ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7 September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

Afr. J. Food Agric. Nutr. Dev. 2022; 22(7): 20774-20792 https://doi.org/10.18697/ajfand.112.21565

HANDLING PRACTICES, QUALITY AND LOSS ESTIMATION ALONG THE VALUE CHAIN OF WARAGASHI, A SOFT CHEESE FROM BENIN

Hounsou M[1], Dabadé DS[1]*, Götz B[2], Hounhouigan MH[1,4], Honfo GF[1], Albrecht A[2], Kreyenschmidt J[3] and DJ Hounhouigan[1]

D. Sylvain Dabadé

Corresponding author email : sylvaindabade@gmail.com

[1]Laboratory of Food Sciences, University of Abomey- Calavi 03 B.P. 2819 Jericho-Cotonou, Benin

[2]Institut of Animal Science, University Bonn, Katzenburgweg 7-9 D-53115 Bonn Germany

[3]Department of Fresh Produce Logistics, Hochschule Geisenheim University, van-Lade Strasse 1, 65336 Geisenheim

[4]Ecole des Sciences et Techniques de Conservation et de Transformation des Produits Agricoles, Université Nationale d'Agriculture, 01BP55, Porto-Novo, République du Bénin"

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7
September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

ABSTRACT

Waragashi is a soft cheese made from cow milk, widely marketed and consumed in Benin and in other African countries (Nigeria, Ghana, Togo). However, the product is prone to deterioration, especially at ambient temperature (28–32°C) because of its high water activity, nutrients and neutral pH. The present study aimed at getting insight into the factors affecting the quality of *waragashi* and estimating losses along the value chain. The entire value chain was investigated (i) to determine the product handling conditions, and (ii) to determine stakeholders' perceptions of related quality, and (iii) to estimate the product proportion and quality loss along the value chain. One hundred and ninety-nine (199) producers, 100 collectors, 156 wholesalers/retailers, and 326 consumers were randomly interviewed in the main Departments of Benin involved in this soft cheese value chain. Descriptive statistics and chi-square tests were used as statistic tools for highlighting the relationships between variables. Significance was accepted at a *P* value of 0.05. The results showed that *waragash*i, produced and sold essentially by women (≥ 97%), is packed in bowls (78.9% of respondents) and plastic boxes (16.1% of respondents) as containers at the production stage and marketing. Daily boiling and soaking in water extract of dye sorghum panicle (traditional red biocolorant used to colour the product) were used as the main preservation methods. *Waragashi* was held mainly at ambient temperature (28–32°C) along the value chain. The priority quality attributes of the product were texture, colour, and taste for producers, whereas texture, odour and appearance were the desirable attributes for consumers. The quality deterioration linked to inappropriate handling conditions occurred mostly at wholesalers/retailers' level. This leads to important financial losses on the product varying from partial (reduction of approximately 30% of the sale price in comparison to that of the fresh product) to total loss of sale price, meaning that the product cannot be sold. Therefore, there is a need to find appropriate solutions to ensure a better-quality management of *waragashi* along the value chain.

Key words: Soft cheese, *Waragashi,* Benin, Value chain-losses, Food quality attributes

