informal processors mainly produce beverages whereas commercial operators produce juice, concentrates (syrups) and jams. The national production of baobab fruit reached 2 143.3 tons in 2010 according to the Senegalese Agriculture Ministry.

Baobab: Compliance with EU safety and quality standards:

Baobab is currently exported to Europe, mainly in the forms of fruit and the pulp, followed by the syrup, and only has to comply with food safety regulations. The Baobab Fruit Company exports primarily to the Italian niche market. According to the exporters only **phytosanitary certification** of the product is required to export to Europe. This certificate from a national Competent Authority demonstrates compliance with environmental and safety regulations to prevent entry and spread of disease and pests into the EU.

EU General Food Law EC 178/2002 and EC 2073/2005:

Baobab pulp flour has several potential end uses; it can be an ingredient for a beverage such as a sports drink, it could also be a pharmaceutical carrying agent for pharmaceuticals or a bio-fortification ingredient. These diverse end products would be subject to various sections of the EU General Food Law.

The general principals of the EU **food safety** laws are that food must be proven safe for human consumption from "farm to fork". Labelling, traceability and recall procedures are clearly stipulated. Re-engineering should bear these principals in mind e.g. the strict regulations on labelling of beverages and jams (Directive 2000/13/EC). Mechanisms for producers to demonstrate compliance with labelling regulations exist in Senegal.

Sensory, microbiological, chemical and nutritional analyses were performed on baobab pulp and intermediary products and the results of the microbiological analyses are represented in Table 14. According to the results of these analyses baobab pulp complies with the EU microbial limits found in EC 2073/2005 and is of good microbiological quality.

The state of Senegal also aims to encourage safe food production through the Senegalese Association for Standardization which has developed several standards for baobab fruit and products (juice, syrup).

-**Pesticides, chemical residues and aflatoxins**

Maximum Residue Levels (MRLs) for pesticides are described by the EC in the harmonized regulation EC 396/2005. Because baobab fruit are harvested from wild trees, products should be free of agricultural chemicals. Nevertheless, the presence of chemicals on nearby farms or in households could present a problem. Harvest from trees near fields with crops subject to agricultural chemical use, storage of product near to household subject to anti-malarial spraying programmes and re-use of bags or sacks could lead to cross-contamination with regulated chemicals.

. Aflatoxin is a highly carcinogenic substance produced by moulds and, because its presence in very small quantities is potentially lethal to humans and animals, it is not tolerated in the EU (EC 1152/2009 and 165/2010). Baobab has a very low aflatoxin risk because the seed pulp is not exposed to the atmosphere until the seed reaches the processing plant and has a very low moisture content. No aflatoxins or ochratoxin A could be detected in analyses of baobab pulp samples.

-**EU Novel Food** registration:

The Novel Foods Regulation (EC 258/97) also 'captured' some traditional foods such as baobab and so has been the subject of a number of revisions. Companies wanting to import foods and food ingredients that have not previously been in common safe use within the EU must apply for authorisation and demonstrate safety through either science or by history of safe use. Application requires a professional dossier to be compiled. This can cost up to Euro 100,000 per application.

The following companies have successfully obtained authorisation to import baobab fruit pulp under the Novel Food Regulation:

-Baobab Fruit Company S.a.r.l. Via A. Mondadori 15 I – 46025 Poggio Rusco (MN)

-Mighty Baobab Ltd. Bostall Lodge Bostall Heath London SE 2 0AT United Kingdom

-Fruit'Art SAS Residence Mont Joli F – 14600 Equemauville

-BAOBAB de saveurs Médina Fall BP 547 Thiés Senegal

-Healey Group Ireland Ltd. HCL House, Second Avenue Cookstown Industrial Estate, Tallaght, Dublin 24 Ireland

An application by PhytoTrade Africa for Novel Foods Approval of baobab as a food ingredient is also pending in the EU.

