

Attachment 5

Value chain report from Benin



Preserving African Food Microorganisms for Green Growth

Value chain analysis of Mawè in Bénin

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Introduction

Maize is one of the major starchy staple foods from cereals group, predominantly consumed in Bénin as well as in other West African countries. Maize products manufacturing plays an important socioeconomic role in the West African cottage industry, mainly in Bénin, where about 40 different maize-based foods were recorded (Nago, 1989). Among them, fermented foods are numerous and derived from two types of intermediate fermented products namely Ogi and Mawè. Ogi is a gruel obtained by fermentation of a suspension of wet-milled maize in water, whereas Mawè is a fermented dough (Hounhouigan, 1994). The latter is suitable as a basis for the preparation of many fermented dishes, including those obtained from Ogi (Hounhouigan, 1994). Spontaneous fermentation of Mawè involves several relevant strains of yeast and lactic acid bacteria (Hounhouigan et al., 1993; Greppi et al., 2013). Also, Hounhouigan et al. (1994, 1999) reported a stimulating effect of the yeast *Candida krusei* on *L. fermentum* and *L. brevis* during a mixed starter culture fermentation of Mawè porridge. The wide range of culinary application of Mawè and the high microbial diversity involved in its fermentation could be two key factors which confer to Mawè a pivotal and the best substrate for starter culture implementation in the order to enhance African fermented cereal-foods sector.

With the purpose of upgrading and upscaling the traditional fermented cereal-based foods, there is a need to establish and to update the indigenous knowledge and know-how on Mawè. Hounhouigan et al., (1993) mentioned and described two types of Mawè in Benin: The 'home-' and the 'commercial' Mawè. Considering the rapid change that occurs in the traditional foods processing in developing countries and particularly in Bénin, it is worthwhile to update information existing on Mawè processing through a value chain study.

The objective of this report is to scope out and reveal the value chain for Mawè in the Beninese context. This value chain included key actors and processes. In addition, the analysis of value chain information allowed building Strengths, Weaknesses, Opportunities and Threat (SWOT). The work builds upon the literature search and socioeconomic survey carried out in *Atlantique, Littoral, Ouémé, Mono* and *Couffo* districts (southern Benin). The value chain analysis of Mawè is the first activity (Task 1.1 of WP1) that FSA team (Benin) has to implement in the frame of Green Growth project funded by Danida.

In the lines below, the aspects such as products description, chain actors and their functions, the main processes in the chain, the services and support necessary to the functioning of the

chain, the opportunities, bottle-necks, problems and key success factors from value chain analysis were discussed. This was followed by the marketing, new business model development and the market Gap analysis.

1- Product description

Mawè is a fermented dough, used for the preparation of traditional cooked dishes including gels like (*Akassa*), paste (*Agbelimawè*, *Come*) steam-cooked bread (*Ablo*), porridge (*Koko*, *Aklui*, *Akluiyonu*) or beverage (*Akpan*). Mawè is generally prepared with maize (Hounhouigan, 1994). It can also be produced with other cereals like rice in rice-based *Ablo* processing (Aholou–Yèyi, 2007; Hounbedji et al., 2014) and sorghum in sorghum-based dried *Aklui* processing. Two types of Mawè have been reported by Hounhouigan et al., (1993): ‘home-’ and ‘commercial Mawè’. The main difference is that commercially fines are separated, grits washed to remove more hulls and germ, and fines added back before soaking. Mawè is produced by women and used in household (home Mawè); or commercialized as ready-to-serve and as domestic ready-to-cook products in open market or streets of urban areas (commercial mawè). The commercial Mawè is usually wrapped in polyethylene before sale (Photo 1). Recently, a new type of Mawè is produced by some Small and Medium-sized Enterprises (SMEs) in dried flour form (dried Mawè), packaged up, labeled and sold in supermarket (Photo 2). The home Mawè, the commercial Mawè (after purchase) and dried Mawè (after purchase) are generally used for preparation of *Koko*, *Akassa* and *Agbelimawè* in households for domestic consumption. Due to the difference in the processing methods, it is worthwhile to mention other types of Mawè used for some commercially street foods (namely *Ablo* and *Come*). These Mawè (namely ‘Mawè for *Ablo*’ and ‘Mawè for *Come*’) are not processed for sale but, are processed by *Ablo* and *Come* processors themselves and directly used as intermediate products for *Ablo* and *Come* preparation, respectively. However, ‘Mawè for *Ablo*’ can be sometimes, ordered to *Ablo* processors for special occasion like funerals. The processing method of ‘Mawè for *Aklui*’ and ‘Mawè for ‘*Akpan*’ are similar to the one of commercial Mawè.



Photo 1: Commercial wet Mawè

Photo 2: Commercial Dried Mawè

2- Value chain map

2.1- Actors

Several actors are involved in Mawè chain since farm to fork. farmers, maize vendors, Mawè processors/sellers and consumers. The typology of these actors is established in Table 1. The Figure 1 shows the supply chain, supporting service, financial, information and physical flows and the institutional environment in Mawè production. Farmers grow, harvest, stock maize and distribute it through cereal wholesalers and retailers (cereal vendors). For reducing production cost, most of Mawè processors prefer to purchase maize directly from wholesalers. However, home Mawè processors (very often), small scale processors and Mawè-based street foods processors (sometimes), supply maize from retailers.

