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Abstract

The two main variants (fermentation in aerobic and semi-aerobic conditions) of the traditional processing of Lanhouin were investigated with four processors in two different processing sites (Ativicondji and adovlocondji) in Grand Popo municipality with the objective to identify the impact of various unit operations on the physico-chemical characteristics of intermediate products at different steps of the processing, and the final product as well. The physico-chemical changes occurred during the processing were determined according to ISO methods described in the SOP. The follow up of processors revealed that, the two technologies consisted of same units operations except the fermentation step which was different according to the material used. The physico-chemical characterisation of samples revealed that, the moisture, sodium chloride (NaCl), lipid, total volatile nitrogen (TVN) contents, and pH and water activity levels of intermediate products and Lanhouin samples varied from 56.3 ± 2.5 to 73.9 ± 2.5 g /100 g, 0.3 ± 0.0 to 14.1 ± 0.0 g/100 g, 9.2±0.8 to 10.9±0.0 %, 135.4 ± 4.3 to 259.8 ± 5.2 mg N / 100 g, 6.8±0.5 to 7.5±0.5, and 0.73 ± 0.0 to 0.97 ± 0.0 respectively. Histamine contents were within acceptable limit for all the Lanhouin samples. The follow up had allowed to identify the critical control points along the processing diagram of Lanhouin and to suggest some corrective actions for the reengineering work.

Introduction

Lanhouin, a traditional fermented fish based condiment is mainly processed in the coastal areas of Benin; it is mostly used as taste enhancer and flavouring agent in many types of dishes (Anihouvi et al., 2005; Kindossi et al., 2012). However, its production is still artisanal; consequently the quality of the Lanhouin depends on the manner which the different unit operations of the process were conducted. Moreover, the most significant operations such as the salting, the ripening and the fermentation are not well defined, nor controlled whereas they determine the final quality of Lanhouin (Anihouvi et al., 2005; Kindossi et al., 2012). For reengineering purpose, it would be necessary to characterise the product on both microbiological and physico-chemical aspects during the processing to identify the role of each unit operation on the final quality of Lanhouin. Two mainly variants, aerobic fermentation and semi aerobic fermentation conditions were noted in the procedures employed for the processing of fresh fish into Lanhouin, but both lead apparently to the same end product (Anihouvi et al., 2005; Kindossi et al., 2012).

The processing sites are mostly located close to the beach; processing activities are carried out late in the evening or early in the morning and this was to avoid high temperature during the first stage of processing and to prevent contact of fish with flies. Activities are carried out mostly by illiterate women as the major executors (Anihouvi et al., 2005). The methods of processing were developed in homes and improvements were based on the observations of practitioners. There is little interest in knowing the role of micro-organisms and the chemical changes that occur in the product. What is recognized are changes in texture, colour, odour and taste. The current study aims to characterise Lanhouin processing diagram, to assess the physic chemical and biochemical changes of intermediate product and Lanhouin samples obtained from the two main technologies generally used to process Lanhouin, and to identify critical point of the process that effect on the quality aspect of the intermediate product and end product.

Material and method

Follow up of processing

The follow up of Lanhouin processing was conducted in Grand Popo municipality (Ativicondji and adovlocondji sites) with four Lanhouin processors (two processors per site).

Production variability

Four productions trials were done during the follow up using two technologies: fermentation in aerobic conditions with basket used as fermentation material (FA) and the fermentation in semi-aerobic conditions using plastic can with cover or plastic bucket with cover as fermentation materials (FSA). The type of fish used during the follow up of two technologies was the fatty fish named king fish/Spanish mackerel.

Diagram establishment

The parameters raised during the diagnosis were different orders. The operational variables, flows of matters, inputs and waste were taken into account to work out the diagram of manufacture. The qualitative description of the process was focused preferably on photographs during manufacture. The list of the equipment used by the operators with each steps were included in this description. Sampling was done on products at different steps to make analyses in laboratory.

The diagram was established according to the model annex 1, which is the example of the process of production of Lanhouin in Benin.

For each unit operation (UO), the necessary information have been noted:

- Principal operational variables:
  - Duration of unit operations
  - Temperatures recording (initial, final, ambient)
  - In the diagram, in column "Analysis-follow-up-sampling" is specified as well as simple measurement of Ti, Tf or Tamb.
- The matter flow for the principal product: initial mass, final mass. These masses can be different for: (i) the process caused losses by exudation, (ii) waste was extracted (viscera, scale, etc…) or (iii) the fish received the addition of ingredients (salt, water, etc…). Moreover, samples were taken at the end of UO. The sampling did not enter in the calculation of the output of previous UO. To be capable to take into account only the variations related to UO and to make partial or total balance, the fish weights were expressed on a basis 100 initial throughout process.
- Flows of input:
  - Volumes of water (washing)
  - The number of labour necessary to the realization of OU.
- Waste matter:
  - Volumes of waste water
  - Viscera and scales

The steps where sampling was done for microbiological and physico-chemical analyses were PA1, PA2, PA3 and PA4 (Table 1).