Table 14. Results for inventory of the technological flora and pathogenic germs of baobab pulp

Parameter and unit of measurement (CFU/g)	SOP number	Baobab pulp per production zone							
		Tambacounda-Kédougou		Thiés		Kaolack		Ziguinchor	
		Number of Samples	Mean	Number of Samples	Mean	Number of Samples	Mean	Number of Samples	Mean
Enumeration of microorganisms	Micro-01, ISO 4833	10	727	5	618	10	560	5	89
Enterobacteriaceae	Micro-02, ISO 21528-2	10	-	5	-	10	-	5	-
Escherichia coli	Micro-03, ISO 16649-2	10	0	5	0	10	0	5	0
Bacillus cereus	Micro-04, ISO 7932	10	0	5	0	10	0	5	0
Staphylococcus aureus and CPS	Micro-05, ISO 6888-1	10	0	5	0	10	0	5	0
Listeria monocytogenes	Micro-06, ISO 112901/A12004	10	Absent	5	Absent	10	Absent	5	Absent
Salmonella	Micro-07, ISO 65792002	10	Absent	5	Absent	10	Absent	5	Absent
Clostridium perfringens	Micro-08, ISO 7937	10	0	5	0	10	0	5	0
Yeasts and moulds	Micro-09, ISO 7954	10	152	5	100	10	70	5	53
Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	10	209	5	134	10	167	5	30

-**Traditional Herbal Remedy** Directive and Dietary Supplements (2004/24/EC)

Because of its high content of polyphenols (see Table 15), fibres and vitamin C, baobab fruit can be use as food ingredient or food supplement in future. Many therapeutic effects of baobab are known traditionally.

In order to sell traditional herbal remedies in the EU they have to be proven as safe by one of two routes: by showing evidence of common use in the EU before 30th April 2004 or by provision of scientific proof of safety and efficacy through testing. In both cases an elaborate dossier has to be prepared and approved. For a new product this can be expensive (from Euro 100,000 up). Total new food supplements, functional foods, botanical extracts or remedies from AFTER products will have to be approved under these directives.

Table 15: The major polyphenol compounds in baobab pulp are:

- Epicathechine M/Z- 288
- Procyanidine M/Z- 577
- Procyanidine dimer M/Z- 729
- Procyanidine trimer M/Z- 865
- Procyanidine tetra M/Z- 1153
- Procyanidine pinta M/Z- 1441

Compliance with EU private standards:

-Regulation within the EU is increasingly moving into the area of **methods of production**. For all products reaching the formal markets (e.g. supermarkets) in Europe, Good Agricultural Practices (e.g. treatment of farm workers, safe use of pesticides, sustainable production methods) are becoming the norm.

-For wild harvested products, such as baobab, EU companies and consumers want evidence that they are not causing **environmental damage** by using the product. For all products reaching the formal markets (e.g. supermarkets) in Europe, Good Agricultural Practices (e.g. treatment of farm workers, safe use of pesticides, sustainable production methods) are becoming the norm. Re-engineering should take the potential negative effect of wild harvesting on product image into account and provide proof of sustainable environmental practices.

Local Senegalese law deals with the treatment of wastewater before discharge into the environment. Most of the companies do not meet these requirements and therefore incur tax penalties.

-**Intellectual Property issues**:

Baobab is commercially interesting and 82 patents have been registered (WIPO), mainly on the cosmetic properties of baobab. Re-engineering will have to take into account existing intellectual property rights. Senegal has laws in place for Geographical Indications that allow registration of domestic geographical indicators (GIs) or the mechanisms for protecting and sharing the benefits of traditional knowledge.

-Potential areas of **certification** that could be used for re-engineering include:

- fair trade certification – assuring EU consumers that the producers of foods get paid a fair and reasonable proportion of the final on-shelf retail price for their products
- organic certification (Senegal has national organic regulations and baobab is wild harvested so products are already organically produced)
- forest friendly certification to prove environmentally sustainable harvesting (could be difficult to prove)
- The Slow Food Movement has members in Senegal http://www.slowfood.com
- HACCP:

For food products exported to the EU some means of assuring safety is needed to comply with the General Food Law. Producers can achieve this by using a food safety certification system such as Hazard Analysis and Critical Control Point (HACCP) or ISO 22000, which is a food safety management standard incorporating HACCP. It is not a requirement for export, but a voluntary certification system provided by a private company. In countries with a significant tourism industry (e.g. Senegal) hotels and airlines are increasingly implementing food management standards to reduce the risk of loss of reputation.