Apart from home Mawè which is directly consumed in household, commercial Mawè and Mawè-based street foods are sold to consumers in open markets and along streets. Processors distribute the dried Mawè through the supermarkets. Commercial Mawè processors are all female and generally, non-educated (68.6%) and married (88.6%) but, it seems that they are older in rural regions (*Mono* and *Couffo*) than urban areas (*Cotonou*, *Calavi* and *Porto-Novo*) (figure 2a). In general, this graph (Figure 2a) shows that there is renewal of generation in the activity. Less than 30 years old people represent quite 49% of the processors which means that young people are interested to the activity. Less than 40 years old people represent more than 78% of Mawè processors which confirm the interest of young people for the activity. This tendency is more confirmed in urban area (*Cotonou*, *Calavi* and *Porto-Novo*, where 79 to 94% of the processors are less than 40 years old) than in rural area (*Mono* and *Couffo*). Besides, 76.3 % of commercial wet Mawè processors and 100% of dried Mawè processors are found in urban areas. Related to commercial Mawè, the large scale processors (processing

more than 200kg of raw material per week) are only found in urban areas, whereas processors of rural areas are mostly small scale processors (process less than 100kg of raw material per week) (Figure 2b). In general, this graph (figure 2b) shows that more than 58% of processors (medium and large scale processors) process more than 100Kg of maize per week. This statistic shows the importance of Mawè processing in maize value chain of Bénin. This socio economic importance is more confirmed in urban area (where 66 to 78% of processors process more than 100Kg of maize per week) than in rural area.

Consumers are the last actors in the chain. They are females and males. They are in majority, officers (61 %) and craftsmen (24 %). 100% of consumers use commercial Mawè for domestic utilizations by producing porridge (*Koko*) and/or paste (*Akassa* and *Agbelimawè*). These domestic Mawè-based foods are generally consumed in household for breakfast (porridge) and lunch/dinner (cooked paste). Sometime, the remaining Mawè is stored for a while (one to five days) before use. Consumers expect Mawè that is white, without foreign matters and alcohol odour free. The Mawè-based foods (porridge like *Aklui*, wet bread like *Ablo*, and cooked paste like *Come*) are bought as street foods and consumed for breakfast (*Aklui* and *Come*), lunch and dinner (*Ablo* and *Come*).

The institutional environment and the supporting services related to Mawè value chain are discussed in section 2.3.