Sampling variability during the follow up of production

The sampling was done on product obtained from step undergo biological, chemical and physical phenomenon. The selected steps were (annex 1: Diagram of production and sampling):

- Ripening: at the end of this step, the fresh fish is in partially deteriorated form; thus chemical and microbiological changes are expected. Chemical compound such as total volatile nitrogen (TVN) and biogenic amines which normally did not exist in the living tissues of fish are formed by autolysis and microbial actions. This step influence on the texture (soft) and on the aroma of the end product. (PA1: soft fish)
- Salting: the fish is salted with variable amount of salt (sodium chloride) to reduce microbial growth and that appeared during ripening. This step influences the colour (bright, shining) and the aroma of the end product. (PA2: salted soft fish)
- Fermentation: the fermentation of fish is a partial broken down phenomenon of complex organic molecules to simpler ones due to enzymes (autolysis) and micro-organisms present in the fish flesh. This is controlled by the addition of salt, thus the process is designed to produce a particular flavour and to preserve the end product as well (PA3: fermented fish)
- Drying: the salted and fermented fish is sun dried to reduce the moisture and stabilized the water activity. (PA4: Lanhouin)

In the same way, this work took into account the establishment of the matter balance during the production as well as the identification of the critical control points of the process, and other sources of danger or potential degradation of the quality of the end product. This consisted of the observation of fish and processing materials handling at all the steps of process and hygiene of the processing environment

The sampling steps and the microbiological and the physico-chemical parameters analysed are summarized in table 1.

Table 1: Sampling steps and physico-chemical parameters analysed

Sampling steps	PA1	PA2	PA3	PA4
Physico- chemical and biochemical parameters				
pH	x	x	x	x
Moisture	x	x	x	x
Water activity	x	x	x	x
Lipid	x			x
NaCl		x	x	x
Biogenic amines	x		x	x

PA1: soft fish; PA2: salted soft fish; PA3: fermented fish; PA4: fermented and dried fish (Lanhouin)

Identification of critical control points

The identification of critical control points along the processing steps was done using the SOP D3.2.11+3.2.2.1 described for this purpose.

Results and discussion

Description of the processing sites

The follow up of activities were carried out in four processing sites presented in the table 2 below. Two processors (A1 and A2) were monitored for the fermentation trials in aerobic conditions and two other (A3 and A4) for the fermentation in semi-aerobic conditions. The environment of four processors monitored was similar in terms of hygiene. The sites were characterised by their very unhygienic conditions with all kind of waste, paving the way for possible microbial or other type of contamination. In addition, the equipments used for the processing were not cleaned or not well cleaned. The photos 1 and 2 present the environment in which Lanhouin is processed

Table 2: Type of fermentation and processing sites monitored

Type of fermentation	Processors	Processing sites
Aerobic fermentation	A1	Adovlocondji AGOUE I
	A2	Ativicondji AGOUE II
Semi aerobic fermentation	A3	Adovlocondji AGOUE I
	A4	Ativicondji AGOUE II

Photo 1: Processing site of Adovlocondji AGOUE I

Photo 2: Processing site Ativicondji AGOUE II

Description and variability of processing methods (with flow diagrams, equipments and promising technology)

- **Processing**

Both technologies monitored include seven units operations which are: the first washing, the dressing (scaling and gutting), the second washing, the ripening, the third washing, the salting, the fermentation and the sun drying. These different steps are showed in figures 1 (photo1-8) and 2. For the fermentation in aerobic conditions the basket was use as fermentation material while for the fermentation in semi-anaerobic conditions, a plastic can was used as fermentation materials.

