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Improving food value chains for cereal doughs in West Africa: case study of mawè in Benin

Marcel Houngbédji, Sègla Wilfrid Padonou, Ana Maria d'Auchamp, Noël Akissoé, Moses Dachariga Mengu, Lene Jespersen, and D. Joseph Hounhouigan

Abstract: *A good understanding of the socio-demographic and economic factors which characterize the food value chains (FVC) of traditional African fermented foods is a major prerequisite for developing and implementing scientific evidence-based policies towards the improvement of Africa's food and nutrition security and sustainable agriculture. This study aims at identifying the key factors which shape the FVC for mawè and its derived products. Mawè is a traditional fermented cereal dough, widely consumed in Benin. The findings of the study show that mawè and its derived products are processed, marketed, and consumed through both 'traditional' and 'traditional-to-modern' value chains. The traditional chain plays a key role in facilitating food affordability for low-income people. However, the traditional-to-modern value chain is increasingly predominant, especially in an urbanized environment, and consequently offers greater opportunities for value chain upgrading for value-added processing of traditional fermented foods. The study offers insights into policy and research challenges in value chain upgrading.*

Keywords: mawè, cereal doughs, food value chain, food safety and nutrition security, traditional African fermented foods

FOOD INSECURITY IN DEVELOPING COUNTRIES is a persistent problem despite the multiple efforts of governments, donors, and individual decision makers to improve household food supply and alleviate malnutrition (Pinstrup-Andersen and Waston, 2011; Gómez and Ricketts, 2013). The prevalence of malnourishment in West Africa has been estimated at 10 per cent in 2010 and 11.5 per cent in 2016 (FAO et al., 2017). The availability and affordability of food and the way that available foods are used for household nutrition are among the fundamental determinants of the prevalence of malnutrition (Yang and Hanson, 2009; Mello et al., 2010). Recently, several authors have shown that the development of sustainable food value chains (FVCs) could tremendously affect availability, affordability, acceptability, nutritional quality,

Marcel Houngbédji (houngbedjimarcel@gmail.com) PhD student; Sègla Wilfrid Padonou (w_padonou@yahoo.fr) Associate Professor; Noël Akissoé (noel.akis@yahoo.fr) Professor, and D. Joseph Hounhouigan (joseph.hounhouigan@gmail.com) Professor, all at Université d'Abomey-Calavi, Benin; Ana Maria d'Auchamp (ana.dauchamp@volvocars.com) Manager Volvo Car Corporation; Moses Dachariga Mengu (mom@dti.dk) Director, Danish Technological Institute (DTI), Denmark; Lene Jespersen (lj@food.ku.dk) Professor, University of Copenhagen, Denmark

and use of foods (Hawkes, 2009; Hawkes and Ruel, 2011; FAO, 2013). Numerous international research organizations (e.g. Food and Agriculture Organization (FAO) of the United Nations, International Food Policy Research Institute (IFPRI), Research Program on Agriculture for Nutrition and Health of the Consultative Group for International Agricultural Research (CGIAR), International Fund for Agricultural Development (IFAD), Committee on World Food Security (CFS)) emphasize the importance of FVCs and food security. Numerous papers have been published (Neven, 2014; Gelli et al., 2015; Trentmann et al., 2015; CFS, 2016), developing frameworks for sustainable FVCs to identify relevant interventions to overcome food insecurity issues along food chains in developing countries.

FVCs comprise all activities necessary to bring farm products to consumers, including agricultural production, processing, storage, marketing, distribution, and consumption (Gómez et al., 2011). As a product moves from the producer to the consumer, a number of transformations and transactions take place along the chain, and value is added successively at each stage. A previous study (Gómez and Ricketts, 2013) examined how FVCs influence the triple malnutrition burden (undernourishment, micronutrient deficiencies, and over-nutrition such as becoming overweight and obesity) in developing countries, and proposed a FVCs typology in four main categories:

- *Traditional*. Traditional traders buy primarily from smallholder farmers and sell to consumers and traders in wet, mostly local, markets.
- *Modern*. Domestic and multinational food manufacturers procure primarily from commercial farms and sell through modern supermarket outlets.
- *Modern-to-traditional*. Domestic and multinational food manufacturers sell through the network of traditional traders and retailers.
- *Traditional-to-modern*. Supermarkets and food manufacturers source food from smallholder farmers and traders.

Gómez and Ricketts (2013) conclude that each type of FVC influences food access (availability and affordability) differently. As each food or food group is involved in a chain with specific characteristics (Gómez and Ricketts, 2013; Oguttu et al., 2014) there is a strong need for deepening our knowledge of the value chain of the various food systems in West Africa.

In West Africa, as in most other parts of the world, the main sources of human nutrition are derived from: staple crops (cereals and root crops); livestock products (meats, poultry, and fish); dairy products (milk, cheese, and yogurt); and fruits and vegetables (Gómez and Ricketts, 2013). However, cereals provide the major staple food and constitute the most important source of nutrition in West Africa (Nout, 2009). In Benin, about 43 per cent of energy intake in 2014 was provided by cereals (FAO, 2014). In the country, cereals undergo several processing methods resulting in the availability of a diversity of cereal-based foods. For instance, about 40 maize-based foods (Nago et al., 1990), 8 sorghum-based foods (Kayode et al., 2005), and 10 rice-based foods (Houngbédji, 2015) have been reported in traditional food systems in Benin. The cereals are first processed into unfermented or fermented doughs that serve as multipurpose intermediate ingredients for the preparation

of several types of meals. The most popular cereal doughs include mawè, *ogi*, and similar mawè-like and *ogi*-like products existing in other parts of West Africa (Hounhouigan, 1994). Mawè is used for the preparation of a variety of West African traditional cooked dishes, including paste (*makumè*, *akassa*, and *come*), porridge (*koko* and *aklui*), beverage (*akpan*), steam-cooked bread (*ablo*), fritters (*massa*, pâté), and couscous (*Yèkè-yèkè*) (Hounhouigan et al., 1993; Houngbédji et al., 2018a). Mawè has been identified as a good example of an intermediate product (Nout, 2009) because of its ease of packaging and its wide range of culinary applications (Hounhouigan, 1994). Whereas most food processing companies currently focus on ready-to-eat products, there may be excellent opportunity in diversifying their product lines by selling intermediate products to consumers (Nout, 2009). For instance, fresh unfermented or fermented dough-like mawè could be provided in modified atmosphere packs and dehydrated fermented or unfermented flour, thus opening novel culinary and technological applications for both local and international food markets (Nout, 2009).