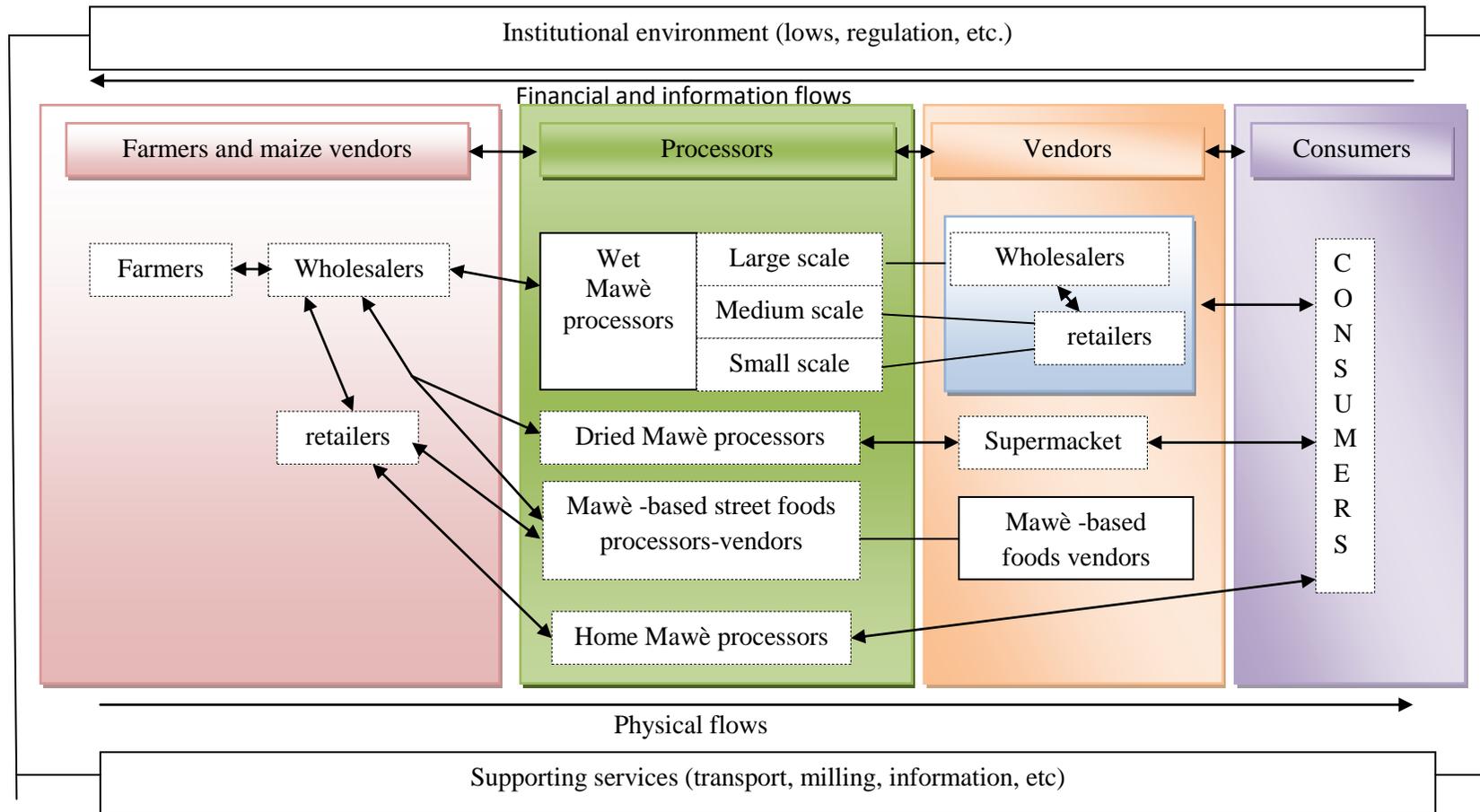


Figure 1: Supply chain, Institutional environment, physical flows and supporting service in mawè production

Table 1: Typology of actors

Actors	Role and Responsibility	Discussion
<u>Farmers (both sexes)</u>	Cultivate, harvest, dry, store maize and sell to cereal vendors and sometimes to processors	Maize is cultivated in all the agro ecological zones of Benin. The abundance period stretch out on August to December. Out of this period, maize is very expensive for Mawè processors, and then influences income generation.
<u>Cereal vendors (both sexes)</u>	Purchase from farmers and sell to processors.	The cereal vendors include wholesalers and retailers. Mawè processors prefer buying maize from wholesalers for reducing purchase price.
<u>Millers (Males)</u>	Grind, sort and wash grains and mill grits for processors	They mill different types of raw materials (maize, sorghum, slice of dried yam, etc.) with the same machine at price proportional to the quantity of raw material and level of fineness required for final product; so there is a potential of cross contamination. Also, losses of flour occurred during milling.
<u>Processors (Females)</u> - Large scale processors of commercial mawè - Medium scale processors of commercial mawè - Small scale processors of commercial mawè -Dried mawè processors -Home mawè processors -Mawè-based street foods processors-vendors	Process large quantities of grains into mawè and sell to retailers. - Process medium quantities of grains into mawè and sell to consumers -Process small quantities of grains into mawè and sell to consumers -Process dried mawè in cottage industries -Process mawè for household consumption -Process mawè and use it as intermediate product to produce <i>Aklui</i> , <i>Ablo</i> and <i>Come</i> sold as street foods	Process more than 200 kg /week; they represent 16,52 % of interviewed processors -Process between 100-200 kg /week; they represent 41,74% of interviewed processors -Process less than 100 kg / week; they represent 41,74% of interviewed processors. -They are mainly the SMEs which process cereals (maize, sorghum, miller, etc.) into dried mawè, dried <i>Aklui</i> and dried fermented or non-fermented flour for <i>Koko</i> , <i>Akassa</i> , <i>Akpan</i> , <i>Ablo</i> , etc. These products are very stable and are distributed through supermarkets. -They process some amount of maize for domestic use
<u>Vendors (Females)</u>	Sell at fixed location or as hawker vendors	Mawè vendors include wholesalers and retailers. The wholesalers are essentially the large scale processors.

		The retailers gather medium, small scale processor and condiments vendors. The latter buys mawè from wholesalers for selling to consumers. There are more fixed location vendors (84.4%) than hawker vendors (15.6%).
Consumers (both sexes)	Buy from producers/sellers and consume generally as <i>Koko, Akassa</i> and <i>Agbelimawè</i>	They expect good quality of mawè (white, without foreign matters, good odour and taste). The required souring level of mawè for consumption is highly variable depending on consumers' will.

