FIELD REPORTS

Production, consumption, and quality attributes of Lanhouin, a fish-based condiment from West Africa

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Indigenous knowledge related to Lanhouin processing, commercialization, and consumption was investigated through a survey in the Mono District in the south of Benin using a questionnaire. The questionnaire focused on the socio-cultural profile of actors, the raw materials used for the processing, the technologies used, the quality attributes, the forms of consumption, and the storage of the product. The data collected were analysed by means of descriptive statistics and correspondence analysis. The results showed that Lanhouin is generally processed in informal small-scale plants. A large number of women are engaged in the production and the trade of Lanhouin and this constitutes the main source of income for most of them. Three variants of technologies were used to produce Lanhouin, but all apparently concluded in the same end product. The appreciation of the quality of Lanhouin by the actors is mainly based on sensory attributes such as the colour, texture, aroma, consistency of flesh, and the general appearance of the product. In Benin, Lanhouin serves various markets: domestic markets and sub-regional markets that contribute to an expanding market. As regards the forms of consumption, Lanhouin is used as a taste and flavour enhancing condiment in some main dishes such as vegetable, slimy vegetable, and tomato sauces.

Keywords: Lanhouin, fermentation, processing, storage, quality, commercialization, consumption

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The fishing industry is important in the socio-economic life of large numbers of poor people

The fishing industry plays an important role in the socio-economic life of large numbers of people around the world, many of whom are among the poorest and most marginalized people in rural communities. In Benin, fisheries form a significant economic sector with estimated annual production of 7,291 tonnes in 2008 for maritime fisheries (DP, 2009). Fisheries generate many employment opportunities such as fish harvesting, processing, and trading. Due to the extreme perishability of fish, however, post-harvest losses are estimated at about 20 per cent in West Africa (Horemans, 1998).

While in developed countries the practice of cold storage limits the problem posed by the extreme perishability of fish, in tropical regions, particularly in West Africa, traditional processes such as drying, salting, smoking, and fermentation are used for preservation of fresh fish. The preservation involves one or a combination of these methods in order to achieve the desired products (Essuman, 1992; Anihouvi et al., 2005). Salted, fermented, and dried fish is generally known as 'fermented fish' (Beddows, 1985). Fermented fish is any fishery product which has undergone degradative changes through microbiological and enzymatic activities either in the presence or absence of salt (Essuman, 1992). For a large segment of the world's population, fermented fish products contribute significantly to the diet by supplementing the protein intake (Beddows, 1985). In Benin, fermented fish is called Lanhouin. It is mostly used as taste enhancer and flavouring agent in many types of dish including dishes of European origin. The production areas in Benin include the Atlantic District and mainly the Mono District in the south of the country which, according to popular belief, is the origin of Lanhouin know-how. In these areas, Lanhouin is produced traditionally by cottage industries through spontaneous and largely uncontrolled fermentation. Recent research on Lanhouin in the Atlantic District revealed two variants of processing as well as a number of problems related to the processing and the quality of the product (Anihouvi et al., 2005, 2006).

In Benin, fermented fish (Lanhouin) is used as a flavouring agent in many dishes

The present field investigation was carried out in the Mono District (where the Lanhouin technology originated) by means of a survey conducted among actors in the Lanhouin sector. It aimed to give a better understanding of the processing of Lanhouin, the raw materials and other ingredients used to produce Lanhouin, the definition of the most important quality attributes according to the actors, and the different forms of consumption of the product. It also investigated the specific problems related to the processing, storage, and commercialization of this product, for a further upgrading of the technology.

Materials and methods

Survey zones and sampling of actors

Field investigations were conducted in the Mono District and mainly in Grand-Popo municipality (Agoué, Avloh, Grand-Popo city), Comé municipality (Comé city), and Djodahand Anèho markets in Togo, close to the Benin–Togo border. The number of actors interviewed was determined according to Dagnelie (1998) as described by Chadare et al. (2008). In the different selected zones, a proportion of actors was assessed through a random check on 534 people (140 processors, 138 traders, and 256 consumers) from different socio-cultural groups and localities, and of both genders at various ages (young, adult, old) (Table 1).