HACCP implementation could be used as a re-engineering tool and should include control of the following critical points in baobab production:

- Quality of fruit used for processing (visual inspection to prevent contamination with spoilage and pathogenic microorganisms)
- Drying of the baobab pulp (to prevent contamination by micro-organisms, mycotoxins or dust) – critical
- Water and ingredient quality used for beverages (use clean potable water and supplier quality assurance for other ingredients to prevent microbial/chemical contamination)
- Bottling and storage of juice (aseptic conditions to prolong shelf-life) – critical

- Storage of pulp (dry hygienic condition and packaging to prevent moisture and contaminant infiltration)

Baobab is already imported into the EU and re-engineering should focus on complying with EU food safety regulations. Implementing HACCP will demonstrate safe production and improve traceability.

The re-engineering of the process should improve the quality of the product and increase the shelf life. Re-engineering could help to bring new products to the market such as functional food extracts from baobab fruit pulp or after blanching baobab fruit in water at moderate temperature.

Because of its high content of polyphenols, fibres and vitamin C, baobab fruit can be used as food ingredient or food supplement with many therapeutic effects.

Optimisation of the processes could reduce production costs of products (such as jam) and would popularise these products which are currently used only by the affluent class and tourists in Senegal. By improving product quality and affordability baobab has huge potential to expand its market both locally in the region and in the EU.

3.9 Bissap:

Hibiscus sabdariffa L. is an herbaceous plant, cultivated largely in tropical and subtropical areas of both hemispheres. Producers of *H. sabdariffa* mostly grow Hibiscus around crop fields or cultivate plots of bissap on areas ranging from 1 to 5 ha in size. It is mostly sold as dried calyxes and the main processing activities of the *H. sabdariffa* calyx are crushing and the production of juice, syrup/concentrate and jam. With an average domestic production of 1200 to 3000 t (per year) and an estimated 30 000 to 40 000 producers, *H. sabdariffa* currently holds an important place in the marketing of agricultural products in Senegal (Cisse *et al*, 2009a).

Bissap: Compliance with EU safety and quality standards:

Bissap is already imported into the EU and only has to comply with food safety regulations.

-To prevent entry and spread of disease and pests into the EU importers have to demonstrate compliance with environmental and safety regulations with a sanitary or phytosanitary certificate from the national Competent Authority.

-**General Food Law** EC 178/2002 and EC 2073/2005:

The general principals of the EU **food safety** laws are that food must be proven safe for human consumption from "farm to fork". Labelling, traceability and recall procedures are clearly stipulated. Re-engineering should bear these principals in mind e.g. the strict regulations on labelling of beverages and jams (Directive 2000/13/EC).

In terms of the microbial limits (EC 2073/2005), bissap products were analysed and found to generally comply with EU standards except for medium to high levels of yeasts and moulds (see Table 16). Although bissap has been classified as having medium aflatoxin risk (EC 1152/2009 and 165/2010), aflatoxins or ochratoxin A were not detected during analyses of Hibiscus calyx. Re-engineering should include precautions to prevent fungal growth by drying calyx quickly after harvesting and storage under appropriate conditions.

-Maximum Residue Levels for **pesticides** are given in EC 396/2005. Most small scale bissap production will be free of agricultural chemicals because small scale farmers cannot afford to use them. Nevertheless, the presence of chemicals on farms or in households nearby and the unregulated sale of non-compliant chemicals are common. Harvest from fields with inter-crops subject to agricultural chemical use, storage of product near to household subject to anti-malarial spraying programmes and re-use of bags or sacks could lead to cross-contamination with regulated chemicals.