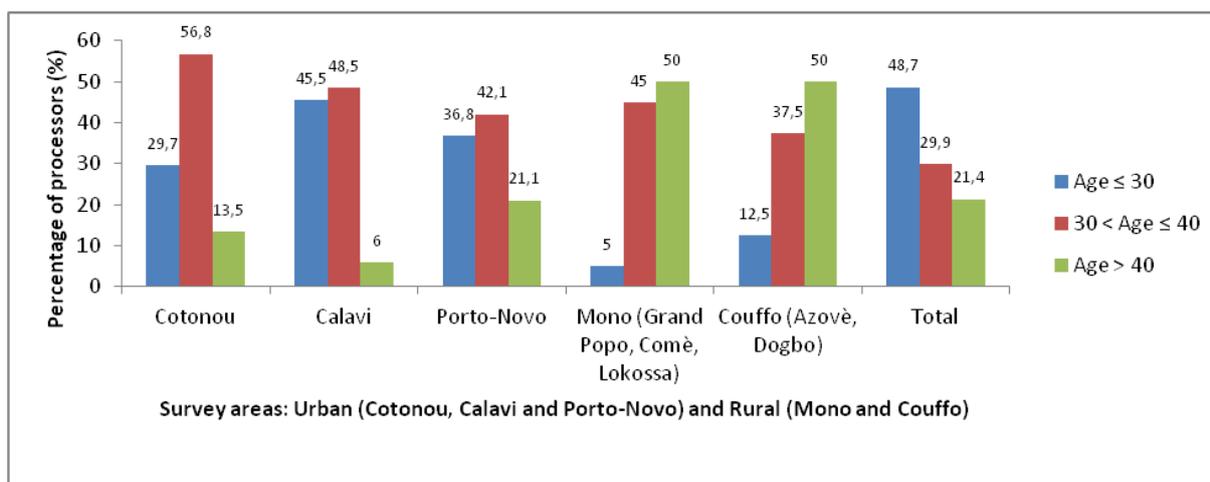


Figure 2a: Distribution of Mawè processors in rural and urban areas according to their age

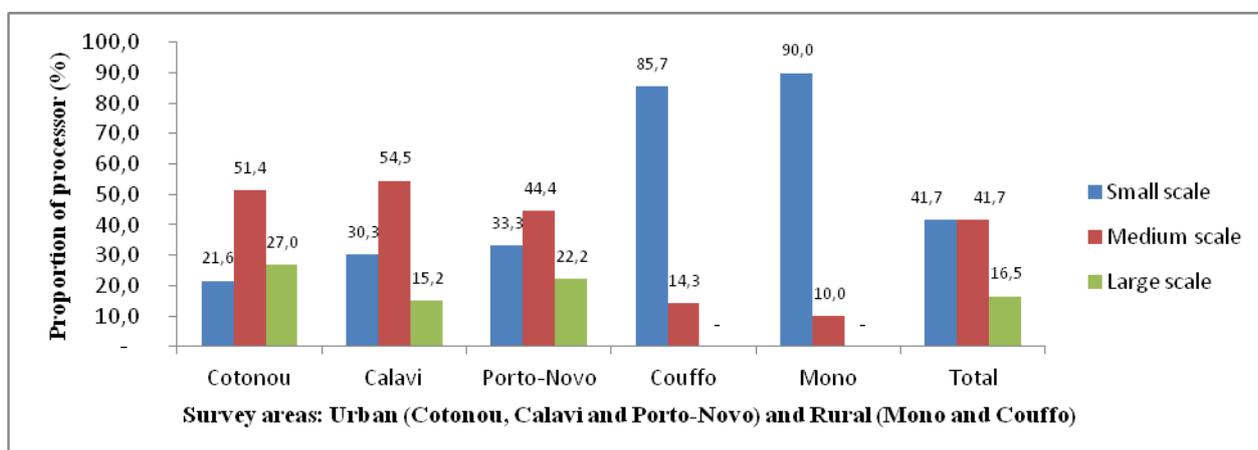


Figure 2b: Distribution of Mawè processors in rural and urban areas according to the amount of processed raw material per week

2.2- Processing

The method of Mawè preparation depends on the type of Mawè to be processed. Hounhouigan et al., (1993) have been the first to describe ‘Home Mawè’ and ‘Commercial Mawè’ processing. Up to now, the processes described by these authors have not greatly changed. Then, the winnowed and sorted maize is washed, crushed in a plate disc mill, and

screened by metal or nylon sieve with 0.5 X 0.5 mm mesh (commercial process), or through a palm-fibre sieve ('sassado') with 2 X 2 mm or 2 X 4 mm apertures (home production method). Grits and hulls are separated by gravity on the sieve and the fine endosperm fraction collected in a bowl. In the commercial process (entirely in the milling shop), the grits are washed by rubbing in water, the germs and remaining hulls floated off and discarded, water decanted, and the sedimented endosperm grits blended with the fine endosperm fraction. In the home production method, the grits are not washed, but home-dehulled. The resulting grits and fine fraction are moistened, held for 2-4 h, and milled to a dough. The kneaded dough is then covered with polyethylene sheet and allowed to naturally ferment to a sour dough and held in the fermentation bowl or wrapped in polyethylene. Nowadays, the same processes are still used; but some changes can be noted as described in typology of processes (Table 2). The Figure 3 completes the processes typology and shows through their processing methods the differences between all types of mawè enumerated above.