Field data collection

The survey was conducted by interviewing Lanhouin processors, traders, and consumers (individual interviews or focus group discussions), using a questionnaire as well as observations of the processors at work. A preliminary survey was conducted in order to identify production sites and pre-test the questionnaire. Interviews were conducted in French and local languages (Xwla, Mina, and Pedah). The questionnaire focused on the socio-cultural profile of Lanhouin processors, traders, and consumers, the raw material and other ingredients used for Lanhouin processing, the fermentation process, the quality attributes and storage of Lanhouin, the consumption form of Lanhouin, and specific problems related to the processing, storage, and commercialization of Lanhouin.

Table 1. Number of actors surveyed per locality and categories of actors in the survey zones

Area surveyed	*Number of actors surveyed*			*Total number of actors surveyed*
	Number of producers	*Number of traders*	*Number of consumers*	
Agoué	57	53	165	275
Avloh	24	25	29	78
Grand-Popo	52	10	43	105
Comé	0	14	5	19
Djodah	7	20	14	41
Anèho	0	16	0	16
Total	140	138	256	534

Data analysis

The collected data was recorded and statistical analyses were performed using Sphinx survey plus2 (version 4.5) software. Principal component analysis (PCA) was performed with SPSS (version 16.0) to describe the link between socio-cultural groups and consumption forms, and socio-cultural groups and variants of technologies.

Results and discussion

Socio-cultural profile of Lanhouin processors

Production and retailing of Lanhouin are the main sources of income for illiterate women

The survey showed that the production and retailing of Lanhouin are mainly carried out by illiterate women. Lanhouin processing constitutes the main source of income for the majority (91.4 per cent) of them. All the processors surveyed were female, aged between 25 and 65 years; 84 per cent of them were between 25 and 50 years, and 16 per cent between 51 and 65 years. The majority of them (99.3 per cent) were married to fishermen or had a family relationship with them. Most of them (61.4 per cent) had no formal education, while 32.1 per cent and 6.4 per cent had primary education and secondary education, respectively. In the survey zones, Lanhouin was mainly produced by processors who inherited the know-how (88.6 per cent); those who received the knowledge from a friend represented only 11.4 per cent of processors interviewed. The main socio-cultural groups involved in the production were: Keta (42.1 per cent), Mina (36.4 per cent), Xwla (17.1 per cent), Pedah (1.4 per cent), and low numbers (2.8 per cent) of Fon and Adja. As reported by Anihouvi et al. (2005), the survey showed that the production of Lanhouin is an artisanal activity which was mainly performed by women. The Keta is one of the most important socio-cultural groups involved in Lanhouin processing in addition to the Xwla and Mina socio-cultural groups, as also revealed by previous work (Anihouvi et al., 2005).

Lanhouin is mainly produced by processors who inherited the know-how

Three categories of processors were identified and their distribution is shown in Table 2: (1) the large-scale processors (18.6 per cent); (2) the medium-scale processors (23 per cent); and (3) the small-scale processors (58.4 per cent). They processed the two main types of Lanhouin: fermented and sun-dried Lanhouin (observed with 100

Table 2. Quantity of Lanhouin produced per category of processor

Quantity (kg) of Lanhouin produced/month	*% of respondents*	*Categories of processor*
Less than 300	58.4	Small-scale processors
300–1,000	23.0	Medium-scale processors
1,000–3,000	18.6	Large-scale processors

per cent of processors) and Lanhouin zodéké, which is a non-dried and slightly fermented Lanhouin produced within 24 h (observed with 1.4 per cent of processors). This type of Lanhouin, also called Lanhouin zokpa, is mainly produced during the scarcity period of the year. The survey also revealed that Lanhouin has various names: Lanhouinhouin, Lanpipi, Yaya, and Landodjé, according to the socio-cultural groups. A similar observation was reported by Essuman(1992) and Abbey et al. (1994) for other African fermented fish products.

Processing techniques for Lanhouin

Illegal substances such as petroleum and insecticides are used to protect against flies and maggot infestation