Table 16. Results for inventory of the technological flora and pathogenic germs of *Hibiscus sabdariffa* from ZIGUINCHOR region

Parameter and unit of measurement *CFU/g sample	SOP number	Variety of Hibiscus used							
		Vimto		Koor		Thai		CLT 92	
		Number of Samples	Mean +/- SD	Number of Samples	Mean +/- SD	Number of Samples	Mean +/- SD	Number of Samples	Mean +/- SD
*Enumeration of microorganisms	Micro-01, ISO 4833	6	410 ± 39	6	589 ± 39	6	678 ± 54	6	376 ± 39
**Enterobacteriaceae*	Micro-02, ISO 21528-2	6	-	6	-	6	-	6	-
**Escherichia coli*	Micro-03, ISO 16649-2	6	0	6	0	6	0	6	0
**Bacillus cereus*	Micro-04, ISO 7932	6	0	6	0	6	0	6	0
**Staphylococcus aureus* and CPS	Micro-05, ISO 6888-1	6	0	6	0	6	0	6	0
**Listeria monocytogenes*	Micro-06, ISO 11290-1/A12004	6	Absence	6	Absence	6	Absence	6	Absence
**Salmonella*	Micro-07, ISO 65792002	6	Absence	6	Absence	6	Absence	6	Absence
**Clostridium perfringens*	Micro-08, ISO 7937	6	0	6	0	6	0	6	0
*Yeasts and moulds	Micro-09, ISO 7954	6	6732 ± 345	6	4890 ± 328	6	3875 ± 336	6	4987 ± 387
*Lactic acid bacteria (LAB)	Micro-10, M-METH-MO-13	6	0	6	0	6	0	6	0

-**Traditional Herbal Remedy** Directive and Dietary Supplements (2004/24/EC): if bissap is to be used as botanical extract, the provision of scientific proof of safety and efficacy through testing is required. Scientific proof has to be prepared and approved in the form of an elaborate dossier which could be an expensive exercise. Many therapeutic effects of bissap are traditionally known and this is reflected in the high volume of patent activity on therapeutical properties of bissap. Table 17 presents the results of polyphenol profiling performed on 18 samples of *H. sabdariffa.*

Table 17. Identification of anthocyanins and polyphenols (performed by CIRAD using the SOP's Bioch-ExtPlantes-05-fr, Bioch-ExtPlantes-06-fr)

Major	Delpninidin of sambubioside
	Cyanidin of sambubioside
Minor	Chlorogenic acid
	Myricetine of glucoside
	Quercetine of sambubioside

Bissap: Compliance with EU private standards:

An example of **private** importer product **standards** applying to Hibiscus calyx is given in Table 18 below:

Table 18. Import norms for dried *H. sabdariffa*

Guidelines	Specifications
Description	Hibiscus sabdariffa
Packaging	Item must be packed in 50 lb. poly (or less) lined boxes or multi-walled sacks (adequately protecting product for shipment) with clear markings indicating the item contained. Shipment must be accompanied by packing list clearly indicating the consignment, weight and country of origin.
Raw ingredient sample:	
(a)Visual	Purple-red colour.
(b)Aroma	Floral, berry-like aroma. Free from objectionable off odors.

(c)Texture	Lump free, free flowing particles
Prepared sample:	
(a)Visual	(a)Visual
(b)Aroma	Slight berry aroma.
(c)Flavor	A well balanced, tart and astringent flavor. Some cranberry notes as well as a slight drying effect. Not excessively tart, acidic or bitter. Should be free of off- flavors and other undesirable spice/botanical notes.
Test Units:	*Specifications*
(a) Free Flow Density	G/CC Minimum 0.45, Maximum 0.60
(b) Moisture	12%
(c) Total Ash	10%
(d) Acid Insoluble Ash	1.50%
(e) Sieve Analysis	Thru US#20 95.0%
5 Min Rotate	Thru US#60 5.0%
(f) Insect Fragments each	400
(g) Whole Insects (field/storage) each	25/5
(h) Salmonella	Negative
(i) Coliform	2 of 5 over 10 CFU, 0 of 5 over 100 CFU
(j) E. coli (MPN)	2 of 5 over 3 CFU, 0 of 5 over 20 CFU
(k) E. coli (Film)	0 of 5 over 10 CFU
(l) S. Aureus	1 of 5 over 100 CFU, 0 of 5 over 1000 CFU
(m) Standard Plate Count	0 of 5 over 1,000,000 CFU
(n) Yeast/Mould	0 of 5 over 10,000 CFU

-**Intellectual Property issues**:

It can be assumed that bissap products have properties which are commercially interesting as 1290 patents have been registered (WIPO). The patents deal mainly with immune-boosting properties of bissap. Re-engineering will have to take into account existing intellectual property rights. Senegal has laws in place for Geographical Indications that allow registration of domestic geographical indicators (GIs) or the mechanisms for protecting and sharing the benefits of traditional knowledge.