For processing of Lanhouin, fresh king fish was washed using well water (collected near the processing site) and gutted with knife to remove the viscera. Then the dressed fish was washed again with four (04) litres of water. The dressing step was followed by the ripening step which consists of living the fresh fish without any treatment. For the ripening, the dressed and washed fish was arranged in a plastic can or plastic of aluminium bowl, and covered with another plastic of aluminium bowl, and left for an average time of 10.5 hours (10 h 30 and 13 h 45 for fermentation in aerobic and semi aerobic condition respectively) at ambient temperature (30 ± 2°C). During this step, the fish was subjected to a process of tissue degradation under enzymes and microorganisms activities. After the 10.5 hours of ripening dry salt was introduced into the slit of evisceration under the operculum, into the gills and was passed on all the fish body. After the salting, the salted fish was arranged in a basket (aerobic fermentation condition), a plastic can with cover or plastic bucket with cover (semi aerobic fermentation); the rest of amount of salt used for curing was added and the fish was covered with old cement paper bag and old clothes, and allowed to ferment for nine (9) days at room temperature (30 ± 2 °C) before being removed. At the end of fermentation, the salted and fermented fish was then rinsed (Photo 12) to reduce the excess of salt and was sun dried for average time of 8 hours. The equipments used per processing steps are presented in table 3.

Table 3: Utensils, etc used for Lanhouin processing

Processing steps	Utensils, etc
Washing	Plastic or aluminium bowl
Gutting	Knife
Ripening	Plastic can, or plastic bowl
Salting	Plastic or aluminium bowl
Fermentation	Basket (FA*) ; plastic can with cover and plastic bucket with cover (FSA*)
Washing off salt	Bowl
Storage and packaging for sale	Basket, cement paper bag

**FA: fermentation in aerobic condition; *FSA: fermentation in semi-aerobic condition*

Washed fresh fish (1) Dressing (2) Washed dressed fish (3) Ripening (4)

Soft fish (5) preparation of basket (6) Dry salting (beginning) (7) Dry salting (end) (8)

aerobic fermentation (basket) (9) Semi aerobic fermentation (can) (10)

Fermented fish (11) Rinsing (12) sun drying (13) Lanhouin (14)