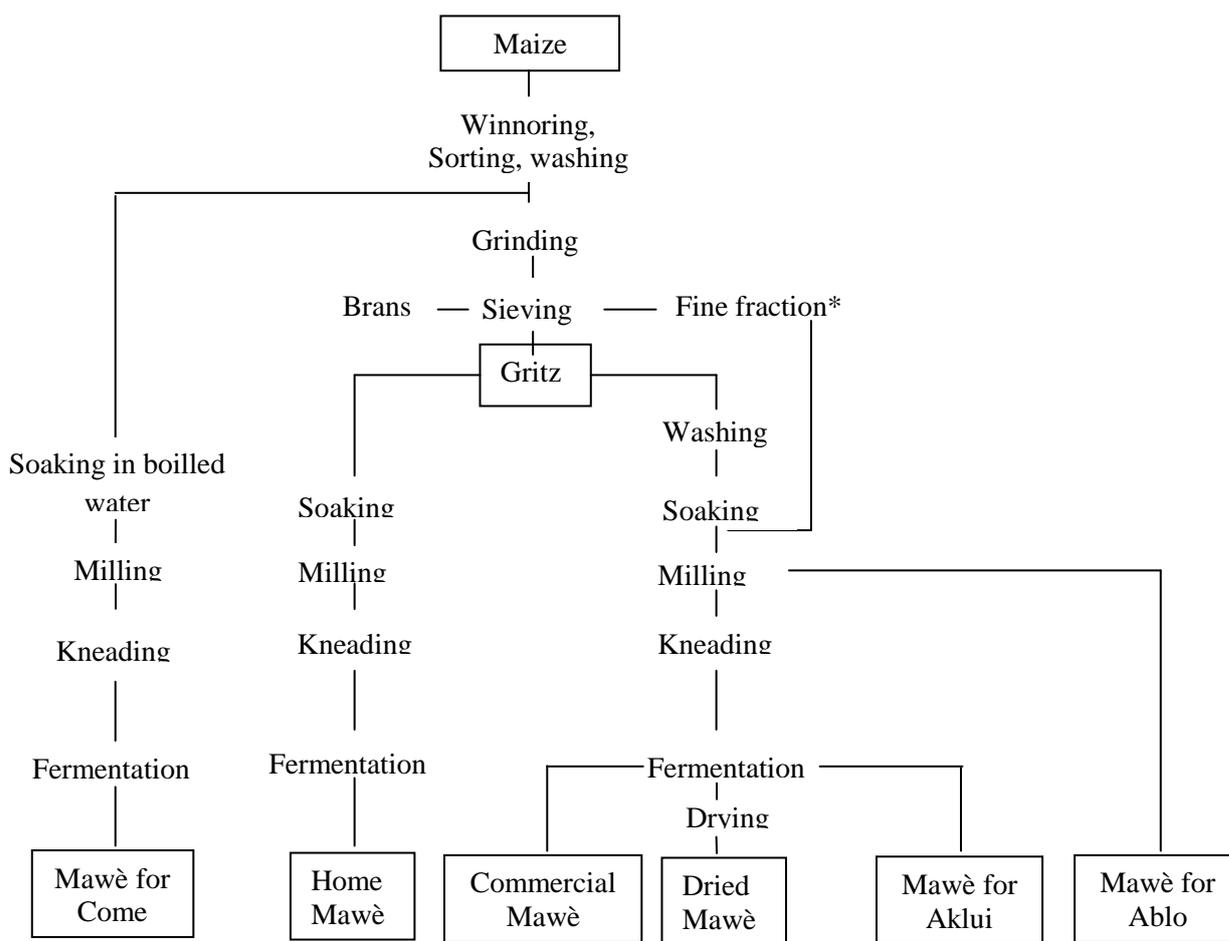


Figure 3: Difference in kinds of Mawè through processing methods

*= During the processing of home mawè the fine fraction is also added to soaked grits before milling

Table 2: Typology of processes

Process	Description	Discussion
Raw materials	White maize	The grains must be well dried and free from stones and weevil. White maize is used for whiteness of mawè. Some processors prefer grains of low size for reducing bran and increasing yield.
Winnowing, sorting and washing	Removal of dust, sand, stones and damaged grains,	Tedious unit operation and more time consuming
Grinding	Grinding of winnowed, sorted and washed grains in a plate disc mill	Grinding allow dehulling of grains
Sieving, grits washing and steeping	Grinded grains are sieved and washed for more hulls and fats removal. Then steeped during 2-10 h at local ambient temperature (28-31°C).	The final whiteness and homogenous texture requirement of mawè depend highly on these operations. They are more constraints and time consuming. According to processors, the final fineness of mawè depends on steeping duration.
Milling	The grains are milled (once) using a plate disc mill	The plate disc mill may be contaminated by other matter because the mill is used to grind other types of products such as leguminous, slice of dried yam etc
Humectation and kneading	The milled maize is moistured and slightly kneaded.	The amount of water added is highly variable. Some processors add very low amount for having a stable product, while others add high amount for a higher final yield.
Fermentation	The mawè is stored in a plastic bowl and held at room temperature (28-31°C) during 12-48 hours for natural fermentation.	Fermentation duration depend on the acidity degree expected by consumers. Some of them demand slightly fermented product, whereas other like purchasing well fermented mawè.
Packaging	Mawè is then shaped in spherical form, wrapped in transparent polyethylene and arranged in plate bowl	The nature of the container (e g the cleanliness) can be a source of contamination of the product

	for transportation to the selling place.	
Selling	Mawè is often sold in fixed location in open market or sometime, by hawker vendors.	During selling, Mawè continue to ferment and become more acid. The highly acid product can be mixed with new product (non-fermented) to break down its acidity.