Raw materials and other ingredients used. The raw materials used to process Lanhouin include sea fish and salt. However, illegal substances such as petroleum, insecticides, or lemon peel are used (claimed by 39.3 per cent, 10.0 per cent, and 4.9 per cent of the processors, respectively), in order to protect the product from flies and maggot infestation during processing (mainly during the drying step) and the storage period. Different species of fish can be used for Lanhouin processing, but the ones claimed by the processors are listed in Table 3. The majority (95.0 per cent) of them used Cassava croaker (*Pseudotolithussenegalensis*).This is followed by lesser African threadfin (*Galeoidesdecadactylus*, 88.6 per cent), Atlantic bumper (*Chloroscombruschrysurus*, 87.9 per cent), kingfish/Spanish mackerel (*Scomberomorustritor*, 81.4 per cent), and crevalle jack (*Caranxhippos*, 77.1 per cent). With the exception of *Chloroscombruschrysurus* and *Caranxhippos*, the three other species mentioned above have already been reported by Anihouvi et al. (2005) as the main species used by Lanhouin processors. Generally, the fishes are bought from the fishermen at the beach and transported to the processing sites by foot, by motorbike, or by car (96.4 per cent, 8.6 per cent, and 1.4 per cent of interviewed processors, respectively).

Regarding the quality criteria for fresh fish for use in Lanhouin production, the majority (97.6 per cent) of processors said they use lean fish to avoid rancidity problems during storage. They also claimed that for lean fish a small amount of salt is needed, while fatty fish usually needs more salt to produce the same amount of Lanhouin. However, 66.0 per cent of producers asserted that Lanhouin produced from fatty fish can be sold at a higher price than those obtained from lean fish because of its flavour. In this respect, the role of lipids in the development of flavour during processing has been reported by various authors (Cadwallader et al., 1994; Durnford and Shahidi, 1998).

Lanhouin produced from fatty fish can be sold at a higher price because of its flavour

According to the processors, two types of salt can be used to produce Lanhouin: locally produced, sun-dried salt obtained from lagoon or sea water (used by 87.9 per cent of interviewed processors);

Table 3. Types of fish commonly used for Lanhouin processing in the survey zones

Local names	*Common names*	*Scientific names*
Agbanmadoui/Zadoui	**Kingfish/Spanish mackerel**	**Scomberomorustritor**
Ahouê	Bonga shad	*Ethmalosafimbriata*
Ekan/djoke	**Cassava croaker**	***Pseudotolithussenegalensis***
Fiovi	Senegal jack	*Caranxsenegallus*
Finvi	Blackmouth croaker	*Pentheroscionmbizi*
Fohomê	Wide-eyed founder	*Bothuspodasafricanus*
Gbohloué	Milk shark	*Rhizoprionodonacutus*
Glanmatan/kobi	Longfin pompano	*Trachinotusgoreensis*
Guinfio/guinlonou	Royal threadfin	*Pentanemusquinquarius*
Handjè	Gorean snapper	*Lutjanusgoreensis*
Hawui	Bigeye grunt	*Brachydenteusauritus*
Kanflanvi	West African ilisha	*Ilishaafricana*
Kokouin	Bastard grunt	*Pomadasysincisus*
Kpankpan	**Crevalle jack**	***Caranx hippos***
Kplouloui	Atlantic rubyfish	*Erythroclesmonodi*
Lipa	Largeheadhairtail	*Trichiuruslepturus*
Lizi	Guachanche barracuda	*Sphyraenaguachancho*
Manvi	Sardinella	*Sardinellaaurita*
Oloto	Flying gurnard	*Cephalacanthusvolitans*
Oungogba	African moonfish	*Selene dorsalis*
Sika-sika	Congo dentex	*Dentexcanariensis*
Sinkplin	Round scad	*Decapteruspunctatus*
Tchikoué	**Lesser African threadfin**	***Galeoidesdecadactylus***
Tchochovi	Guinea croaker	*Pseudotolithusepipercus*
Zozrovi	**Atlantic bumper**	***Chloroscombruschrysurus***

and imported salt (used by 12.1 per cent of processors). Texture and colour are the most important criteria used to appreciate the quality of salt for the majority of processors (86.5 per cent), who asserted that the salt should be coarse and its colour should be white (88.6 per cent of respondents), while 11.5 per cent of the processors preferred a russet red colour.

Lack of processing standardization causes product quality to vary between batches or processing sites

Processing of fish into Lanhouin and associated problems. The study showed that the processors use simple artisanal technologies for fermentation, drying, packaging, and storage of Lanhouin. All these methods date back in history and are used by different socio-cultural groups. There is a lack of standardization of processing techniques, and product quality could vary from batch to batch or from one processing site to another in the different zones visited. For the majority (92.2 per cent) of the interviewed processors, Lanhouin

should be processed with fresh fish; however 7.8 per cent of them claimed that rotting fish can also be used, but in that case the ripening stage is no longer applied. Three variants of the technology of Lanhouin production were observed, with the difference mainly in the type of container and conditions used for the fermentation stage. The two predominant ones are fermentation under aerobic conditions (used by 50 per cent of respondents) and fermentation in semi-anaerobic conditions (observed with 51 per cent of respondents). The three variants apparently lead to the same end product.