Figure 1: processing steps of Lanhouin

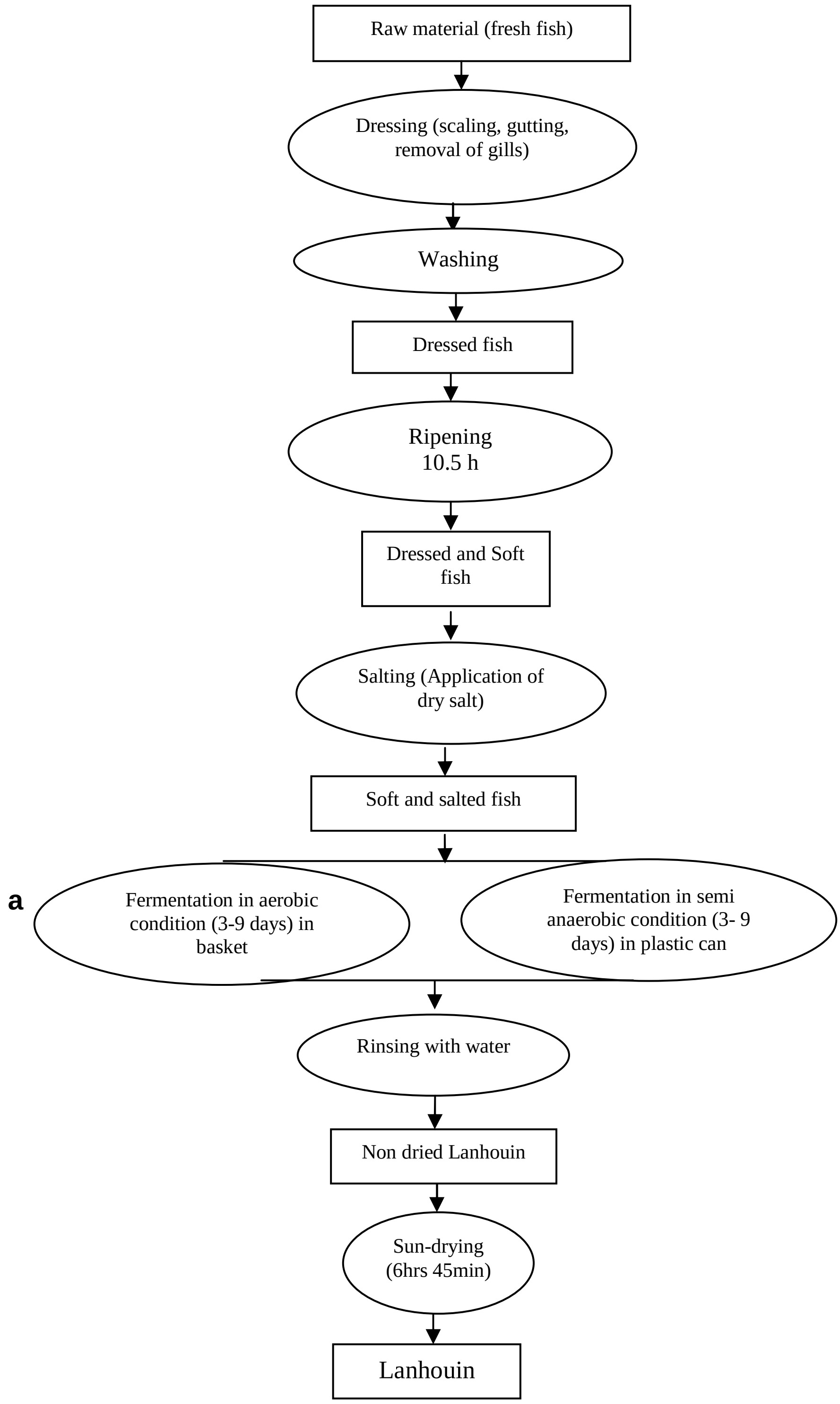

Figure 2: Flow diagram of Lanhouin processing in aerobic (a) and semi aerobic (b) fermentation condition

- **Physico- chemical changes during processing**

The results of physico- chemical changes occurred in intermediate products and Lanhouin samples during the processing are summarized in tables 4 and 5. For the fermentation in aerobic condition, the moisture content in raw fish (soft fish) decreased from 73.9 ± 2.5 g/ /100g to 60.7±5.5 g/100g in salted and fermented fish, and 56.3 ± 2.5 g /100g in the lanhouin samples after drying (Table 4). Similarly, for the fermentation in semi aerobic condition, the moisture contents of treated fish samples decreased from 73.8±0.1 to 63.8 ±2.4, 61.5±3.6 and 56.5±3.3 for the soft fish, the salted and fermented fish and the salted, fermented and dried fish (lanhouin) respectively (Table 5).

Table 4: chemical characteristics of intermediate products and Lanhouin obtained from aerobic fermentation process (n=2)

Parameters	SOP number	Soft fish	Salted soft fish	Salted and fermented fish	Lanhouin
Water activity (Aw)	Chem-MeatFish-003-fr	0.97±0.0	0.92±0.0	0.79±0.0	22.9±8.4
Moisture (%)	Chem-MeatFish-002-fr	73.9±2.5	68.8±2.1	60.7±5.5	56.3±2.5
pH	Chem-MeatFish-004-fr	7.5±0.5	7.1±0.1	7.4±0.4	7.5±0.5
NaCl content (g/100 g wwb)	Chem-MeatFish-001-en	0.5±0.0	8.4±1.4	10.0±0.3	10.9±0.5
Lipid (g/100g sample)	Nutri-MeatFish-002-fr	10.3±0.3	ND	9.8±0.6	9.2±0.8
ABVT (mg N / 100 g	Anti-Nutri-MeatFish-003-fr	158.6±11.2	ND	169.4±18.6	135.4±4.3
Histamine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	64.8±7.8	ND	5.82 ±0.0	11.2±0.4
Cadaverine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	85.8±4.1	ND	ND	ND
Putrescine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	99.5±7.4	ND	17.4±5.5	26.7±2.5
Spermidine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	39.2±1.9	ND	103.0±35.8	49.8±3.5

wwb: wet weight basis; ND: not determined ; n: number of samples analysed

Table 5: chemical characteristics of intermediate products and Lanhouin obtained from semi aerobic fermentation process (n=2)

Parameters	SOP number	Soft fish	Salted soft fish	Salted and fermented fish	Lanhouin
Water activity (Aw)	Chem-MeatFish-003-fr	0.90±0.0	0.80±0.0	0.73±0.0	0.73±0.1
Moisture (%)	Chem-MeatFish-002-fr	73.8±0.1	63.8±2.4	61.5±3.6	56.5±3.3
pH	Chem-MeatFish-004-fr	7.3±0.1	6.9±0.0	6.9±0.5	6.8±0.5
Chloride content (g/100 g wwb)	Chem-MeatFish-001-en	0.3±0.0	8.6±1.4	14.1±0.0	13.2±0.0
Lipid (g/100g sample)	Nutri-MeatFish-002-fr	10.9±0.0	10.7±1.1	10.2±1.5	9.8±1.0
ABVT (mg N / 100 g)	Anti-Nutri-MeatFish-003-fr	259.8±5.2	139.4±7.4	172.7±1.1	165.7±2.0
Histamine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	57.3±11.2	ND	19.5±1.3	12.3±1.8
Cadaverine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	58.0±20.2	ND	104.4±69.2	ND
Putrescine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	40.9±10.0	ND	68.5±85.2	170.8±50.9
Spermidine (mg/100 g wwb)	Anti-Nutri-MeatFish-004-fr	29..3±14.3	ND	13.3±1.3	140.7±8.6