2.3- Services

The supporting services are essentially, transportation, milling, information providing, etc. Transporters are male and transport maize from farmers to vendors and from vendors to processors. Besides, large scale mawè processors are helped by transporters to bring mawè on open market for distributing to retailers. The millers are exclusively male; their activity consists of grinding maize for Mawè processors. Another service like information providing (for example, concerning price change) is done among actors.

Most of time, the transportation of maize and Mawè is done by motor-bike driver. Maize milling is also an important service supplied by millers. The millers are males as well as transporters. Another important support service in the value chain of Mawè is the role of container or other materials sellers who supply Mawè processors in plastic bags or polyethylene papers, large plate or bowl/bucket, sieves, etc. for Mawè production, packaging and selling. It is worthwhile to add that the exchange of information (concerning change of price, etc.) between actors is another important service characterizing the Mawè value chain.

As Mawè is processed by the traditional and informal food sector, the rules related to formal food processing sector are not applied. The reason is that there are no specific rules about the traditional food products. However, the rules concerning the hygiene of processing site and selling places are mostly controlled by the food inspection office “la Direction de l’Hygiène et de l’Assainissement de Base (DHAB)” of the Ministry of Public Health and “la Direction de l’Alimentation et de la Nutrition Appliquées (DANA)” of the Ministry of Agriculture, livestock and fishery in charge of this type of control. Other supports for official export are the official laboratories in charge of quality control. In the “Union Economique et Monétaire Ouest Africaine” (UEMOA) zone there is free trade of goods; this means that a Mawè processor don’t need any permit before exporting, but they have to prove that their product is safe through the report of analysis done on the product by an official laboratory (DANA

laboratory) followed by the safety certificate given by DANA which is the only official control service in charge of such activity.

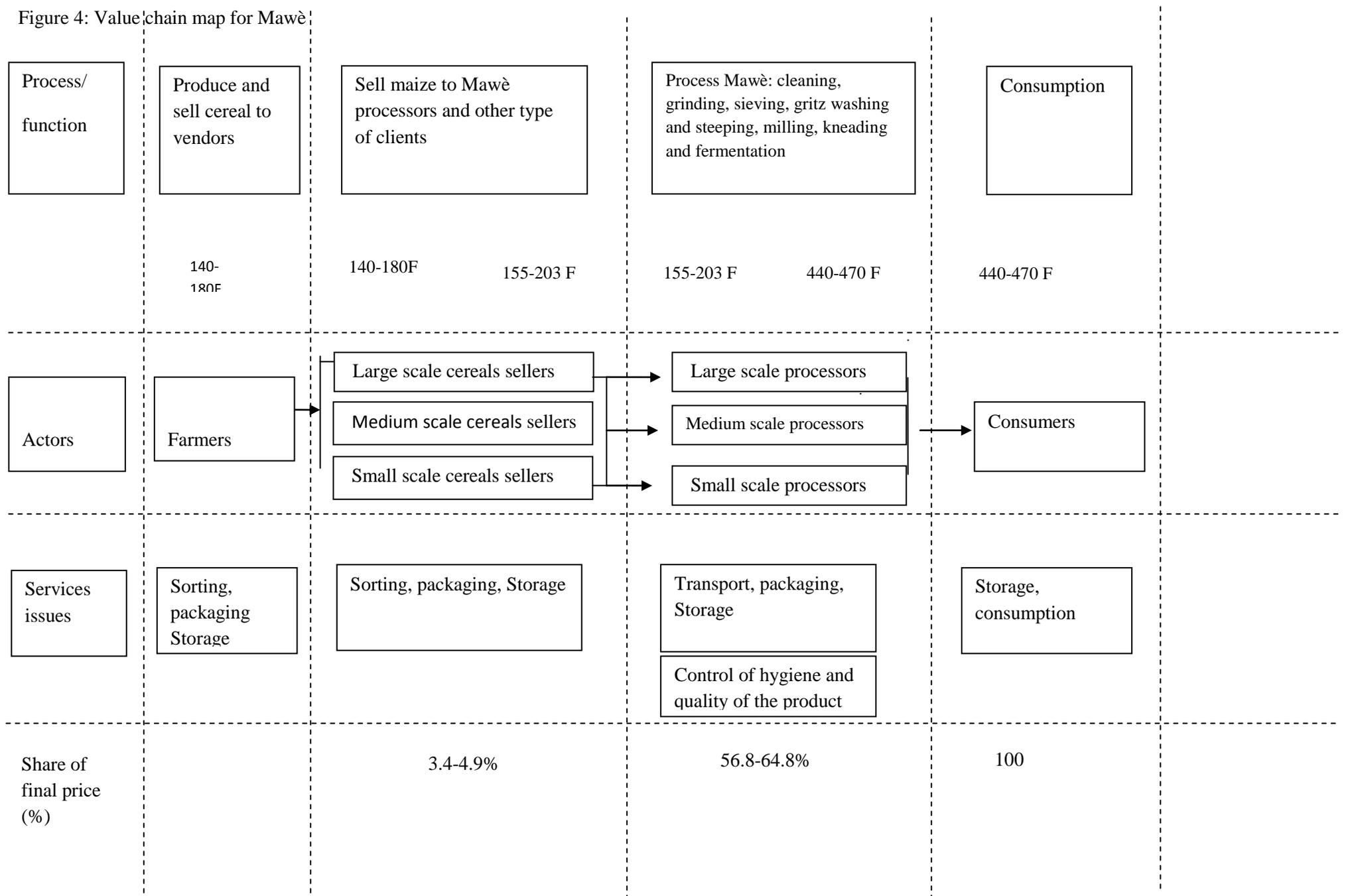
2.4- Summary of bottle-necks, problems, opportunities and key success factors from value chain analysis