Mawè is most commonly produced using maize, but sorghum, millet, and rice are also used. Mawè is generally processed as a cottage industry, marketed and consumed as street food, or, in some cases, in open markets and supermarkets. The operations related to the production, marketing, and consumption of mawè and derived products occur in a complex food environment defined by several factors such as the physical, economic, political, and sociocultural surroundings that influence the supply chain, consumer choices, and nutritional status of the products. Other factors include composition, labelling, promotion, and trade policies affecting availability, price, and quality (Swinburn et al., 2014). This complex food chain, in the case of mawè and its derived products, has so far been very little investigated and documented. An in-depth analysis of that environment is not only of scientific interest but also important to control food supply and food demand along the production chain, to identify value-adding processes in the FVC, and also to monitor food insecurity and food safety issues that could eventually help to set the relevant research and policy interventions for developing sustainable food chains.

The current paper characterizes the value chain of mawè and derived products and analyses socio-economic aspects of their production, sale, and consumption in Benin. The study provides insight into the key factors affecting the current value chains of mawè and derived products and the potential for their transformation into sustainable chains that will improve the triple bottom line of the various FVC actors from processors to retailers and consumers.

Methods

Study design

The study is built on a literature search and a socio-economic and value chain survey. The literature search gathered useful published information such as processing methods of mawè and derived products, actors involved, products used, and the institutional environment. The socio-economic and value chain survey was performed to update and supplement existing information.

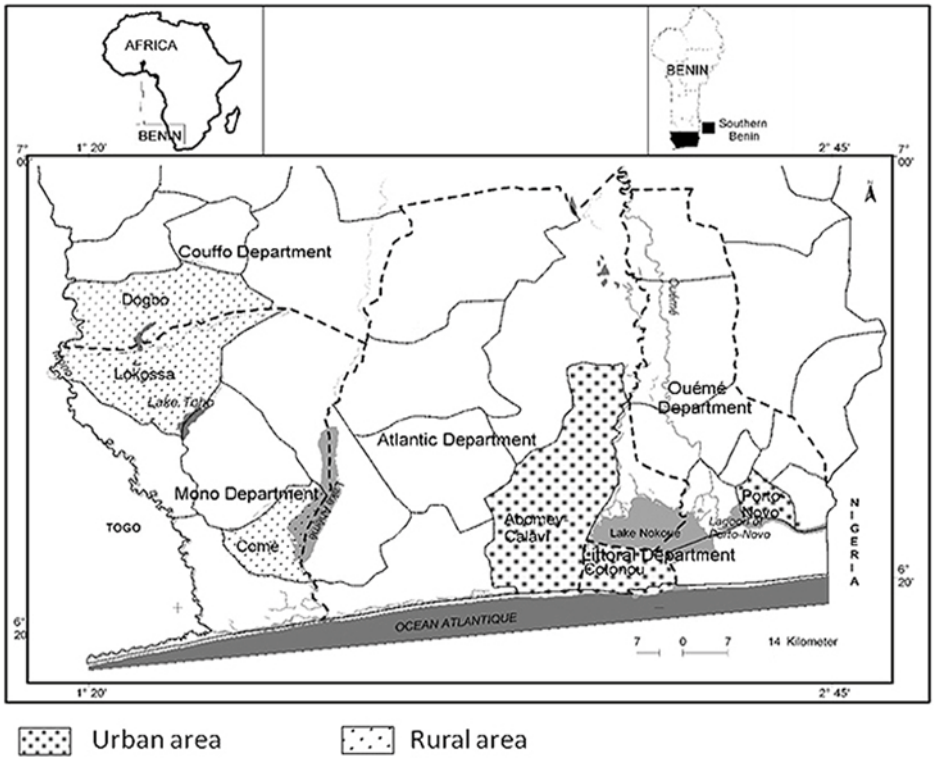

Figure 1 Map of Benin showing the departments and their capitals covered in the study

Study areas

The study was conducted in southern Benin where mawè and derived products are mostly produced, marketed, and consumed. The field survey covered the main urban areas of three departments, namely, Cotonou in Littoral Department, Abomey-Calavi in Atlantic Department, and Porto-Novo in Ouemé Department, as well as in rural areas in two Departments, namely, Comè and Lokossa in Mono Department and Dogbo in Couffo Department (Figure 1).

Sampling strategy

The informants comprised three groups of mawè FVC actors, including processors, sellers, and consumers. A random check was carried out on 399 processors of cereal-based food in order to estimate the proportion (p) of mawè processors among the total number of cereal-based food processors in the survey area. The total number (N_t) of mawè processors interviewed was calculated using the following formula (Dagnelie, 1998):

$$N_t = \frac{4p(1-p)}{d^2}$$

where p is the proportion of mawè processors among the total number of cereal-based food processors, and d is the expected error margin which was fixed at 0.05. The number (n) of processors interviewed in each community was calculated as follows: $n = T \times N_t$ where T is the proportion of people living in that community among the total number of people living in the survey area. Hence, a total of 115 mawè processors was calculated and randomly selected and interviewed on the processing aspect of cereals supply strategy.

As all the interviewed mawè processors could directly sell mawè either as wholesalers or retailers, they were all interviewed on sales aspects related to the mawè value chain as well. Moreover, as some mawè processor-sellers distribute mawè through retailers, those retailers directly linked to the mawè processor-sellers included in the survey were also interviewed on sales aspects related to the mawè value chain. Finally, a total of 118 mawè sellers were interviewed during the survey.