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

INTRODUCTION

Waragashi, also known as *wagashi* in Benin, *woagashie* in Ghana, or *wara* in Nigeria, is a soft cheese made from cow milk, which is an important source of animal protein in various food recipes [1, 2] in many African countries. In Benin, the population has been consuming this product for over a hundred years [1, 3, 4]. Its consumption can contribute to the reduction of malnutrition that persists in developing countries [5, 6]. Some studies have shown the nutritional composition of *waragashi.* For example, Egounléty found 40% moisture, 24% protein, 30% lipids and 1.2% calcium in the fresh product [1, 7], while Adetundji obtained 33.8% protein, 31.5% lipids, 8.1% lactose, 4.1% zinc, 7.3% copper, 4.8% iron and 2.4% manganese [8]. Also, Mazou reported 69.7% moisture, 30.3% protein and 11.4% lipids [9]. Due to the high content of moisture, protein and lipids, this soft cheese is perishable. Therefore, it is difficult to maintain the product at ambient temperature (28–32°C) for the stakeholders along the value chain [10]. Daily boiling, soaking in water extract of sorghum panicle dye (traditional red biocolorant used to change its colour), soaking in whey or in water during the sale, sun-drying on the roof straws and smoking, are commonly used to preserve its freshness [6, 10, 11, 12, 13]. During these preservation processes, both qualitative and quantitative losses could occur, thereby leading to the need to assess handling practices of the product and those especially associated with qualitative and quantitative losses within its value chain. Therefore, the current study aimed at determining the factors that affect the quality of *waragashi,* and estimating the losses along the value chain. More specifically, this work (i) investigated the product entire value chain to determine this soft cheese handling practices (ii) determined stakeholders' perceptions of the desirable quality attributes, and (iii) estimated qualitative and quantitative losses within the value chain.

MATERIALS AND METHODS

Survey areas

A survey was conducted in seven districts across different Departments of Benin (Figure 1). These districts, named Gogounou, Pehunko, Parakou, Dassa-Zoume, Djidja, Abomey-Calavi and Cotonou, are in the Departments of Alibori, Atacora, Borgou, Collines, Zou, Atlantic and Littoral, respectively. The choice of these study areas was based on expert opinions (demography and manufacturing) and available statistics which classified these areas as zones of production and, or marketing of *waragashi* [14]. However, based on the high number of agricultural households involved in *the* production, marketing and consumption, among the number of populations in the Department, the present work chose the top five districts (Alibori, Atacora, Borgou, Collines, and Zou) in terms of production, based on available statistics [14] and the last two districts (Atlantic and Littoral) as high *waragash*i marketing and consumption zones. The two most populated cities in Benin Republic (Cotonou and Abomey-Calavi) and the biggest market in Benin Republic (Dantokpa) are in Littoral and Atlantic [14].

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7
September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