The sorting of raw material, sieving and washing of grits are the most constraining unit operations in Mawè processing. In addition, these operations are time-consuming as well as grits steeping and Mawè fermentation; consequently, Mawè production needs relatively long time (1-3 days). Other problem is that Mawè becomes too sour during storage/marketing. As a way-out, after 3-4 days, the unsold are usually mixed with new production (non-fermented mawè), giving finally a lightly sour product. When the unsold is not recycled, Mawè becomes non-consumable after 5-10 days characterized by yellow color; unpleasant appearance, taste and odour. To increase the shelf life of Mawè, some processors reduce amount of water to be used during kneading before fermentation but, this practice decreases final yield, and then, increases the cost price. The Faculty of Agronomic Sciences has developed a new type of Mawè and Aklui (Mawe derived product) in a dried form during the period 1990-2000. These technologies have inspired the development of dried Mawè and Aklui business. The products which shelf life is more than one year are generally sold in supermarkets. However, the drying is very constraining (investment for dryer purchasing, possible loss of acidity during drying and variability of quality, time consuming, etc.). Finally the new products are costly for traditional consumers. However, there is a new market for the new products represented by urban population with higher income and African diaspora in Europe, America and Asia.

The re-engineering of the Mawè processing is an opportunity to promote new business development. The re-engineering activity should focus on the control of fermentation and drying steps. More specifically, using multifunctional starter for Mawe fermentation will insure microbial safety, pleasant and constant sensory profile. Hounhouigan et al. (1994, 1999) have tested the use of starters of lactobacilli and yeasts in the fermentation of Mawè porridge. This study revealed that fermentation of Mawè for porridge preparation can be carried out using a single starter culture of *L. fermentum* biotype *cellobiosus* strains LF 4809 and LF 0603, *L. fermentum* strain LC 4809, *L. brevis* strain LC 4805. Also, the yeast *Candida krusei* exerted a stimulating effect on *L. fermentum* and *L. brevis* during a mixed starter culture fermentation of mawè porridge.

This study need to be completed for a better improvement in the order to extend the marketability of Mawè. The target customers could be at national level, both high and low income groups, traditional caterers, street food vendors, restaurants and boarding schools, and other African countries, and Africans in the diaspora (UK, France and USA) and Europeans (UK and France) for external customers. The value chain map for Mawè is summarized in the Figure 4.

Figure 4: Value chain map for Mawè



Socio economic data collected along the chain during the survey revealed that the maize vendors buy maize from farmers for 140-180 FCFA/kg and sell it to processors for 155-203 F CFA/kg; the processors produce $1350 \pm 23\text{g}$ of Mawè from 1 kg of maize and sell to consumers for 440-470 F CFA and this according to the period of sale; the rough average share of the final price along the chain are 3.4-4.9% and 56.8-64.8% for maize vendors and Mawè processors respectively (Fig. 1). This means that the farmers and other actors of the chain share about 35.2-43.2% of the final price of Mawè.

3- Marketing and new business model development

3.1- Products

The analysis of existing type of Mawè shows the possibility to develop new products for new business model development. These new products could be improved commercial humid Mawè, commercial dried Mawè and Aklui. Such new products development could be done through the use of relevant starter cultures (of lactic acid bacteria and yeast in combination) and the fermentation process optimisation. Such practices could insure the microbial safety and long shelf life of Mawè and its derived products.

3.2- Price

About 100% of commercial Mawè processors related during the socio-economic survey that the price of raw materials (maize) is the first determining factor in the market mix of Mawè. Generally cost of labour is not calculated. According to Mawè processors, maize is expensive from January to June. The selling price of Mawè follows the same variation during the year. The Table 3 shows for example that at the moment of the survey (October-November), 1Kg of maize is sold for 155FCFA vs 203FCFA when maize is more expensive (June for example). As a result, 100g of wet Mawè cost 33 and 35FCFA for both periods, respectively. As well as the dried Mawè is concern, currently, 100g cost 128 F CFA. The higher price of the dried Mawè is due to drying and packaging operations which are costly and time consuming and confer to Mawè higher dried matter content ($90 \pm 1\%$ vs. $56 \pm 4\%$ for commercial humid mawè), long shelf life and good appearance.