When the fresh fish is processed into Lanhouin using one of the two predominant technologies described above, the fish is scaled, gutted, arranged in a container, covered with old cleaned clothes, and left at ambient temperature for ripening for 11–16 hours. The ripened fish is washed again and arranged in a basket to drain; dry salt is then rubbed into the gills, the belly cavity, and on the surface, and the ripened and salted fish is allowed to ferment for three to nine days before being sun-dried for one to two days (Figure 1). Sometimes a second salting is applied after the first two days of fermentation, when the fish will be fermented for more than three days, and fermentation allowed to progress until the last day. After processing, the Lanhouin is generally packaged in a basket lined with old clothes or cement paper bags, in a jute bag and secured with an old fishing net.

The principal correspondence analysis (PCA) performed on species of fish and variants of technology resulted in two axes accounting for 77.8 per cent of the total variation, of which 48.3 per cent was explained by the first axis (Axis 1) and 29.5 per cent by the second (Axis 2) (Figure 2). Figure 2 shows the correlation between the variants of technology and various types of fish used for Lanhouin processing. Fish species used for a particular variant are grouped together with the technology. Regarding axis 1 (Figure 2), of the main five species mostly used for Lanhouin processing, Kingfish (*Scomberomorustritor*) is used more for aerobic fermentation while Crevalle jack (*Caranx hippos*) and Cassava croaker (*Pseudotolithussenegalensis*) are used for anaerobic and semi-anaerobic fermentations, respectively. With respect to axis 2, Atlantic bumper (*Chloroscombuschrysurus*), lesser African threadfin (*Galeoidesdecadactylus*), and cassava croaker (*Pseudotolithussenegalensis*) are more often used for fermentation in semi-anaerobic and anaerobic conditions.

The major problems observed include the general unhygienic conditions of the processing environment

The major problems observed with the Lanhouin processors are the general unhygienic conditions of the processing environment (presence of solid and liquid waste, flies, domestic animals) as well as the processing materials. Other practices noticed include the use of non-potable water (sea water collected near the bank or well water) for washing the fish and improper packaging of the product (use of baskets covered with old sacks, old clothes, or cement paper