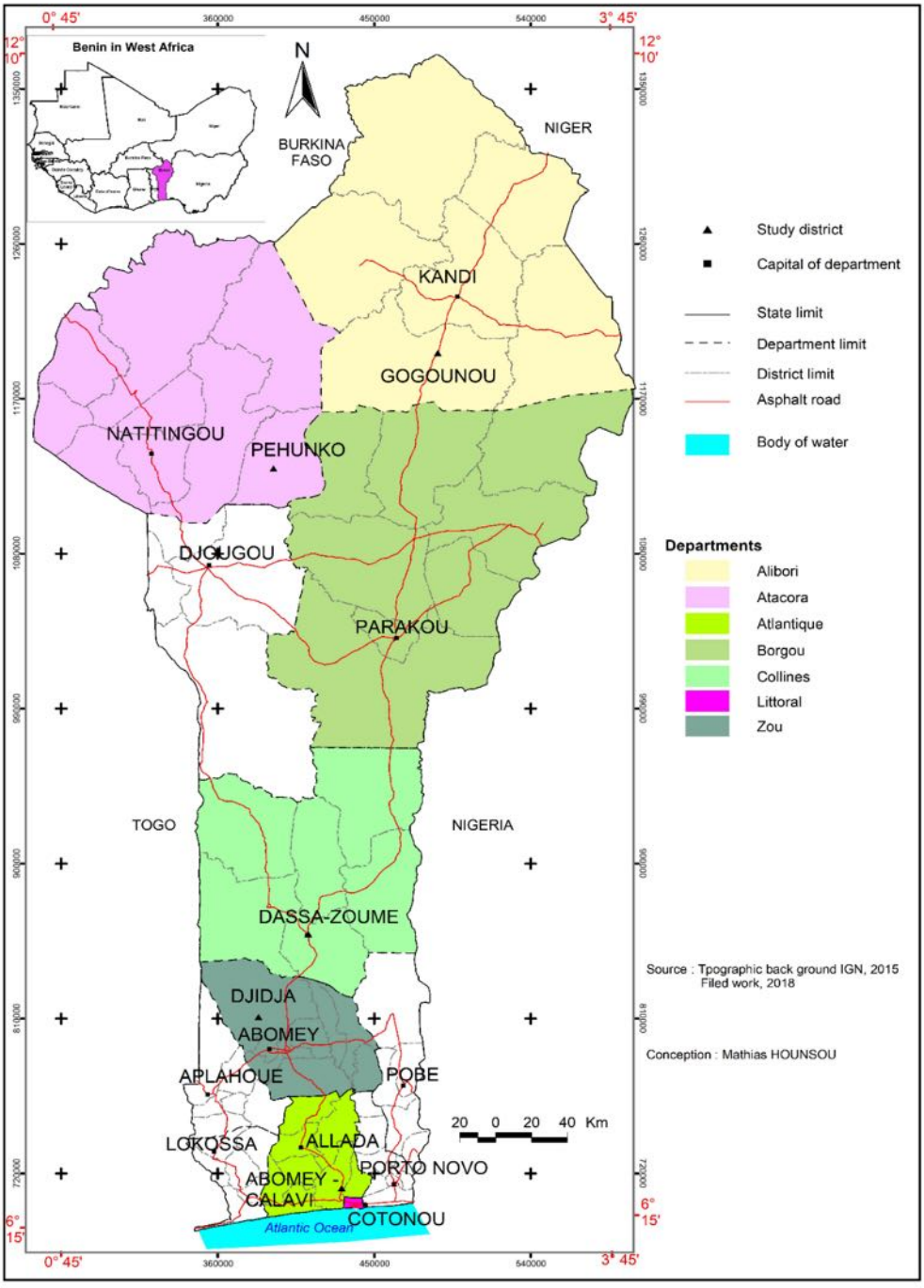

Figure 1: Map of Benin showing study areas

Sampling of respondents

The number (N_t) of the *waragashi* value chain stakeholders interviewed in each department (Table 1) was calculated using the following Dagnelie [15] formula:

$$(N_t) = 4p\,(1\text{-}p)/d^2 \qquad (1)$$

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

where *p* is the proportion of the number of agricultural households involved in *waragashi* production, marketing and consumption, among the number of populations in the department, and *d* is the expected error margin fixed at 0.05.

Based on the number of agricultural households involved in the product value chain within a department, 3 districts or villages showing high numbers of agricultural households were selected [14].

The sample of respondents (Sp) in one (1) district was determined using the ratio of the number of agricultural households in one (1) district (D1) multiplied by the number of the respondents (N_t) among the number of agricultural households in the three (3) districts (D1, D2 and D3) (showing a high number of agricultural households within a department) considered (proportional allocation to size).

$$Sp = \frac{(D1 * Nt)}{(D1+D2+D3)} \quad (2)$$

Data collection

An exploratory interview was implemented to get insight into the value chain of *waragashi* and thereafter, questionnaires were developed for in-depth interviews. The study was conducted between June and November 2018 using face-to-face interviews.

Estimation of Quantitative Losses within *Waragashi* Value Chain

Each member of the stakeholders' forum was asked to estimate the loss of *waragashi* that they usually record. For that, the daily quantities of this soft cheese produced (for producers) or bought (for collectors, wholesalers/retailers and consumers) for four days (average duration of the sale of an entire batch of *the product* by wholesalers), were assessed. Besides, the quantity of *waragashi* lost: (i) physically (fresh or non-fresh product) (ii) due to deterioration in quality inducing the reduction of the sale price and (iii) due to the complete spoilage of the product were assessed. These three types of losses were called (i) loss of fresh *waragashi* (ii) loss linked to partial quality deterioration (the product is still marketable although at reduced price) and (iii) loss linked to complete quality deterioration (the product is unmarketable).