-Potential areas of **certification** that could be used for re-engineering include:

- fair trade certification - standards for Hibiscus calyx already exist
- organic certification (Senegal has national organic regulations and small-holders do not have access to expensive external inputs such as fertilizers so products are already organically produced)
- forest friendly certification to prove environmentally sustainable harvesting (*H. sabdariffa* is grown as crops and not wild harvested)
- The Slow Food Movement has members in Senegal http://www.slowfood.com
- HACCP, a food safety certification system:

For food products exported to the EU some means of assuring safety is needed to comply with the General Food Law. Producers can achieve this by using a food safety certification system such as Hazard Analysis and Critical Control Point (HACCP) or ISO 22000, which is a food safety management standard incorporating HACCP. It is not a requirement for export, but a voluntary certification system provided by a private company. In countries with a significant tourism industry (e.g. Senegal) hotels and airlines are increasingly implementing food management standards to reduce the risk of loss of reputation.

HACCP implementation as a re-engineering tool should include control of the following critical points in bissap production:

- Drying of the harvested calyx (to prevent contamination by micro-organisms or dust) – critical
- Packaging of dried calyx (sufficient moisture barrier to prevent uptake of moisture under humid conditions leading to mould growth and colour loss) – critical
- Quality of water for soaking and other ingredients e.g. sugar during juice preparation (prevent microbial contamination)
- Bottling and storage of juice (aseptic conditions to prolong shelf-life) – critical

Bissap is already imported into the EU and re-engineering should focus on complying with EU food safety regulations.

3.10 Jaabi:

Jaabi is the tropical fruit of the *Ziziphus mauritiana* tree in Cameroon. It is marketed either directly, after harvesting by farmers, to wholesalers and retailers who carry the grains to urban markets or after traditional baking into yaabande, a traditional jaabi cake. Yaabande

is obtained by pounding jaabi grain, sprinkling the flour obtained with water, molding the flour and cooking either by sun exposure, direct roasting on a fire, or steam-cooking. No other ingredients are added during the baking process.

The jaabi and yaabande market is currently mostly in the far northern regions of Cameroon, in farmers' homes or on local markets by wholesalers and retailers. Due to the small volume and wild harvesting issues, the crop is traditionally neglected in terms of research and regulation by Cameroon state institutions.

Wholesalers buy dry fruit from farmers and distribute it both internally and to neighbouring countries like Chad and Nigeria. Very little information is available on compliance with international regulations.

Jaabi: Compliance with EU safety and quality standards:

-**Environmental safety:**

To prevent entry and spread of disease and pests into the EU importers have to comply with regulations to manage the associated risks. To export jaabi to Europe a **phytosanitary certificate** from a national Competent Authority to demonstrate compliance with environmental and safety regulations would be required.

-**General Food Law** EC 178/2002 and EC 2073/2005:

Jaabi and yaabande cake has several potential end uses. These diverse end products would be subject to various sections of the EU General Food Law.

The general principals of the EU **food safety** laws are that food must be proven safe for human consumption from "farm to fork". Labelling, traceability and recall procedures are clearly stipulated. Re-engineering should bear these principals in mind.

Sensory, microbiological, chemical and nutritional analyses were performed on jaabi flour and intermediary products and the results of the microbiological analyses are represented in Table 19. According to the results of these analyses jaabi fruit or cooked pulp do not comply with the EU microbial limits found in EC 2073/2005. Relatively high levels of *Escherichia coli* (above the authorised EU limit of 4 log cfu/g) and *Bacillus cereus* indicate insufficient hygiene or control over the process. The microbiological quality was not improved by steam cooking, stifle cooking or sun drying. Food pathogens such as *Salmonella spp* and *Staphylococcus aureus* were present in several of the products and are cause for concern. The presence of *Salmonella spp* could put jaabi in the category of High Risk foods (EC 669/2009) and should be addressed by re-engineering through a safety management system.