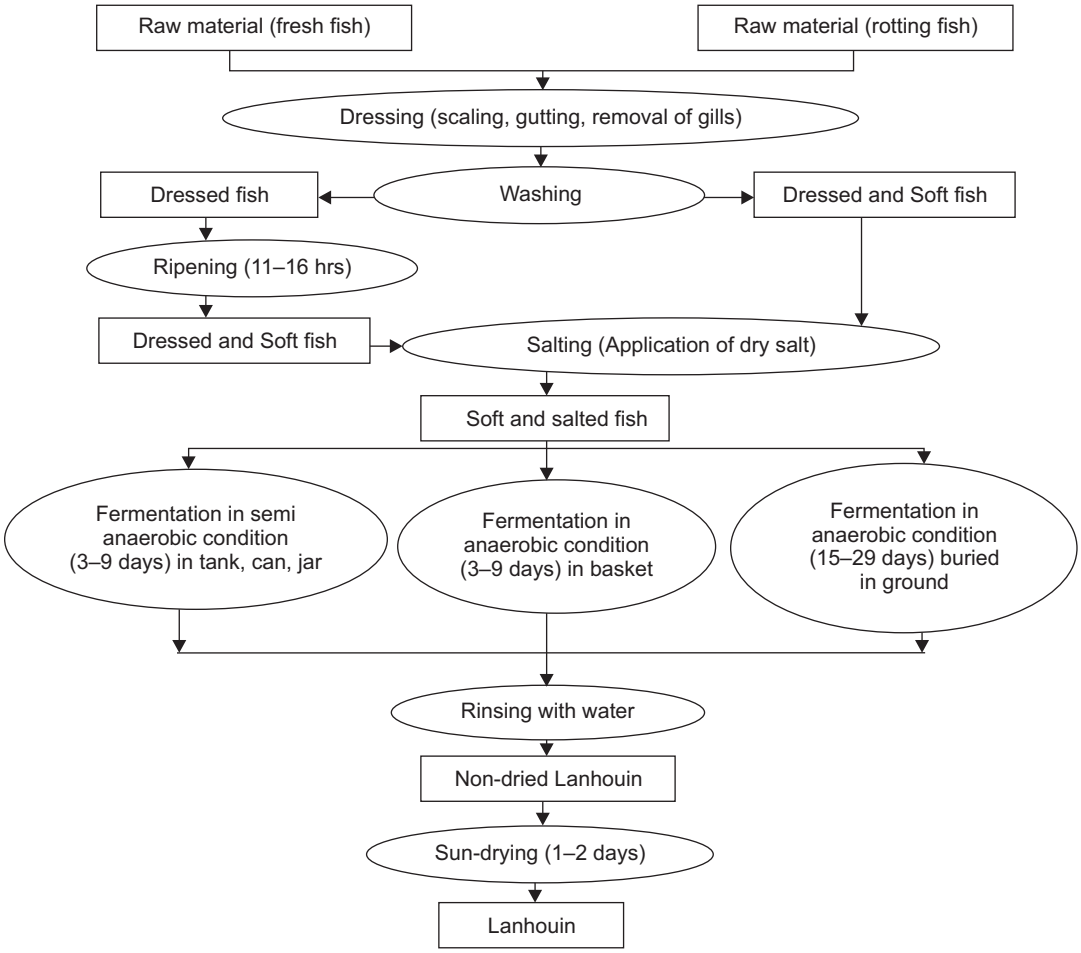

Figure 1. Flow diagram of Lanhouin processing

bags). Such practices could be potential sources of contamination by pathogenic bacteria. The ratio of salt used varied from one production site to another and from one processor to the other, and is usually not quantified. As salt is the only preservative agent used, low salt fermentation could possibly permit the growth of some pathogenic organisms in the product (Horner, 1997). In addition, the salt is not stored under favourable conditions and the salt is often reused in subsequent fermentations. This practice could be a potential source of contamination by halophilic bacteria. There is a lack of standardization of the processing techniques, and product quality could vary from batch to batch or from one processing site to another in the different zones visited. The presence of flies was also a big problem

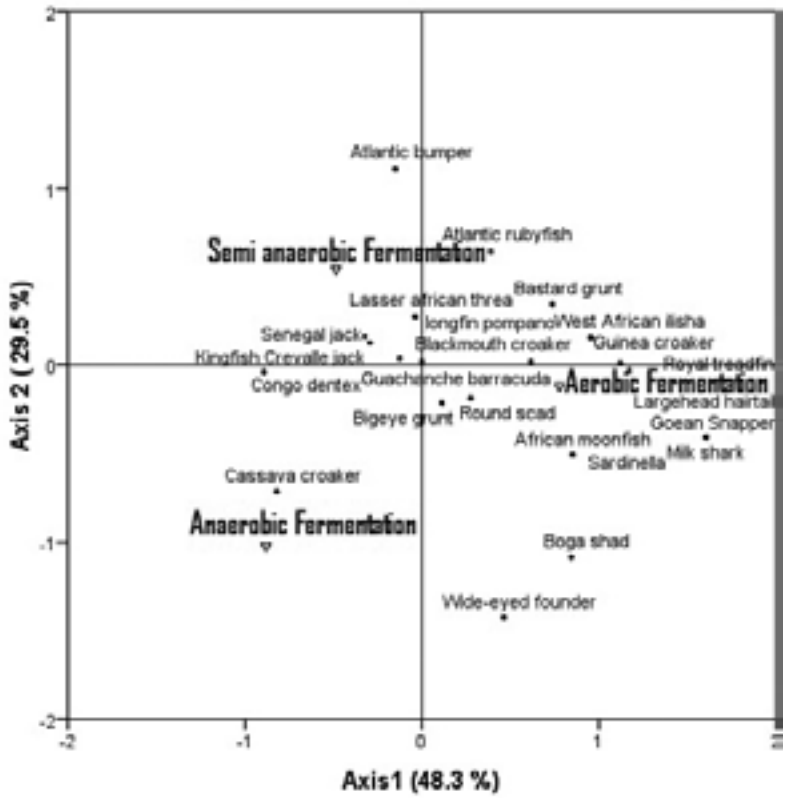

Figure 2. Correspondence Analysis to reveal linkages between species of fish and variants of technology used to process Lanhouin on axes 1 and 2.

for the processors, leading to the illegal use of household insecticides to prevent flies settling on the product. The use of insecticides for this purpose poses a health hazard to the consumers. In addition, drying on the ground exposes the end product to contamination by domestic animals, microorganisms, and soil. Processors usually package the Lanhouin in baskets covered with old sacks, old clothes, or cement paper bags during fermentation, storage, and when transporting the product to the market. The unhygienic nature of these materials could be potential sources of microbial or other types of contamination.