Estimation of Financial Losses within the *Waragashi* Value Chain

On average, 228 units of *waragashi* weighing from 300 g to 600 g with a diameter of 13–15 cm were bought in four days by wholesalers/retailers. The estimated quantity (expressed in %) of partially spoiled product was obtained from informants and the sale price was assessed in comparison to the sale price of fresh product. From a total of 228 units of *waragashi*, the average price of the product lost in quality (non-fresh *waragashi* with medium quality) and the average price of the fresh product, the cost of the quantity (expressed in %) of partially spoiled *waragashi* and the cost of the remaining (expressed in %) fresh product, were determined. Similarly, supposing that all the *waragashi* units were sold at the fresh *waragashi* price, the cost of 100% fresh product was also calculated. Finally, the average of quantity lost in four days by wholesalers/retailers, was calculated using the following formula:

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

$$Al = [(Wft - Wf)] – (Wp) \quad (3)$$

With:
Al: average of quantity lost in four days by wholesalers/retailers
Wft: cost of the 100% of fresh *waragashi*,
Wf: cost of the remaining (expressed in %) fresh *waragashi*
Wp: cost of the quantity (expressed in %) of partially spoiled *waragashi*

Stakeholders' Quality Perception of *Waragashi*
The quality of *waragashi* was appreciated by each stakeholder group based on the quality criteria of the product (Table 2). Each informant was asked to provide the quality criteria used at purchase regarding appearance, colour, texture, odours, taste and size. A scoring scale was used for each quality criterion. Quality criteria are scaled on a positive gradient varying from 1 (low = bad) to 5 (high = good) (5 points hedonic scale). Then, for each stakeholder group, the ten top quality criteria were ranked (Table 6).

Data Processing
Raw data were recorded in Sphinx software (5.1.0.4-Baulac and Moscarola, France) and transferred to Microsoft Excel 2016 spreadsheets. They were processed using descriptive statistics and presented in tables and figures (histograms for losses in quality of *waragashi*) and chi-square test for highlighting relationships between variables such as ranking priority of *the product* quality criteria by different groups of stakeholders using XLSTAT 2014.5.03. (Addinsoft, France). Significance was accepted at a *P* value of 0.05.

RESULTS AND DISCUSSION

Socio-demographic profile of stakeholders along *Waragashi* value chain
Waragashi value chain stakeholders include producers, collectors, wholesalers/retailers and consumers (Table 3). More than 97% of stakeholders involved in this soft cheese production and marketing are women. Most respondents were between 30 and 54 years of age (70.4% for producers, 84% for collectors, 61.8% for wholesalers/retailers and 42.9% for consumers). Most *waragashi* producers (99.5% of respondents) and wholesalers (44.6% of respondents) did not receive any formal education. These findings confirm the considerable role played by women in the traditional food processing in Benin, as reported in previous studies [16, 17]. In agreement with Sessou *et al.* [13], producers, retailers and consumers were identified in this study as part of the value chain structure. However, changes have occurred over time with involvement of new stakeholders mainly collectors and wholesalers as reported in this study. This finding suggests that food value chain in developing countries is dynamic as previously reported by Houngbédji *et al*. [17] and Gómez and Ricketts [18].

***Waragashi* handling Practices in Value Chain**
Most *waragashi* producers (62.3%) and collectors (67%) were from the Northern (Gogounou, Pehunko and Parakou) or the Central part of Benin (Dassa-Zoume and

Djidja). As shown in Table 4, as marketing strategies, stakeholders used face-to-face marketing (63.8% and 79% for producers and for collectors, respectively) and phone (36.1% and 21% for producers and for collectors, respectively) for the product availability. Before production, producers informed collectors about availability and the period the product would be available. After purchasing, collectors carry the products home. Most of the wholesalers (75% of respondents) bought the soft cheese from collectors in the North of the country and carried them to the biggest cities in the South (Abomey-Calavi, Cotonou, and Porto-Novo) by bus. Some wholesalers (25%) made a phone call to the collectors who supplied them with the product by bus. Most consumers (92.9%) (Table 4) bought *waragashi* from wholesalers or retailers in markets. Few consumers (7.1%) called wholesalers via phone to bring the product to their home by common means of transportation (motorbike taxi).