wwb: wet weight basis; n: number of samples analysed

These values of moisture contents obtained for Lanhouin samples during this investigation agree with those reported in retailed Lanhouin samples collected from markets, Momoni samples and salted anchovy samples (Essuman 1992; Hernández-Herrero et al., 1999; Sanni et al., 2002; Anihouvi et al., 2006). It was suggested that the variation in moisture contents of samples could be the result of variable drying time and level and type of salt used for the processing. However, the moisture content seems to be an inexact indicator of the susceptibility of a product to undergo microbial spoilage. A major factor, which determines the microbial, chemical and enzymatic stability of foods, is the water activity (Aw) (Anihouvi et al., 2006). The water activity for all samples varied from 0.73 ± 0.0 to 0.97 ± 0.0 and decreased as the processing progressed. For both variants of technology, the levels of Aw ranged between 0.90 ± 0.0 and 0.97 ± 0.0, 0.73 ± 0.0 and 0.79 ± 0.0, and 0.73±0.1 and 0.75 ± 0.0 for the soft fish, the salted and fermented fish and Lanhouin respectively. However Aw values around or below 0.70 is needed to control microbial and enzymatic activity during the storage of Lanhouin. These levels of water activity measured on the samples were probably due to the short drying time (average time of 10.5 h) practiced by the processors during the monitoring survey. The pH values of samples increased from 6.8 ± 0.5 to 7.5 ± 0.5 as the process progressed and this independently to the variant of fermentation. However, the lowest values of pH were recorded in samples fermented in semi-aerobic condition. These pH values obtained were in agreement with those reported by (Anihouvi et al., 2006). In addition, some of these pH values were similar with those for momoni (6.47 ± 0.1 - 6.56 ± 0.1) (Sanni et al., 2002). The salt (NaCl) content of soft fish varied from 0.3 ± 0.0 - 0.5 ± 0.0 g/100 g while after curing, the salt contents in salted soft fish and Lanhouin samples varied from 8.6 ± 1.4 to 14.1 ± 0.0 g/100 g wwb for the fermentation in semi-aerobic (Table 5) and from 10.0 ± 0.3 to 10.9 ± 0.5 for salted and fermented fish and Lanhouin fermented in aerobic condition (Table 4). All the NaCl contents recorded were slightly higher than those reported by Anihouvi et al. (2006) in retail Lanhouin samples obtained from king fish (5.2 ± 1.0); but these salt content values were agree with those reported by Dossou-Yovo et al. (2011) on Lanhouin samples made from kingfish (11.8 ± 0.03). The lipid content of intermediate product and Lanhouin samples ranged between 9.2 ± 0.8 and 10.9±0.0 % wwb. Through these results, it appeared that the lipid contents of fermenting fish samples decreased slightly with processing time. In contrast, the total volatile nitrogen (TVN) content of samples increased as the process progressed, and varied from 135.4 ± 4.3 to 259.8 ± 5.2 mg N / 100 g wwb; but after salting a decrease in TVN was observed, suggesting that the presence of salt reduced microbial and enzymatic activity and consequently the production of TVN. The highest values of TVN contents were recorded in soft fish independently to the variant of technology (Tables 4 and 5). Level of TVN in fish is used as spoilage indicator due to bacterial and enzymatic action leading to amines production from proteins degradation (Hernández-Herrero et al., 1999; Anihouvi et al., 2006). It was suggested that white-fleshed fish is fresh when TVN contents were below 20 mg N/ 100 g, and fresh fish would be rejected for human consumption when the TVN content exceeds approximately 50 mg N/100 g. However, TVN contents higher than those limits have been reported by various authors for various fermented fish products (Perez-Villarreal and Pozo, 1992; Abbey et al, 1994; Hernández-Herrero et al, 1999; Itou and Akahane, 2000; Tungkawachara et al, 2003). Biogenic amines (histamine, cadaverine and putrescine) were present at all stages of the process but their levels seemed to decrease drastically after the salting step, and were within acceptable limit for both salted and fermented fish and Lanhouin samples with regard to histamine. The effect of salt concentration in histamine production has been reported by various authors (Anihouvi et al, 2011; Besas and Dizon, 2012).