Aflatoxins were detected in only one of the 10 varieties of fruit and jaabi which were sampled. Levels ranged from 1.1 ppb aflatoxin B1 to 2.6 ppb total aflatoxin – below authorised EU limits. Low level (at 0.2 ppb.) of ochratoxin A also occurred in this sample. It is speculated that the mycotoxin levels increased during prolonged storage of this sample (before analyses). The storage period is a factor which should therefore be taken into account in future re-engineering.

Table 19. Results for inventory of the technological flora and pathogenic germs of Jaabi

Parameter and unit of measurement	Jaabi per production zone and process (Mean +/- SD)												
	Maroua				Mokolo			Mora			Garoua		
	Number of Samples	Fruit	Steam cooking	Stifle cooking	Number of Samples	Fruit	Steam cooking	Number of Samples	Fruit	Solar drying	Number of Samples	Fruit	Steam cooking
Enumeration of microorganisms													
Enterobacteriaceae													
Escherichia coli (ufcx 10^2/g)	05	**Dakamji:** 76.0±5.7 **Lamouji:** 190.0±25.5	**Dakamji:** 230.2±20.6 **Lamouji:** 4.3±2.0	**Dakamji:** 160.6±10.8	06	**Dakamji** 40.00±5.7 **Lamouji**18.0±2.8	**Dakamji** 240.2±10.4 **Lamouji** 18.0±2.8	04	**Dakamji:** 170.8±11.0 **Lamouji:** 100.6±0.9	**Dakamji** 60.0±5.7 **Lamouji:** 61.0±0.1	05	**Dakamji:** 42.0±8.5 **Lamouji:** 140.0±20.3	**Dakamji:** 42.0±8.5 **Lamouji:** 140.0±20.3
Bacillus cereus (ufcx10^2/g)	05	**Dakamji:** 2.2±0.1 **Lamouji:** 2.8±0.6	**Dakamji:** 40.0±5.7 **Lamouji:** 260.0±10.4	**Dakamji:** 32.0±0.1	06	**Dakamji**1.0±0.3 **Lamouji** 0.0	**Dakamji** 1.0±0.3 **Lamouji:** 14.0±2.8	04	**Dakamji:** 0.6±0.1 **Lamouji:** 3.6±0.6	**Dakamji** 12.6±0.9 **Lamouji:** 470.0±30.1	05	**Dakamji:** 1.9±0.3 **Lamouji:** 6.0±0.3	**Dakamji:** 14.0±2.8 **Lamouji:** 4400.0±16.0
Staphylococcus aureus (ufcx10^2/g)	05	**Dakamji:** 4.0±0.0 **Lamouji:** 3.9±0.1	**Dakamji:** 4.4±0.1 **Lamouji:** 11.0±0.1	**Dakamji:** 1.0±0.1	06	**Dakamji:** 1.0±0.1 **Lamouji** 6.0±0.1	**Dakamji :**4.2±0.1 **Lamouji:** 2.3±0.1	04	**Dakamji:** 1.8±0.1 **Lamouji:** 0.4±0.0	**Dakamji :** 3.7±0.1 **Lamouji:** 32.0±0.4	05	**Dakamji:** 4.0±0.0 **Lamouji:** 1.0±0.0	**Dakamji:** 0.4±0.0 **Lamouji:** 700±14
Listeria monocytogenes													