Quality attributes of Lanhouin

The appreciation of the quality of Lanhouin by the processors, traders, and consumers is mainly based on observations of sensory attributes such as the colour, texture, aroma, consistency of flesh, and the general appearance of the product. Previous studies have

Table 4. Percentage of respondents per category of actors and quality attributes

Processing sites/markets level	*Texture/Consistency of flesh*	*Colour*	*Aroma*	*Absence of foreign matter*
Processors	85.70	72.10	74.30	0.00
Traders (wholesalers/retailers)	86.20	71.70	22.50	23.20
Consumers	98.00	97.30	38.70	75.00

reported the use of similar quality attributes on various fermented fish products (Essuman, 1992; Abbey el al., 1994; Anihouvi et al., 2005). Other attributes such as taste and the absence of foreign matter were mentioned by some actors. The lack of packaging has also been pointed out by some consumers as a negative aspect for Lanhouin handling. The percentage of respondents per category of actors who described the various quality attributes as important is summarized in Table 4. Thus, most of the processors (72.1 per cent), traders (71.7 per cent), and consumers (97.3 per cent) found brightly coloured and shining Lanhouin most attractive. About 74.3 per cent of processors and 22.5 per cent of traders asserted that a good Lanhouin should have a strong aroma, while for 38.7 per cent of the consumers Lanhouin should have a strong but not repugnant aroma. Concerning the texture, around 85.7 per cent of processors, 86.2 per cent of traders, and 98.0 per cent of consumers claimed that Lanhouin should have a soft texture, with firm and spongy flesh to allow good dispersion in the dishes. Moreover, 75.0 per cent of consumers and 23.2 per cent of traders interviewed insisted that Lanhouin should be free from dead flies and maggots (larvae) to be safe for consumption. According to 90.7 per cent of the processors, apart from the fish species, the added value of Lanhouin depends on the soft texture, the spongy consistency, and the bright shining colour of its flesh. These quality characteristics are conferred to the product through a number of unit operations, such as ripening, which involves a partial hydrolysis of the flesh and breakdown of proteins into their constituent peptides and amino acids due to microbial and enzymatic activities. The development of a strong aroma mainly during the fermentation step is a consequence of microbial and enzymatic activities. However, in the presence of salt only halophilic bacteria can survive (Horner, 1997) and therefore contact with salt limits the activity of spoilage bacteria during the fermentation step.

Most processors, traders and consumers found brightly coloured, shining Lanhouin most attractive

Lanhouin should have a soft texture, with firm spongy flesh for good dispersion in dishes

Commercialization of Lanhouin and the socio-cultural profile of Lanhouin traders

In Benin, Lanhouin serves various markets: domestic markets (urban and rural) and regional markets. Three different types of Lanhouin

Different types of Lanhouin were fermented and sun-dried or fermented and not dried

were encountered at market level: fermented and sun-dried Lanhouin (commercialized by 96.4 per cent of traders interviewed), fermented and non-dried Lanhouin (commercialized by 22.5 per cent of traders interviewed), and Lanhouin zodéké (commercialized by 12.3 per cent of traders interviewed). In the same way, three categories of traders were observed in the commercialization of Lanhouin in the survey zones: the wholesalers (30.6 per cent of respondents), the intermediary sellers (48 per cent of respondents), and the retailers (22 per cent of respondents). The retailers mainly buy Lanhouin from medium-scale processors, but some of them also process. The wholesalers and the intermediary sellers may also be processors; they serve the domestic and regional market, while the retailers serve only the local market. Exports to the neighbouring countries of Togo and Ghana are not recorded but represent significant amounts. Socio-economic data collected from the survey zones showed that a wholesaler, an intermediary seller, and a retailer sell a rough average of 30, 6.6, and 0.6 tonnes of Lanhouin per year with an annual profit of CFA10,500,000, 2,310,000, and 210,000,respectively (US$1 = 500 CFA).