During the interviews with mawè sellers conducted at the place of sale, all buyers (mawè consumers) who approached the sellers with the intention of purchasing mawè were also interviewed, leading to 109 informants on mawè consumption aspects. This sampling strategy ensured that when a processor is interviewed, consumers who liked buying mawè from this processor are also interviewed, given that some consumers prefer to purchase mawè from a specific seller or processor-seller for a specific quality requirement.

Field data collection

Field data were collected from informants using questionnaires. Prior to the formal survey, the questionnaires were tested during a random check and were then adjusted. The questionnaires were designed to have complete information on the identity of informants such as gender, age, sociocultural background and origin, religion, profession, and literacy level. The information collected from processors comprised the different types of mawè and their use, the processing method of each type of mawè, factors that can add value to the products and quality criteria, supply strategy of raw material, cereal suppliers, and their location. Information also covered the purchasing methods used, means of transportation, the information flow, and the existence of any formal contractual arrangement among processors, suppliers, and sellers. From mawè sellers, data collected included the quality preference for good commercialization, storage problems, quality parameters for which consumers are willing to pay more, income generation capacity, price of buying, price of selling, and changes in price over time. From consumers, data collected comprised quantity and frequency of consumption, time and place of consumption, accompanying dishes, and quality criteria. Additionally, the information gathered from processors, sellers, and consumers were triangulated by two focus group interviews in each department. Each focus group comprised two farmers, three cereals suppliers, two mawè producers, two mawè sellers, and two final consumers.

Data processing and statistical analyses

The collected data were synthesized and statistical analyses were done using STATISTICA v7.1 software. Descriptive statistics were calculated and multiple

correspondence analyses were performed to link sociocultural characteristics of processors, sellers, and consumers to the socio-economic conditions along mawè value chains.

Results and discussion

Product description

Mawè is an uncooked fermented dough from local cereals, used for the preparation of traditional cooked dishes including paste (*akassa*, *makumè*, and *come*), porridge (*koko* and *aklui*), and beverage (*akpan*). In its unfermented or early fermented phase, mawè can be used to prepare *yèkè-yèkè* (couscous-like product) and *ablo* (steam-cooked bread). Mawè was originally produced with maize in the household (homemade mawè) for domestic consumption (Hounhouigan et al., 1993; Hounhouigan, 1994; Houngbédji et al., 2018a). The types of mawè have diversified over time in response to the changes in food consumption patterns and food quality requirements in urban areas. Such changes include an increased need for ready-to-use products that are attractive and can be purchased easily, which led to the development of commercial maize mawè. The commercial maize mawè is usually wrapped in a polyethylene bag and sold as ready-to-cook products in the open market. Later, the commercial sorghum mawè was developed and commercialized in urban markets. Some small- and medium-sized enterprises process commercial maize mawè or sorghum mawè in dried flour form (dried mawè), packaged, labelled, and sold in supermarkets.

Other types of mawè used in the preparation of some street foods such as *ablo* and *come* (a fermented, cooked, and slightly salted paste) were also encountered. These types of mawè, namely, mawè for steam-cooked bread and undehulled maize mawè, are not produced for direct sale but used by processors themselves as intermediate products for *ablo* and *come* preparation, respectively. Figure 2 shows the processing methods of all the different types of mawè enumerated above.

Mawè is used to prepare many cooked dishes for domestic consumption or as street foods. The most important of these dishes are porridges, pastes, steam-cooked bread, beverage, and couscous. Porridge-like products include *koko* and *aklui*, widely produced and consumed in West Africa. These porridges (7–14 per cent dry matter) (Icard-Vernière et al., 2010) are sugared and generally consumed as breakfast and snack foods in accompaniment with fritters and roasted peanuts. They are also traditionally used as weaning foods, but this practice is not recommended nowadays because of their low energy density and nutrient content. *Koko* could be prepared either from thin gruel of wet mawè dough or from dried mawè flour bought in supermarkets, and boiled in water until gelatinization before consumption. *Koko* is produced both for home consumption and for sale as street food. Similar products can be found in Nigeria, Ghana, Burkina Faso, Côte d'Ivoire, and Senegal (Nago and Hounhouigan, 1998; Songré-Ouattara et al., 2008; Soro-Yao et al., 2014). In Benin, *koko* can also be prepared with fermented, undehulled maize or sorghum dough, in which case it is known as *gbangba*, or with *ogi* (a gruel obtained through fermentation of a suspension of wet-milled and wet-sieved maize or sorghum), in which case it is known as *ogi-koko*. *Koko* can also be prepared with whole rice or broken