Parameter and unit of measurement	Jaabi per production zone and process (Mean +/- SD)												
	Maroua				Mokolo			Mora			Garoua		
	Number of Samples	Fruit	Steam cooking	Stifle cooking	Number of Samples	Fruit	Steam cooking	Number of Samples	Fruit	Solar drying	Number of Samples	Fruit	Steam cooking
Salmonella (presence+/ absence; -)	05	**Dakamji**: + **Lamouji**: -	**Dakamji**: + **Lamouji**: +	**Dakamji**: -	06	**Dakamji**: - **Lamouji**: -	**Dakamji**: + **Lamouji**: +	04	**Dakamji**: - **Lamouji**: +	**Dakamji**:- **Lamouji** +	05	**Dakamji**: - **Lamouji**: -	**Dakamji**: + **Lamouji**: +
Clostridium perfringens (ufc/g)	05	**Dakamji**: 0±0 **Lamouji**: 0±0	**Dakamji**: 0±0 **Lamouji**: 0±0	**Dakamji**: 0±0	06	**Dakamji**: 0±0 **Lamouji**: 0±0	**Dakamji**: 0±0 **Lamouji**: 0±0	04	**Dakamji**: 0±0 **Lamouji**: 0±0	**Dakamji**: 0±0 **Lamouji**: 0±0	05	**Dakamji**: 0±0 **Lamouji**: 0±0	**Dakamji**: 0±0 **Lamouji**: 0±0
Yeasts (ufcx10^2/g)	05	**Dakamji**: 3.6±0.6 **Lamouji**: 2008±2.3	**Dakamji**: 32.4±4.5 **Lamouji**: 180.0±5.6	**Dakamji**: 8.0±0.1	06	**Dakamji**: 7.2±0.1 **Lamouji** 18.8±2.3	**Dakamji** 35.6±7.9 **Lamouji** :1.0±0.1	04	**Dakamji**: 19.6±2.3 **Lamouji**: 2.0±0.5	**Dakamji** 54.6±5.9 **Lamouji**: 90.0±0.3	05	**Dakamji**: 62.6±2.0 **Lamouji**: 2.4±0.6	**Dakamji**: 38.2±2.5 **Lamouji**: 1800±2.8
Moulds (ufc/g)	05	**Dakamji**: 30.0±2.8 **Lamouji**: 14.0±2.8	**Dakamji**: 4.0±0.1 **Lamouji** : 0±0	**Dakamji**: 6.0±0.8	06	**Dakamji**: 4.0±0.1 **Lamouji** : 6.0±0.6	**Dakamji**: 10.0±2.8 **Lamouji**10.0±1.8	04	**Dakamji**: 20.0±2.8 **Lamouji**: 20.0±2.8	**Dakamji** : 4.0±0.1 **Lamouji**: 7.1±0.6	05	**Dakamji**: 4.0±0.1 **Lamouji**: 4.0±0.1	**Dakamji**: 14.0±2.8 **Lamouji**: 0±0

-**Pesticides, chemical residues and aflatoxins**

Maximum Residue Levels (MRLs) for pesticides are described by the EC in the harmonized regulation EC 396/2005. Because jaabi fruit are harvested from wild trees, products should be free of agricultural chemicals. Nevertheless, the presence of chemicals on nearby farms or in households could present a problem. Harvest from trees near fields with crops subject to agricultural chemical use, storage of product near to household subject to anti-malarial spraying programmes and re-use of bags or sacks could lead to cross-contamination with regulated chemicals.

Jaabi has been classified as having medium aflatoxin risk (EC 1152/2009 and 165/2010). Re-engineering should therefore include precautions to prevent fungal growth by effectively drying the flour to a low moisture content and by storage of grains and flour under appropriate conditions.

-**EU Novel Food** registration:

The Novel Foods Regulation (EC 258/97) applies to some traditional foods such as jaabi. Companies wanting to import foods and food ingredients that have not previously been in common safe use within the EU must apply for authorisation and demonstrate safety through either science or by history of safe use. Application requires a professional dossier to be compiled and could cost up to Euro 100,000 per application.

Jaabi is already produced and consumed in the EU and is therefore not a novel food. The fermented grain products have been in common use in the EU since long before the regulation came into force and it probably will not need Novel Foods clearance unless it undergoes substantial re-engineering.

-**Traditional Herbal Remedy** Directive and Dietary Supplements (2004/24/EC)

Jaabi is apparently consumed also for its therapeutic properties against inflammatory diseases and diabetics, and for its diuretic properties. In order to sell traditional herbal remedies in the EU they have to be proven as safe by one of two routes: by showing evidence of common use in the EU before 30th April 2004 or by provision of scientific proof of safety and efficacy through testing. In both cases an elaborate and costly dossier has to be prepared and approved. Jaabi could possibly qualify on the historical premise. Totally new or re-engineered food supplements, functional foods, botanical extracts or remedies will have to be approved under these directives.

Jaabi: Compliance with EU private standards:

-The **methods of production** are receiving increasing attention in EU regulation. For all products reaching the formal markets (e.g. supermarkets) in Europe, Good Agricultural Practices (e.g. treatment of farm workers, safe use of pesticides, sustainable production methods) are becoming the norm.