Both genders, but mainly women (96.4 per cent) and a few men (3.6 per cent) are involved in Lanhouin commercialization in the survey zones. Most of the women are between 20 and 65 years old, but mostly above 30 years old, and belong to different socio-cultural groups, including mainly: Mina (38 per cent), Keta (33 per cent), Xwla (12.3 per cent), and Pedah (10.1 per cent) groups.

Storage of Lanhouin and problems associated with storage

The storage duration of Lanhouin can vary according to the type of Lanhouin: dried Lanhouin or non-dried Lanhouin. After processing, the majority (95 per cent) of processors generally package Lanhouin in a basket and cover it with old clothes or cement paper bags, or in jute bags, secured with an old fishing net. Similar storage practices were also indicated by 65.2 per cent of traders interviewed. Dried Lanhouin could be stored for 75–120 days (claimed by 67 per cent of processors) while the non-dried Lanhouin could be stored in the presence of salt for 90–180 days (claimed by 62.1 per cent of processors). The major problem in relation to storage of Lanhouin is the spoilage (claimed by 68.8 per cent of respondents) due to insect infestation, because of the lack of appropriate packaging material. Indeed, packaging materials such as baskets do not offer any barrier to insect infestation. Another storage problem is that bacterial and enzymatic activity continues within stored Lanhouin, leading to an unstable product. These types of problem lead to the illegal use of substances such as petroleum (claimed by 39.3 per cent of respondents) and insecticide (10 per cent of respondents) during the storage period.

The major problem in storage of Lanhouin is spoilage due to lack of appropriate packaging materials

Frequency, occasion, place, and forms of consumption of Lanhouin

For most consumers (69.5 per cent of female and 30.5 per cent of male, aged between 20 and 65), Lanhouin is used as a condiment to season dishes such as slimy vegetable sauces prepared with okra (*Abelmoschusesculentus*), leaves of *Corchorusolitorius* L. and seed of *Irvingia gabonensis* (claimed by 98.4 per cent), leafy vegetable sauces (*gbékoui*, *avouvo*, *gboma*) (63.7 per cent), cooked tomato sauce, *agbanmèdessi* (53.1 per cent), uncooked tomato sauce, *yégbéssési*, also called *monyo* (29.3 per cent), fried rice (7.4 per cent), stew (5.5 per cent), ground *egussi* (*Citrullus lanatus*,Thunb.), or groundnut sauce (3.1 per cent). Regarding the frequency of consumption of the dishes mentioned above, most respondents eat slimy vegetable sauces (13.7–51.8 per cent), vegetable sauces (12.8–34.3 per cent), cooked tomato sauce (11.4–43.6 per cent), uncooked tomato sauce (7.5–18.8 per cent), fried rice (1.8–5.1 per cent), stew (1.1–5.1 per cent), and *egussi* or groundnut sauce (0.9–1.4 per cent) once or several times per week (Table 5). Concerning the occasion and the place of consumption, these dishes are consumed at breakfast (11–35.3 per cent of respondents), lunch (11.5–37.6 per cent), and dinner (11.1–37.7 per cent) and at various places (home, street food and restaurant, funeral ceremonies, and other types of festivity).

Table 5. Consumption pattern of the main dishes containing Lanhouin

Frequency of consumption (times/week)	*Dishes containing Lanhouin*			
	Slimy vegetable sauces (%)	*Leafy vegetable sauces (%)*	*Cooked tomato sauces (%)*	*Uncooked tomato sauce (%)*
6–7	20.5	12.8	43.6	12.8
4–5	13.7	21.4	40.2	18.8
2–3	51.8	25.0	11.4	7.5
1	36.4	34.3	12.9	11.4
Occasion of consumption				
Breakfast				
Lunch				
Dinner	35.3	24.4	23.5	11
	37.6	25.1	20.4	11.5
	37.7	25.0	20.8	11.1
Place of consumption				
Home	37.6	25.0	20.2	11.5
Street food from sales women	33.7	25.4	18.9	14.8
Restaurants	33.3	28.6	19.0	9.5
Funeral ceremonies	52.9	23.50	17.6	5.9
Other types of festivity	50.0	25.0	18.7	6.3

The PCA to investigate associations between the forms of consumption of Lanhouin and socio-cultural groups showed that the Fon and Mina groups mainly use Lanhouin to season tomato and slimy vegetable sauces. The Xwla, Pedah, Keta, and Saxwè groups use Lanhouin as condiment to season vegetable sauces, uncooked tomato sauce, and slimy vegetable sauce.