For the two improved types of Mawè, in addition to factors evoked above, the use of starter culture could increase the final cost of Mawè. However, the fermentation time can be reduced

and then should affect the final price of the product. These factors could be taken into account to fix their selling price.

Table 3: Price variation of Mawè

	Price of 1 Kg of maize (FCFA)	Quantity of obtained Mawè (g)		Price of obtained Mawè (FCFA)		Price for 100g (FCFA)	
		Wet	Dried	Wet	Dried	Wet Mawè	Dried Mawè
Moment of survey (Oct-Nov 2014)	155	1350 ± 23	891 ± 15	440	1140	33	128
When maize is expensive (June for example)	203	1350 ± 23	-	470	-	35	-

3.3- Place

Currently commercial Mawè is mainly sold in open market (66.4%). However, some vendors sell commercial Mawè along street (18%). Also, 15.6% of interviewed vendors were hawker. Dried Mawè is often sold in supermarket. The new Mawè to be developed (improved commercial Mawè and improved dried Mawè) could be also sold in supermarket and for use in the restaurant. The target customers are both high and low income groups at national and international levels. Beside ‘Prebiotic’ and safety due to the use of relevant starter culture, the dried Mawè has also the advantage to be very stable with a long shelf life. These characteristics could allow dried Mawè and Aklui to be sold in other African countries and overseas.

3.4. Promotion

As indicated above, two new Mawè are expected to be promoted. These products could be promoted through a number of actions such as Nutritional information on the packages, radio advertisements, catchy TV advertisements, TV documentary, sponsoring of educational programs to attract the youth (T-shirts advertising Mawè), attractive messages and participation to national and international food fairs.

4- SWOT

The strengths, weaknesses, opportunities and threats (SWOT) for two new versions of Mawè are summarized in Tables 3.

Table 3: SWOT analysis for Mawè production

<p>STRENGTHS</p> <ul style="list-style-type: none"> • Long tradition of production of Mawè in Benin • Availability of raw material • Mawè is consumed by all classes of people • Mawè is an intermediate product for a large diversity of fermented dishes • The ease of packaging of Mawè • Cheap source of micronutrients 	<p>WEAKNESSES</p> <ul style="list-style-type: none"> • Short shelf life of commercial humid Mawè • Inappropriate processing technology (e.g. tedious unit operations, spontaneous fermentation) • Unavailability of starter culture for controlling Mawè fermentation
<p>OPPORTUNITIES</p> <ul style="list-style-type: none"> • Possibility to develop relevant starters cultures to control the fermentation • Possibility to mechanize the processing • Standardize the fermentation conditions • Improve presentation (packaging) • Look for new market for improved Mawè among Africans in the diaspora. 	<p>THREATS</p> <ul style="list-style-type: none"> • Behavioural changes in elite/youthful consumers • Types of maize used for Mawè going into depletion due to climate change

It appeared that there is a potential to promote Mawè with the reengineering perspectives and this because Mawè production is a long tradition in Benin and Mawè is consumed by almost all Beninese as intermediate product in breakfast, lunch and dinner.

The reengineering perspectives will contribute to add value to the two versions of Mawè and Aklui and the development of new SMEs. The production of good quality of Mawè will offer opportunities to attend new markets in all countries of Africa, even overseas.

Two assumptions are formulated to support this SWOT analysis: i) Types of maize used to produce Mawè will always be available and 2) after re-engineering Mawè can be produced on an industrial scale.

5- GAP analysis

The commercialization of Mawè is done in informal market. After improvement, the new products are expected to attend the formal trade market. For this, the new Mawè has to be safe and must respond to required specifications. The traditional Mawè is known as good microbial quality product since the microorganisms which are involved in its fermentation are mostly lactic acid bacteria. However, the fact that the Mawè undergoes spontaneous fermentation cannot insure the better safety and specification for formal trade market. It is worthwhile to identify the multifunctional strains in the order to develop starter culture for Mawè and its derived food.

Conclusions and recommendations

This report summaries the value chain for Mawè in Benin. Different actors are associated to Mawè production e.g. farmer, cereal vendors, millers, Mawè producers/sellers, packaging sellers. Services from the intercity car drivers and regulation structures are also needed to make the chain work. The main unit operations for Mawè production include sorting and washing of grains, grinding, sieving, grits washing and steeping, milling, kneading, fermentation, drying and packaging. The price of final product depends mainly on the price of raw materials (maize). Mawè is mainly sold in open market; but it is expected that after improvement, Mawè will be sold in different places such as supermarkets, restaurants and hotels, in Benin as well as abroad. Apart from time consuming and constraint of sorting and grits washing, the major problems associated with Mawè production are related to the fermentation step and the short self-life of humid Mawè. To overcome these problems, the development of starter culture to control Mawè fermentation could help to insure safety and to meet consumer's expectation of Mawè and its derived products.

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