Various *waragashi* storage containers were used along the value chain (Figure 2A). The most used were bowls (78.9% and 97.5% of producers and wholesalers/retailers, respectively), plastic boxes (75% of collectors), and plastic colanders (75.3% of consumers). The plastic colanders were used to strain off water or oil from the product after boiling or frying it.

Different *waragashi* holding times were recorded along the value chain (Figure 2B). Most of the producers and collectors (72.9% and 85.0%, respectively) and approximately half of wholesalers/retailers or consumers kept the fresh *waragashi* for a maximum of one day. However, by boiling the product on a daily basis, it can be kept up to 7 days at ambient temperature. *Waragashi* holding time can exceed 7 days when preservation methods like chilling, grilling or drying are applied (Figure 2C).

In *waragashi* value chain in Benin, the most common preservation method used is boiling (Figure 2C). When the fresh product is not sold the same day, stakeholders boil it to inactivate spoilage organisms and this can be done daily up to seven days. According to the stakeholders surveyed, the method prevents them from losing the product. However, daily boiling reduces the size, weight and appearance of the product, which leads to reduction of its sale price. Other preservation methods mainly applied by consumers were frying, grilling and sun drying (Figure 2C). Also, soaking in whey and soaking in water extract of sorghum panicle dye were used by producers (27.2% and 2.1%, respectively). Among these preservation methods, soaking in whey and daily boiling could affect more negatively the quality, safety and shelf life of *waragashi*. During soaking in whey or water, the migration of micronutrients from the cheese into whey or water could occur, reducing the nutritional quality of the product. Daily boiling of *waragashi* modifies the organoleptic characteristics of the product such as its texture and taste. Like the present findings, Sessou [13] and Nout *et al*. [19] reported that the use of repeated heat treatment could leach or destroy the nutrients contained in the product giving way to free radicals which would induce oxidation and rapid rancidity. Therefore, the daily boiling used by stakeholders to preserve *waragashi* should be improved to ensure its sensory and nutritional quality. For example, appropriate packaging solutions using locally available resources can be developed to extend the shelf life of the product and to improve its safety.

ajfand SCHOLARLY, PEER REVIEWED
AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT
Volume 22 No. 7
September 2022
PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST
ISSN 1684 5374