Conclusion

The survey revealed that the processing of Lanhouin is not only a form of preservation of fresh fish, but also a form of recycling of rotting fish. Three variants of fermentation processes were identified through the survey but the two predominant ones are fermentations in aerobic and semi-anaerobic conditions with dressing, ripening, salting, and sun-drying as common unit operations. The recorded perception of the important quality attributes of Lanhouin according to the actors provided clear guidelines for re-engineering perspectives. Processing steps such as ripening, salting, drying, and packaging were identified for potential re-engineering which can improve the quality of Lanhouin. Regarding the consumption pattern, Lanhouin is mostly used at home and at ceremonies in dishes such as sauces. The major problems identified during the survey included the lack of hygiene and standardization of the processing techniques, the use of inadequate packaging materials, and the unstable nature of Lanhouin during storage.

The perception of important quality attributes provided clear guidelines for re-engineering perspectives

References

Abbey, L.D., Hodari-Okae, M. and Osei-Yaw, A. (1994) *Studies on Traditional Processing and Quality of Fermented Fish (Momone)*, Ghana/Netherlands Artisanal Fish Processing and Applied Research Project Report, Food Research Institute, Accra, Ghana.

Anihouvi, V.B., Hounhouigan, J.D. and Ayernor, G.S. (2005) 'La production et la commercialisation du *lanhouin,* un condiment à base de poisson fermenté du golf du Bénin', *Cahiers agricultures* 14(3): 323–330 <http://www.jle.com/e-docs/00/04/0D/C2/vers_alt/VersionPDF.pdf>.

Anihouvi, V.B., Ayenor, S.G., Hounhouigan, J.D. and Sakyi-Dawson, E. (2006) 'Quality characteristics of *lanhouin*, a traditionally processed fermented fish in the republic of Benin', *African Journal of Food Agriculture Nutrition and Development* 6: 1–15 <http://www.ajfand.net/Volume6/No1/Anihouvi1625.pdf>.

Beddows, C.G. (1985) 'Fermented fish and fish products', in B.J. Wood (ed.), *Microbiology of Fermented Food*, pp. 1–39, Elsevier Applied Science, London.

Cadwallader, K.R., Back, H.H., Chung, H.Y. and Moody, M.W. (1994) 'Contribution of lipid derived components in the flavour of alligator meat', in C.T. Ho and T.G. Hartman (eds), *Lipids in Food Flavors*, ACS Symposium series 558, American Chemical Society, Washington, DC.

Chadare, F.J., Hounhouigan, J.D., Linnemann, A.R., Nout, M.J. R. and Van Boekel, M.A.J.S. (2008) 'Indigenous knowledge and processing of *Adansonia digitata* L. food products in Benin', *Ecology of Food and Nutrition* 47(4): 338–362 <http://dx.doi.org/10.1080/03670240802003850>.

Dagnelie, P. (1998) *Statistiques théoriques et appliquées: Inférence statistique à une et à deux dimensions*, p. 559, de Boeck Université, Tome 2, De Boeck and Larcier S.A., Brussels, Belgium.

Durnford, E. and Shahidi, F. (1998) 'Flavour of fish meat', in F. Shahidi (ed.), *Flavor of Meat, Meat Products and Seafoods*, 2nd edn, pp. 130–158, Blackie Academic and Professional, London.

DP (2009) *Direction des Pêches, Rapport du service suivi-évaluation, fiche annuelle de production*, Ministère de l'Agriculture de l'Elevage et de la Pêche, Direction des Pêches, Cotonou, Bénin.

Essuman, K.M. (1992) *Fermented Fish in Africa: A Study on Processing, Marketing and Consumption*, p. 80, FAO Fisheries Technical Paper 329, FAO, Rome.

Horemans, B. (1998) *The State of Artisanal Fisheries in West Africa in 1997*, Programme for the Integrated Development of Artisanal Fisheries in West Africa, Technical Report 122, FAO, Rome.

Horner, W.F.A. (1997) 'Preservation of fish by curing (drying, salting and smoking)', in G.M. Hall (ed.), *Fish Processing Technology*, 2nd edn, pp. 32–72, Blackie Academic & Professional, London.