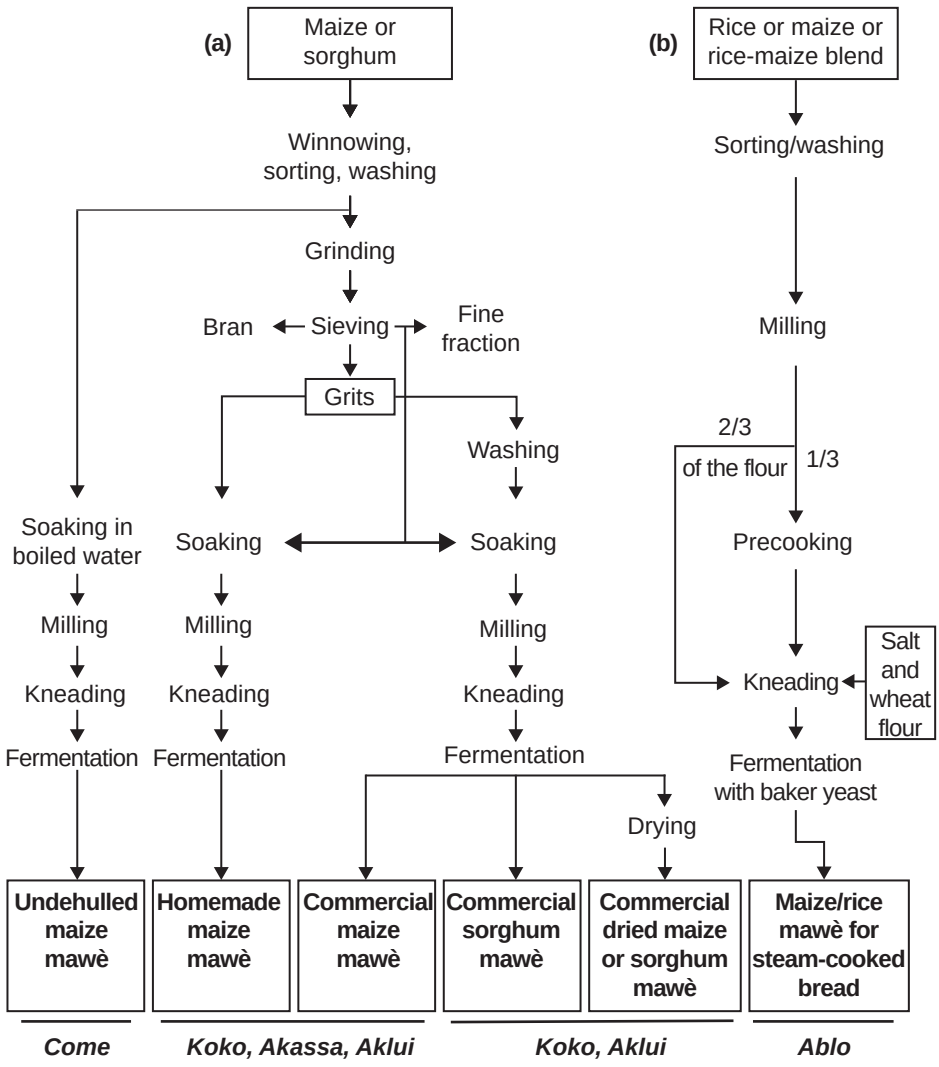

Figure 2 Flow diagrams for production of the six mawè types: (a) production methods of undehulled maize, homemade maize, commercial maize, commercial sorghum, and commercial dried maize or sorghum mawè, and (b) production method of maize/rice mawè used for steam cooked bread, with examples of the most popular finished products are provided for each mawè type

rice gruel, in which case it is known as *lessi koko*. *Aklui* is a mawè-based granulated porridge produced not only in wet form for home use or for sale along streets but also in dried form, packaged and sold in supermarkets and open markets.

Examples of paste-like products include *akassa* and *come*, also known as *komi* or *kenkey* in Ghana (Jespersen et al., 1994). These products are served with sauces for breakfast, lunch, or dinner. *Akassa* and *akassa*-like products, also known in Togo, Ghana, and Nigeria, can be produced with mawè or mawè-like products by diluting the dough in water and boiling until full gelatinization.

Steam-cooked bread known as *ablo* in Benin (Houngbédji et al., 2018b) or *aboloo* in Ghana (Johnson and Halm, 1998) is prepared with maize- or rice-based mawè and sold as street food. It is consumed as a side dish with different kinds of sauces for dinner and sometimes for lunch.

Beverage known as *akpan* is a traditional yogurt-like product made from fermented cereal and consumed as a thirst-quenching beverage in Benin. *Akpan* is prepared with *ogi* or with mawè, and its socio-economic aspects of production and consumption in southern Benin have been recently studied (Sacca et al., 2012).

Couscous-like products (e.g., yèkè-yèkè in Benin and similar products in Togo and Burkina Faso), are steam-cooked granules made of non-fermented mawè and mawè-like products. Couscous can be eaten after boiling in tomato sauce accompanied by meat or fish. Millet-based couscous is mostly prepared in Burkina Faso and can be used with fermented or non-fermented milk and added sugar (Icard-Vernière et al., 2010).

Supply chain and main actors

Figure 3 shows that the value chains of mawè and derived products start from farmers who grow cereals that reach mawè processors through cereal collectors and sellers. Mawè processors can sell their products to consumers directly or through condiment sellers. Table 1 supplements Figure 3 by showing the typology of the main actors along the chains including their roles.

As shown in Figure 3, there is a successive role and interdependency among actors. The actors along the chain work together in a coordinated way for mutual benefit and high value addition. They constitute a network of actors that aims, as reported by Da Silva and De Souza Filho (2007), at maximizing profits not only by eliminating inefficiencies at each step of the chain but also by maximizing aggregate revenues for all stakeholders. By working in this collaborative manner, the network succeeds in producing acceptable and affordable mawè and derived products for which consumers are willing to pay a higher price. For instance, maize sellers are aware of the need to provide mawè processors with maize varieties that are white and clean. Therefore, they require these characteristics from farmers or from wholesale distributors. In doing this, mawè processors need to dedicate less time and labour to sorting, cleaning, and washing. In turn, this makes the produced mawè more affordable and very white, enticing consumers to buy more. As a result, mawè processors are able to increase the frequency of production and in return can buy more cereals from suppliers, thus increasing profit along the whole chain.

The above example points out very clearly not only the interdependency but also the propagation and the feedback characteristics of agri-food chains as reported by several authors (Da Silva and De Souza Filho, 2007; Neven, 2014). This means that any action having an impact in a particular step or component of the chain will induce effects that propagate backwards and forwards along the entire chain.