The critical control points identified during the follow up of the processing are summarized in table 6. This was followed by table 7 regarding each step to be improved.

Table 6: identified critical point and corrective actions

Designation of the "hazard", the problems (note from 6 to 9)	Operation (step) concerned	Possible cause *(see listing under the table)*	Corrective actions suggested (reengineering/implantation of one OU)	Feasibility *
Microbial contamination (8) Physical contamination (8)	Unloading Buying	Bad fish handling, utensil used for unloading Quality of raw fish	Visual inspection during buying Discard rotten fish	Awareness
Microbial contamination (8) Chemical (production of histamine if evisceration is delayed) (8)	Dressing (evisceration, scaling)	- Microbial proliferation ; -Microbial cross contamination of fish by viscera; by processing materials	Make sensitive the processor to put viscera in a vat envisaged so that it does not be in contact of dressed fish or no dressed fish; training in fish handling and good hygiene practices including materials hygiene Process fresh within reasonable time	Awareness
Microbial contamination (6)	Washing1	Microbial cross contamination of water or material to fish	Use of potable water, evaluate microbiological quality of water; evaluate the microbiological quality of dressed washed fish; Good hygiene practices including materials hygiene	Potable water should be used wherever necessary to avoid cross contamination.
Microbial risk ((8) Chemical risk (7)	Ripening	Proliferation of microorganisms and biogenic amines production in the fish	Combination of ripening and salting to limit both microbial proliferation and biogenic amines production. The salting will be done by immersion in brine; Use of good quality salt Use of citric acid to decrease the pH during ripening	Ripening by immersing the gutted fish in a solution of citric acid to decrease the pH
Microbial contamination (8)	Washing 2	Microbial and chemical contamination due to materials and water used	Use of potable water, evaluate microbiological status of washed dressed fish; Hygiene of washing materials	Potable water should be used wherever necessary to avoid cross contamination.

Designation of the "hazard", the problems (note from 6 to 9)	Operation (step) concerned	Possible cause *(see listing under the table)*	Corrective actions suggested (reengineering/implantation of one OU)	Feasibility *
Microbial contamination (8) Physical contamination (6)	Salting	Ingredients (microbiological quality of salt used) -Impurities in salt	Do not use any salt provide from source or doubtful quality	
Microbial contamination (8)	Fermentation	Fish handling, materials of fermentation or other utensils, surfaces	Fermentation in wood box or plastic; good hygiene practices including materials hygiene Development of starter culture for the controlled fermentation (biopreservation)	Surfaces, utensils, should be thoroughly cleaned and where necessary disinfected after raw food (fish), has been handled or processed.
Microbial contamination (8)	Washing 3	Microbial contamination by the washing water, utensils, flies, and environment	Good hygiene practices including materials hygiene; use of repellent agent; Use of authorised chemical additives to the rinsing water	Addition of appropriate amount of sodium sorbate or potassium sorbate to the rinsing water to prevent insect infestation during drying and storage
Microbial contamination (8) Physical contamination (7)	Drying	Flies and other insects; drying materials, (favour the contamination of product, since it is done in very unhygienic conditions) sand, larvae	Improve the drying system (develop drying equipment; sun-drying under insect-proof netting	Results of analyses of dried lanhouin
Microbial growth during storage (7); Physical contamination (7)	Packaging	storage materials; insect infestation ; storage materials	Improve packaging to protect product integrity (prevent contamination by dust, insects, fungi and other micro-organisms)	Used of appropriate packaging materials; according to the type of Lanhouin (Lanhouin in form of dried fillet or in form of powder)

The standard fields of possible causes are indicated below:

- ***Raw product**: raw materials, ingredients, storage, quality*
- ***Material**: machines, tools, equipment, capacity, age, a number, maintenance, quality*
- ***Labour**: formation/competence, absenteeism, motivation, hygiene of the personnel, painfulness of the tasks, ergonomics…*

- ***Medium(environment)**: physical environment, utilities (water, energy), lighting, noise, installation, temperature, climate*
- ***Methods**: instructions, handbooks, procedures, steps procedures*
- ***Measurements**: control*
- ***Management**: organisation*
- ***Finished product**: outgoing element*

Table 7: Steps to be improved for lanhouin processing

Points à améliorer	Impact sanitaire du danger Notation* de 1 à 3	Fréquence d'apparition Notation* de 1 à 3	Criticité Note globale : impact * fréquence
Dressing (evisceration, scaling	3	3	9
Washing	2	3	6
Ripening	3	3	9
Salting	3	3	9
Fermentation	2	3	6
Drying	2	3	6
Packaging	2	3	6

1- faible; 2- moyenne; 3- forte

Conclusion

This investigation showed that apart from data on NaCl content in Lanhouin samples, the pH values, the moisture contents as well as the levels of Aw cannot offer suitable conditions for the safety of Lanhouin and the keeping capability. In this respect the reengineering action will be focused on how to get low pH and low Aw after processing, since these conditions could improve the microbial and chemical status of the end-product Lanhouin.