-For wild harvested products, such as jaabi, EU companies and consumers want evidence that they are not causing **environmental damage** by using the product. Proof of environmentally sustainable production processes should be provided or re-engineering should address production practices to alleviate the potential negative market effect of wild harvesting.

Cameroon internal regulation, Law N° 96/012 of August 5th 1996, relative to environmental management stipulates, in Article 2 par 2, that the environmental protection and rational management of natural resources provided to human life are of general interest. In consequence, since jaabi activities are performed in the savannah region, a fragile ecology environment, its processing and marketing at large scale have to comply with contractual clauses relating to the protection of the environment. Re-engineering should aim to demonstrate compliance with this legal requirement.

-**Intellectual Property issues**:

There is considerable commercial interest in jaabi with 105 patents registered (WIPO), mainly on its immune-boosting properties. Re-engineering will have to take into account existing intellectual property rights. Cameroon has implemented Sui generis as a mechanism for protecting and sharing the benefits of traditional knowledge.

-Potential areas of **certification** that could be used for re-engineering include:

- fair trade certification – assuring EU consumers that the producers of foods get paid a fair and reasonable proportion of the final on-shelf retail price for their products
- organic certification (jaabi is wild harvested so products are already organically produced)
- forest friendly certification to prove environmentally sustainable harvesting (could be difficult to prove)
- HACCP, a food safety certification system:

For food products exported to the EU some means of assuring safety is needed to comply with the General Food Law. Producers can achieve this by using a food safety certification

system such as Hazard Analysis and Critical Control Point (HACCP) or ISO 22000, which is a food safety management standard incorporating HACCP. It is not a requirement for export, but a voluntary certification system provided by a private company.

For jaabi to comply with EU food safety and especially microbiological standards (EC 2073/2005) implementation of HACCP and pre-requisite systems such as Good Manufacturing Practice is crucial.

HACCP implementation should include control of the following critical points in jaabi production:

- Inspection of harvested fruit (prevent contamination with micro-organisms and soil)
- Storage conditions of jaabi grains (bags should prevent moisture uptake, mould growth and insect infestation)
- Hygienic processing (coring, peeling, pounding, sieving performed with clean equipment)
- Quality of water added to flour (should be clean and free of microbial and chemical contamination)
- Steaming, roasting or sun-drying of yaabande cake should follow hygienic practices (prevent growth of spoilage and pathogenic micro-organisms as well as environmental contamination) – critical

Especially the latter process should be strictly re-engineered to implement safe processes, thereby eliminating the high levels of spoilage and pathogenic micro-organisms currently present in the product.

Jaabi shows great promise as a functional food if current issues of food safety and sustainable harvesting are adequately addressed.

4. Summary of product safety:

The analyses showed that kenkey and baobab complied with EU food safety regulations. While the microbiological profiles of akpan, gowé, kenkey, kishk Sa'eedi and bissap were mostly acceptable, the relatively high levels of yeast and mould and mycotoxins in some of these products is cause for concern and should be addressed in reengineering. Lanhouin, kitoza, kong and jaabi did not comply with all the microbiological safety standards.

The presence of histamine could be a problem in lanhouin and polycyclic aromatic hydrocarbon levels should be monitored in kitoza and kong.

5. Conclusion:

All production processes would benefit from the implementation of HACCP although this could be challenging in small home-based industries. For products which are already produced on a semi-commercial scale (baobab, bissap and to some extent kenkey) the implementation of a HACCP system will greatly improve export potential. Madagascar is not on the list of countries allowed to import meat products into the EU and kitoza should therefore be developed for the regional market.

Re-engineering should take environmental sustainability into account especially for wild harvested plants (baobab and jaabi) and fish (e.g. lanhouin) as well as intellectual property issues (kishk Sa'eedi, gowe, kenkey, baobab, bissap and jaabi). Researchers on baobab, bissap and jaabi should investigate Traditional Herbal Remedies regulations and also regulations regarding Novel Foods and Slow Foods certification (the latter also for kishk Sa'eedi). Re-engineering should then be focused on achieving compliance with the relevant standards or regulations.

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