Furthermore, Figure 3 shows that there are two types of value chains of mawè and derived products in Benin: a 'traditional' FVC and a 'traditional-to-modern' FVC. The whole chain traditionally extends from the farmers to the processors. Afterwards, the chain continues along the traditional FVC for the wet commercial mawè and all street mawè-based foods, whereas the chain of dried mawè and dried *aklui* moves over to the modern chain distribution through supermarkets. The packaged and stabilized

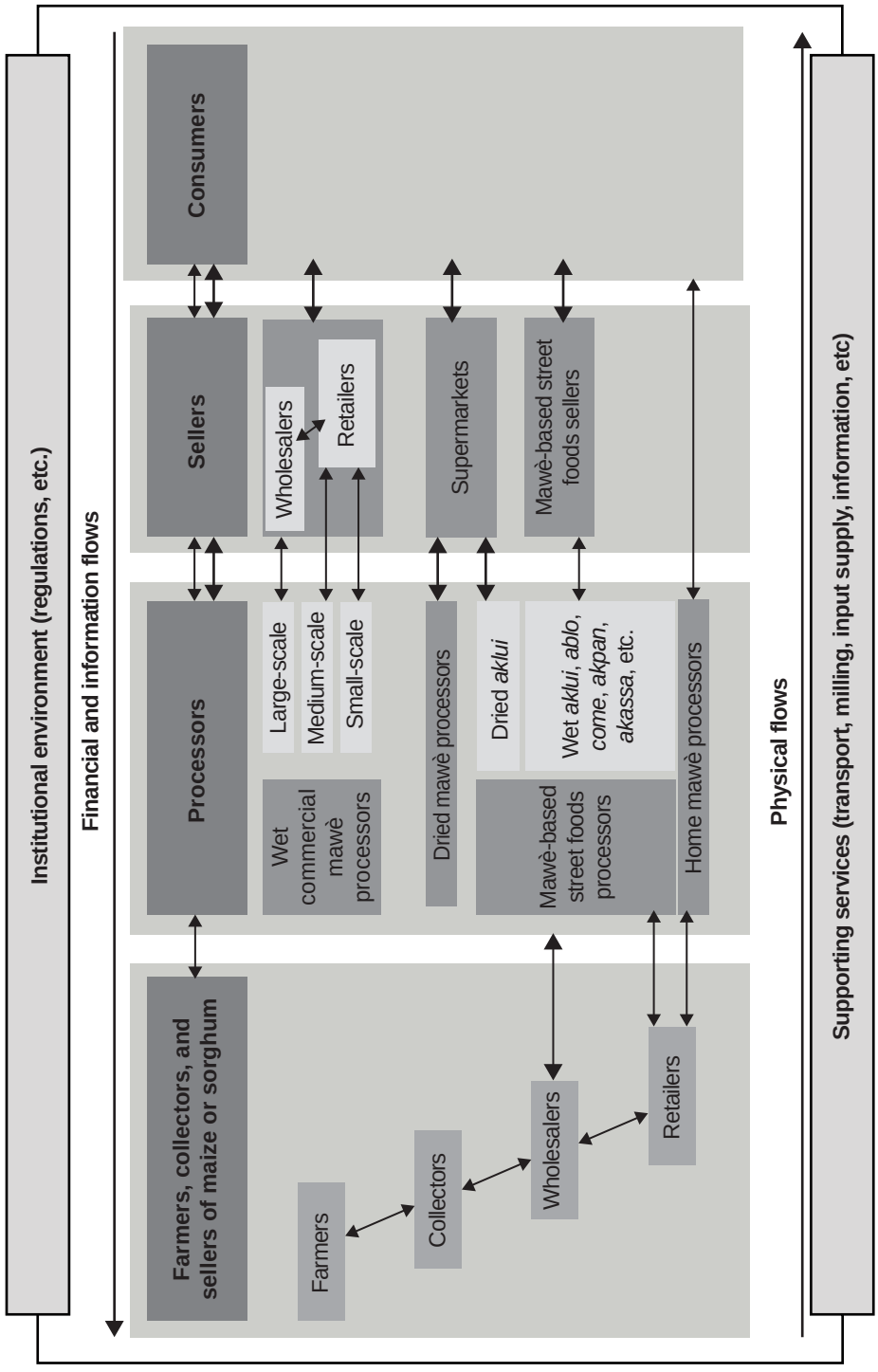

Figure 3 Supply chain, institutional environment, physical flows, and supporting services in mawè processing

Table 1 Typology and characteristics of main actors

Actors	*Role/definition*	*Discussion/characteristics*
Farmers	Cultivate, harvest, dry, store maize and sorghum and sell to cereal collectors/sellers	Maize and sorghum are mostly cultivated in rural areas in Benin. Maize is abundant in the period from August to December
Cereal suppliers/ sellers	Collect and purchase cereals from farmers and sell to processors	Cereal sellers include rural collectors, wholesalers, and retailers. Mawè processors prefer buying cereals directly from wholesalers for reducing purchase price
Processors		
– Large-scale processors of commercial mawè	– Process large quantities of grains into mawè and sell to retailers	– Process 200–1,000 kg/week; they represent 12.2% of interviewed processors
– Medium-scale processors of commercial mawè	– Process medium quantities of grains into mawè and sell to consumers	– Process between 100 and 200 kg/week; they represent 40.8% of interviewed processors
– Small-scale processors of commercial mawè	– Process small quantities of grains into mawè and sell to consumers	– Process less than 100 kg/ week; they represent 47% of interviewed processors
– dried mawè processors	– Process dried mawè in cottage industries	– The dried mawè processors are mainly the small medium enterprises which process cereals (maize, sorghum, millet, etc.) into dried mawè, dried *aklui*, and dried fermented or non-fermented flour for the preparation of *koko*, *akassa*, *akpan*, *ablo*, etc. These products are very stable and are distributed through supermarkets
– mawè-based street foods processors and sellers	– Process mawè and use it as intermediate product to produce *aklui*, *ablo*, and *come* used for roadside restaurants	
– home mawè processors	– Process mawè for household consumption	– Process some amount of maize for domestic use
Sellers	Sell mawè and derived products at fixed location or as hawker sellers	Mawè sellers include wholesalers and retailers. The wholesalers are essentially the large-scale processors. The retailers are not only medium- and small-scale processors who sell themselves their produced mawè but also condiments sellers who buy from large-scale processors and sell to consumers. Most of the interviewed mawè sellers sell in a fixed location (84.4%) whereas a few of them are street hawkers (15.6%)
Consumers	Buy and consume mawè generally as *koko* and *akassa*. They also buy mawè-based foods directly from the roadside retailers. Some consumers with high income prefer to purchase dried mawè and dried *aklui* in supermarkets	Consumers expect good quality of mawè (relevant acidity, whiteness, without foreign matter, good odour and taste). The required acidity level of mawè is highly variable depending on consumers' preference. Thus, some consumers buy mawè that did not undergo more than 12 or 24 hours of fermentation while other consumers like more acidified products

characteristics of dried mawè and dried *aklui* make them year-round products with the ability to be sold in supermarkets. It was found that packaged and year-round products are mostly part of the modern value chain in developing countries while the seasonal and non-stabilized products (like wet commercial maize or sorghum mawè and mawè-based street foods, in the case of our study) mostly follow the traditional chain (Reardon Gulati, 2008; Gómez and Ricketts, 2013).