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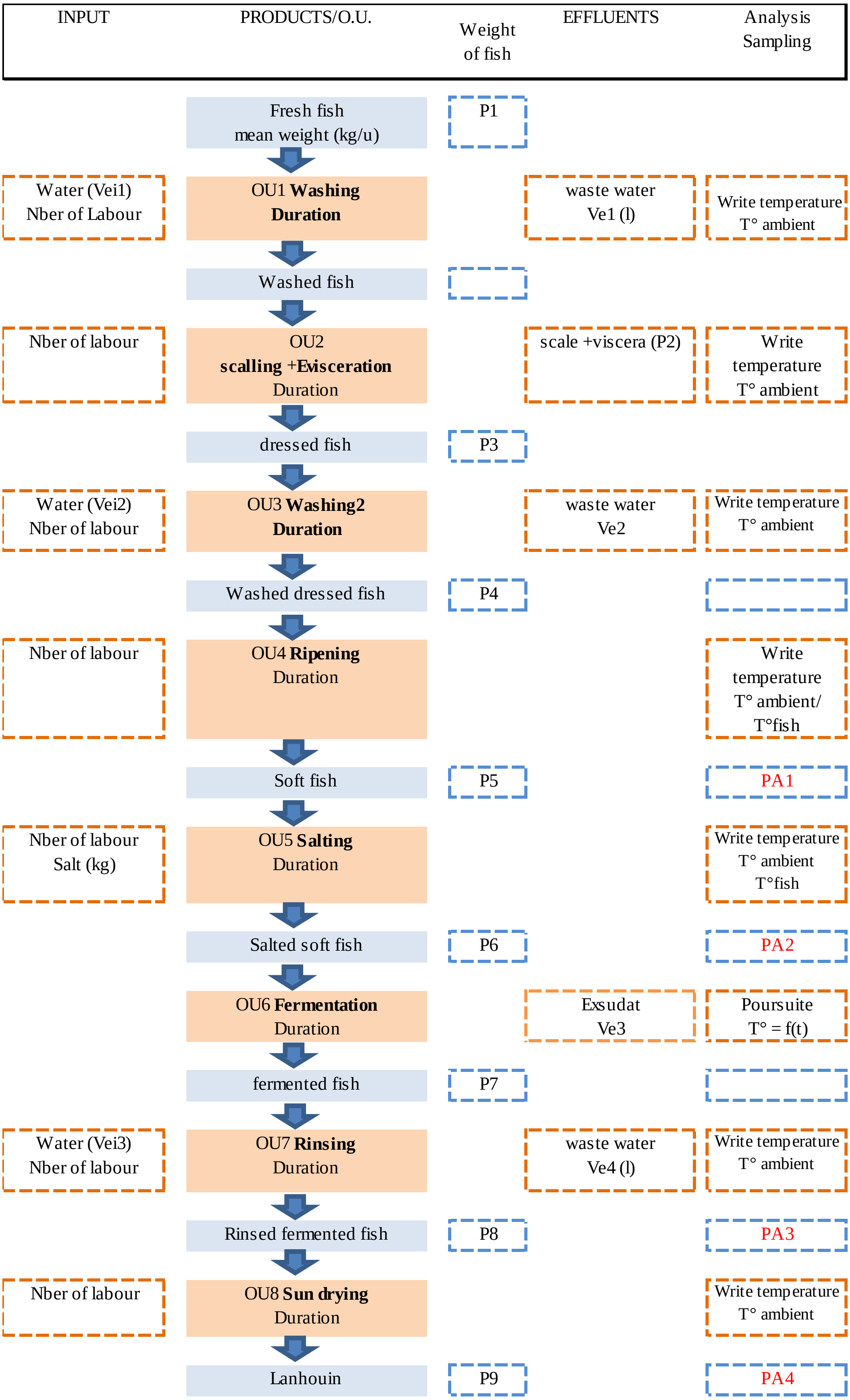
Annex 1: process of production of Lanhouin in Benin