The nature of the relationship between actors depends on the type of value chain in which they operate. All relationships set along the traditional FVC are informal. Actors belonging to this chain stated that they did not have any formal contractual relationships with other actors of the chain. As a result, the products from the traditional chain cannot reach modern markets but they are affordable for consumers with low income. In contrast, the dried mawè and dried *aklui* processors of the modern value chain need to prove the compliance of their products with certain hygienic and quality requirements, leading to the prevalence of contractual agreements or documentation. This also makes it possible for the products from the modern chain to be sold in modern supermarkets and restaurants. The supply of these products to supermarkets or restaurants is well documented, with delivery amounts and price levels being predetermined.

As previously reported for many African foods (Goldman et al., 2002; Gómez and Ricketts, 2013), our investigation also found that the type of value chain influences the behaviour of consumers regarding the choice of mawè. For instance, all respondents buying commercial mawè asserted that they were willing to buy this kind of mawè because of its affordability. In this regard, we agreed that the traditional FVC offers consumer products at a low price, making consumers (mostly those with lower income) buy more products in the traditional chain compared with the modern chain (Gómez and Ricketts, 2013). In the traditional chain, the use of less expensive traditional tools for processing and the flexibility in varying the quality standards of the final product are some of the factors which make the products cheaper and therefore more affordable. On the other hand, these practices tend to make products from the traditional chain less safe for consumption. This calls for the development of policies for food safety education among producers, sellers, and consumers within the traditional FVC.

Enabling environment

The enabling environment in an agri-food chain is defined as the set of supporting services, policies, and institutions that form the general setting under which enterprises are created and operate (Da Silva and De Souza Filho, 2007). Since the enabling environment significantly influences the food system (Gillespie et al., 2015) our study investigated the particular characteristics of the 'enabling environment' of the mawè production chain.

The supporting services comprise provision of inputs, milling, and transportation. The millers grind different types of raw materials including maize, sorghum, rice, grits, and roots. While the milling shops serve mainly to grind cereals, they are also used by medium- and large-scale producers as convenient locations to undertake some of their other operations such as soaking of grits and dripping. This avoids extra time and expense related to transportation of grits. The importance of milling shops in cereal

processing and in traditional agri-food processing has previously been investigated in Cotonou by Hounhouigan (1994) and Nago et al. (1990). Transporters are city, inter-city, and motorbike taxi drivers. The inter-city taxi drivers are especially solicited by cereal suppliers and wholesalers who collect and store small volumes of cereals from farmers in rural areas and transport them to the towns. Cereal collection, storage, and transportation from areas of abundance to areas of scarcity are very common in cereal supply chains in West Africa because of the high probability of increasing value over time and over space (Neven, 2014). City and motorbike taxi drivers may intervene in any step of the chain. They help cereal collectors in the farming areas and are also solicited by cereal retailers and mawè processors.

The mawè and derived products FVC is characterized by an inadequate policy and institutional environment. As mawè and derived products are mainly processed by the traditional and informal food sector, the formal rules related to food processing are not enforced resulting in a great flexibility among traditional producers in the application of appropriate food standards. This trend has been reported from other developing countries by Henson and Reardon (2005) and Lee et al. (2010). However, in Benin, rules concerning hygiene of processing sites and selling places are enforced within the traditional food sector, including mawè and derived products. The observance of these rules is monitored by the state controlled food inspection offices. Generally, though, these inspections are often inadequate and poorly supervised. In addition, there is no traceability system and mawè and derived products sold in open markets and along streets are not controlled by official quality control laboratories. There is therefore a need to set the specific standards for mawè and derived products, to improve quality and safety inspection services, to build the capacity of local accredited laboratories to carry out domestic and internationally accepted tests, and to develop an effective traceability system.

Value chain economics

The value-added process along the chain (Table 2) shows that maize sellers buy maize from farmers or collectors at €18–20 per 100 kg and sell to processors at €26–31. The processors produce 135 ± 23 kg of mawè from 100 kg of maize and sell to consumers at between €64 and €71. The rough average share of the final price along the chain is 28 per cent for farmers and collectors of maize, 13–16 per cent for maize sellers, and 56–59 per cent for mawè processors and sellers (Table 2). However, each actor along the chain must cover the costs of supporting services using a part of what they earn. For instance, the mawè producer/sellers expend about 5 per cent of the final price for salaries, milling, transportation, etc. This means that the mawè producer/sellers dominate the chain with 51–54 per cent of the final price.

Socio-demographic profiles of processors, sellers, and consumers

The socio-demographic characteristics of commercial maize mawè processors, sellers, and consumers are shown in Table 3. All mawè processors and sellers interviewed were females (100 per cent). Most of them were between 30 and 40 years old

Table 2 Value chain economics for commercial maize mawè

	Farmers and collectors of maize	*Sellers of maize*	*Processors of commercial maize mawè*	*Consumers*
Function	Cultivation and collection of maize	Marketing of maize	Production and marketing of commercial maize mawè	Purchasing and consumption of commercial maize mawè
Price (based on 100 kg of maize) in euros	18–20	26–31	64–71	64–71
Percentage share of final price	28	13–16	56–59	–

Table 3 Socio-demographic traits of commercial maize mawè processors, sellers, and consumers

Characteristics	*% of Respondents*		
	Processors (n = 115)	*Sellers (n = 118)*	*Mawè buyers (n = 109)*
Gender			
Male	0	0	30.3
Female	100	100	69.7
Age (years)			
Under 30	20	25.4	51.4
[30–40]	59.1	51.7	32.1
Over 40	20.9	22.9	16.5
Religion			
Animist	11.3	12.7	15.6
Christian	87.8	85.6	69.7
Muslim	0.9	1.7	14.7
Educational level			
Illiterate	70.4	70.3	–
Primary school	27.9	28.0	–
Junior secondary school	1.7	1.7	–
Senior secondary school	0	0	–
University	0	0	–

(59.1 per cent for processors and 51.7 per cent for sellers), illiterate (70.4 per cent for processors and 70.3 per cent for sellers), and Christian (87.8 per cent for processors and 85.6 per cent for sellers). Mawè buyers are both female (69.7 per cent) and male (30.3 per cent). Young people (51.4 per cent for those under 30 and 32.1 per cent for those between 30 and 40 years old) consume more mawè than the older age groups (16.5 per cent).

Scale of production in relation to processors' age and place of residence

A multiple correspondence analysis (MCA) was performed to reveal the relationship between scale of production, processors' age, and place of residence (Figure 4). The MCA shows that most medium- and large-scale processors are between the ages of 30 and 40 and mostly reside in urban areas (Abomey-Calavi and Cotonou). Most small-scale processors are older and reside in rural areas (Mono and Couffo Departments). These tendencies point out the interest of younger people in mawè processing, especially in urban areas.

Relationship between consumers' characteristics and frequency of consumption

A MCA was carried out to show how the frequency of consumption of mawè is reflected in the socio-demographic characteristics of consumers (Figure 5). The results show that commercial mawè is regularly purchased in urban areas (Cotonou and Abomey-Calavi) by young people, mostly female, Christian, and students. Consumption is also high among office workers who are mostly in the older generation in more urban than rural areas. These observations can be explained by a number of socio-economic factors, which have a bearing on food consumption patterns among urbanites. Among these are purchasing power and socio-professional status as pointed out by Delisle (1990) and Thuillier-Cerdan and Bricas (1998). For instance, most of the students living in Cotonou and Abomey-Calavi claimed

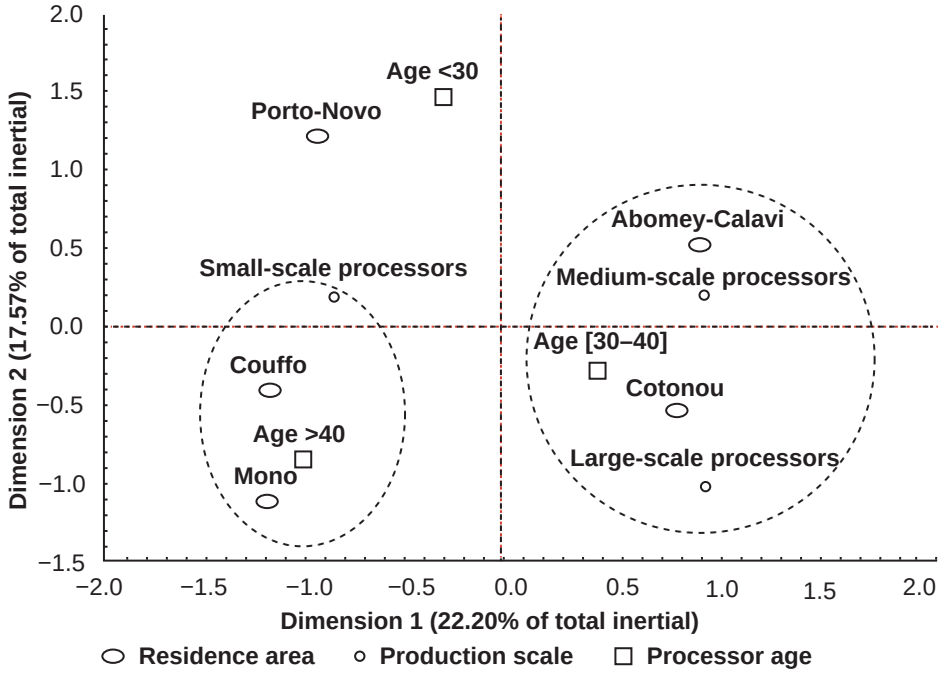

Figure 4 Multiple correspondence analysis plot showing the relationship between production scale, processor age, and residence area