Annex 2 : Matter balance in aerobic fermentation condition

Matter balance of aerobic fermentation production							
	Base real	7,2	±0.0	kg	Fresh fish	Hours	Base 100
mi1	mi1	7,20	0,92	kg	Evisceration (2,5 min)		100,0
viscera		0,25	0,00	kg		0,042	
mf1		6,95	0,92	kg			96,5
Yield1		0,97	0,00				
mi2		6,95	0,92	kg	Washing (3,5 min)		96,5
visceres		0,05	0,00	kg		0,058	
mf2	Water (4,5 litres)	6,90	0,92	kg			95,8
Yield2		0,99	0,00				
					Dressed fish		
mi3		6,90	0,28	kg	Ripening (13 h45min)		95,8
Exsudat1		0,40	0,00			13,78	
mf3		6,50	0,28	kg			90,3
Yield3	(mf3/mi3)	0,94	0,00				
					Soft fish		
mi4		6,50	0,35	kg	Washing 2 (3,5min)		90,3
Exsudat2		0,10	0,00	kg		0,058	
mf4		6,40	0,35	kg			88,9
rendt4	(mf4/mi4)	0,98	0,00				
					Washed soft fish		
mi5		6,40	0,64	kg	Salting (6 min)		90,3
Salt addition		4,68	0,25	kg		0,1	
mf5		11,08	0,11	kg			156,2
Yield5	(mf5/mi5)	1,73	0,10				
					Salted soft fish		
mi6		11,08	0,11	kg	Fermentation (9 days)		156,2
Exsudat		3,48	0,11			216	
mf6		6,70	0,21	kg			94,5
Yield6	(mf6/mi6)	0,60	0,01				
mi7		6,70	0,21	kg	Rinsing (3,5 min)		94,5
Water/salt	(2,5litres/-salt)	1,95	0,07			0,05	
mf7		4,75	0,14	kg			67,0
Yield7	(mf7/mi7)	0,71	0,00				
					Rinsed fermented fish		
mi8		4,75	0,14	kg	Sun drying (10h)		67,0
						10	
mf8		3,89	0,05	kg			54,8
Yield8	(mf8/mi8)	0,82	0,03				
					Lanhouin	240,1	
Global yield	(Yield1 x 2 x 3 x 4x5x6)	0,54	0,06				

Annex 3: matter balance in semi aerobic fermentation condition

	Matter balance of semi aerobic fermentation production						
	Base real	9,7	±0,0	kg	fresh fish	Hours	Base 100
mi1	mi1	9,65	0,21	kg	Evisceration (4,5 min)		100,0
viscera		0,28	0,11	kg		0,08	
mf1		9,38	0,32	kg			97,2
yield1		0,97	0,01				
mi2		9,38	0,32	kg	Washing (4 min)		97,2
viscera		0,04	0,01	kg		0,07	
mf2	Water (4,5 litres)	9,34	0,31	kg			96,8
yield2		1,00	0,00				
					Dressed fish		
mi3		9,34	0,31	kg	Ripening (10h30min)		96,8
Exsudat1		0,23	0,11			10,56	
mf3		9,12	0,42	kg			94,5
yield3	(mf3/mi3)	0,98	0,01				
					Soft fish		
mi4		9,12	0,42	kg	Washing 2 (4 min)		94,5
Exsudat2		0,08	0,04	kg		0,07	
mf4		9,04	0,45	kg			93,7
yield4	(mf4/mi4)	0,99	0,00				
					Washed soft fish		
mi5		9,04	0,65	kg	Salting (4,5 min)		94,5
Salt addition		4,70	3,11	kg		0,08	
mf5		13,74	3,56	kg			143,6
yield5	(mf5/mi5)	1,52	0,35				
					Salted soft fish		
mi6		13,74	3,56	kg	Fermentation (9days)		143,6
Exsudat		2,90	2,40			216,00	
mf6		9,05	1,17	kg			94,5
yield6	(mf6/mi6)	0,66	0,13				
mi7		9,05	1,17	kg	Rinsing (4 min)		94,5
Water/salt	(2,5litres/-salt)	2,38	1,10			0,07	
mf7		6,67	0,07	kg			68,7
yield7	(mf7/mi7)	0,74	0,09				
					Rinsed fermented fish		
mi8		6,67	0,07	kg	Drying (6h 48)		68,7
						6,08	
mf8		5,33	0,39	kg			55,6
yield8	(mf8/mi8)	0,80	0,06				
					Lanhouin	232,99	
Global yield	(yield1x2x3x4x5x6x7)	0,55	0,02				