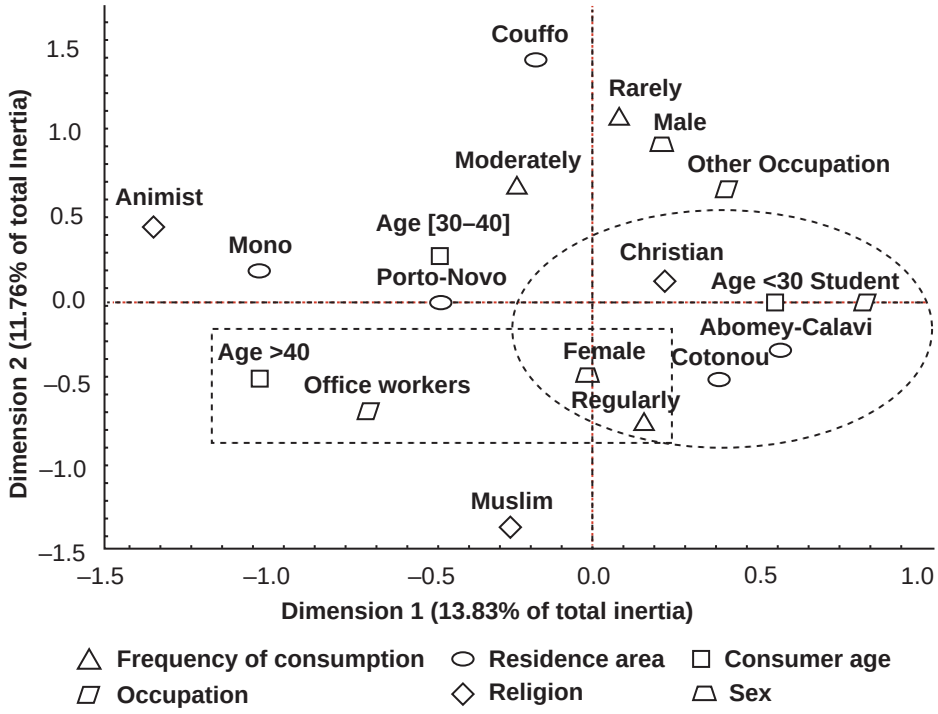

Figure 5 Multiple correspondence analysis plot showing the relationship between socio-economic traits of consumers and frequency of mawè consumption. The socio-economic traits of consumers included in the analysis are age, sex, place of residence, occupation, and religion

to have low purchasing power and thus have a preference for cheaper foods such as mawè and derived products. Moreover, as mawè is a ready-to-cook product, it meets the requirement of office workers who spend more time at work and consequently strive to shorten as much as possible the preparation time for domestic food. Thus, students consume mawè because of their low purchasing power while the office workers like buying mawè because of their time constraints.

Problems and challenges along the mawè FVC

The mawè FVC faces various problems and challenges at each step along the chain that cumulatively impact on its overall competitiveness. At the production end of the FVC, the most important problems include low soil fertility and productivity, poor farming practices, high losses due to pest attacks, improper use of pesticides, and the damaging impact of climate change, which results in low and unreliable rainfall patterns and unpredictable changes in the farming calendar. At the postharvest and processing end of the chain, the main problems relate to mycotoxin development during storage as well as laborious and time-consuming processing methods. Traditional household processing using spontaneous and non-controlled fermentation processes also have a high risk of pathogenic contamination. Other problems

include the lack of adequate equipment and infrastructures for processing, lack of quality control inspection, and a lack of awareness of processors regarding quality issues. At the marketing and consumption end of the chain, some key problems include the short shelf life of mawè and derived products, inadequate infrastructure and unhygienic conditions at the sales points, and a general lack of effective marketing techniques. For consumers, the main problems include the high cost of good quality products, such as dried mawè and *aklui*, and safety issues in the case of traditionally processed products.

Policy and research strategies to support the development of a sustainable mawè FVC

Figure 6 presents a set of policy and research strategies needed to transform the current FVC of mawè and derived products in order to attain a higher level of value addition for the various actors engaged in it. All interventions aimed at transforming the FVC must aim at achieving the following three main goals:

- Enhancing the supply of nutritious mawè and derived products through the development of short cycle, high productivity, and nutritious cereal seeds, training of farmers on good agricultural and postharvest practices, and provision of farm credits, and the improvement of road and energy infrastructures, etc.
- Improving marketing and distribution conditions through measures such as improved packaging in small quantities, use of multifunctional starter culture that could lead to products meeting organoleptic preferences of consumers, and the use of social media and other ICT-enhanced marketing techniques.
- Enhancing the safety and nutritional quality of mawè and derived products by addressing such factors as hygienic production practices, setting hazard analysis and critical control points (HACCP) and a traceability system along the chains, and provision of accredited laboratory services for quality control.

These interventions could impact all aspects of the FVC by enhancing farm labour productivity, minimizing loss and waste, shifting family labour to wage labour, increasing value addition, increasing nutritional and organoleptic quality of mawè and derived products, and creating the basis for the growth of small- and medium-sized food processing enterprises.

Creating high value addition for the mawè FVC will provide households with sufficient financial resources that could drive the demand and supply of inputs and services (Neven, 2014; Gelli et al., 2015). Furthermore, the competitiveness of the entire FVC could be improved through a reduction in the cost of inputs, services, and outputs, while increasing benefits for actors. As a result, mawè and derived products will be affordable for poor consumers. These goals cannot be reached if the chains are not holistically addressed, targeting each step with specific relevant interventions. For instance, the strategies targeting improvements in the hygienic and nutritional quality of mawè and derived products need to be tackled from 'farm to fork' in order to be effective. Furthermore, in order to forestall the rejection of any interventions, they have to be aligned with the actors' sociocultural characteristics

Figure 6 Areas of policy and research intervention for the development of sustainable value chains for mawè and derived products. This analytical framework is based on data from this study and information from literature review

and consumer preferences. For instance, short cycle, high productivity, and nutritious new varieties of maize or sorghum will not be adopted by the farmers if they are more difficult to process (e.g. difficult to mill) and if they do not meet the quality expectations of consumers (e.g. whiteness of mawè). It is also important for sustainability that the interventions introduced are sensitive to the environment and protection of natural resources. For instance, it is highly important that new farming practices do not damage soil fertility.

Conclusion

This paper contributes to the understanding of the socio-economic aspects of the production and consumption of mawè and derived products in Benin. Six different types of mawè are produced and used in the preparation of a variety of cooked dishes. These prepared dishes are then either consumed at home or are sold through various outlets. The whole production, processing, commercialization, and consumption of mawè and its derived products takes place within two main forms of food value chains: a 'traditional' value chain and a 'traditional-to-modern' value chain. The 'traditional' chain appears to facilitate food affordability to low-income people. However, the traditional chain does not always offer safe foods and a steady year-round supply, unlike the 'traditional-to-modern' value chain. The study demonstrated the importance of both chains in food security of stakeholders. However, a number of problems occur along the chains and impact negatively on the supply and demand of mawè and derived products. Insights are given into policy and research interventions needed to improve the sustainability of mawè value chains. Future interventions must address enhancing supply and demand of safe and nutritious mawè and derived products through research and relevant policies.

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