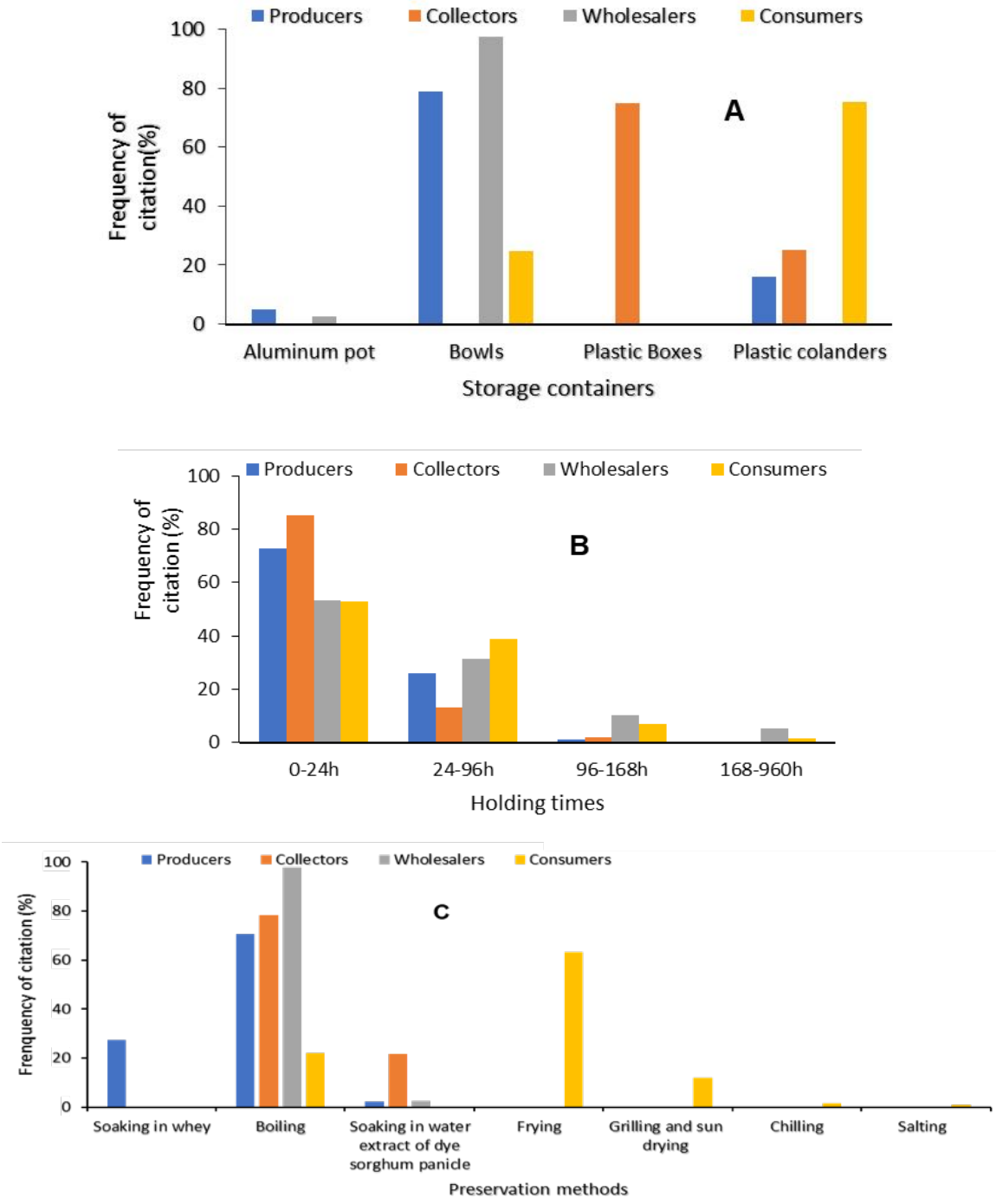

Figure 2: Citation frequency of stakeholders on (A) storage containers, (B) holding times and (C) preservation methods of *waragashi*

Loss estimation in the *Waragashi* value chain

Waragashi losses occur at various steps along the value chain (Figure 3A). The estimated lost quantity by different groups of stakeholders is shown in Figure 3B. Based on the survey, three types of losses were identified. First, the physical loss of fresh *waragashi* by the stakeholders, second, the product isn't physically lost, but its

quality has decreased leading to reduction of sale price (monetary loss), third, the product can't be consumed by humans due to its high quality loss.

Fresh *waragashi* loss occurred with approximately 20% of producers and 40% of wholesalers/retailers. More than 90% of wholesalers/retailers claimed that there was a loss in quality of their *waragashi,* which led to a lower sale price while only 17.1% of *waragashi* producers encountered the same problem.

As far as the quantity lost is concerned (Figure 3B), the physical loss of the fresh *waragashi* was the lowest type of loss occurring in the value chain (<10%) for all groups of stakeholders. The acceptable loss in quality of the product can reach nearly 50% of the total product of wholesalers/retailers. This loss represented approximately 55% of *waragashi* bought by consumers but only 5.9% of *waragashi* produced by producers. The complete loss of *waragashi* for human consumption wasn't noticed at producers' level but represented approximately 11% of the total *waragashi* of all other groups of stakeholders.

Combining the outcomes of Figure 3A and Figure 3B, losses occur in *waragashi* value chain mostly during the marketing of the product, meaning at wholesalers'/retailers' level. This contrasts with the fruit and vegetable value chain, where losses usually occur in the earlier stages of the food value chain, during production and transportation [20, 21, 22].

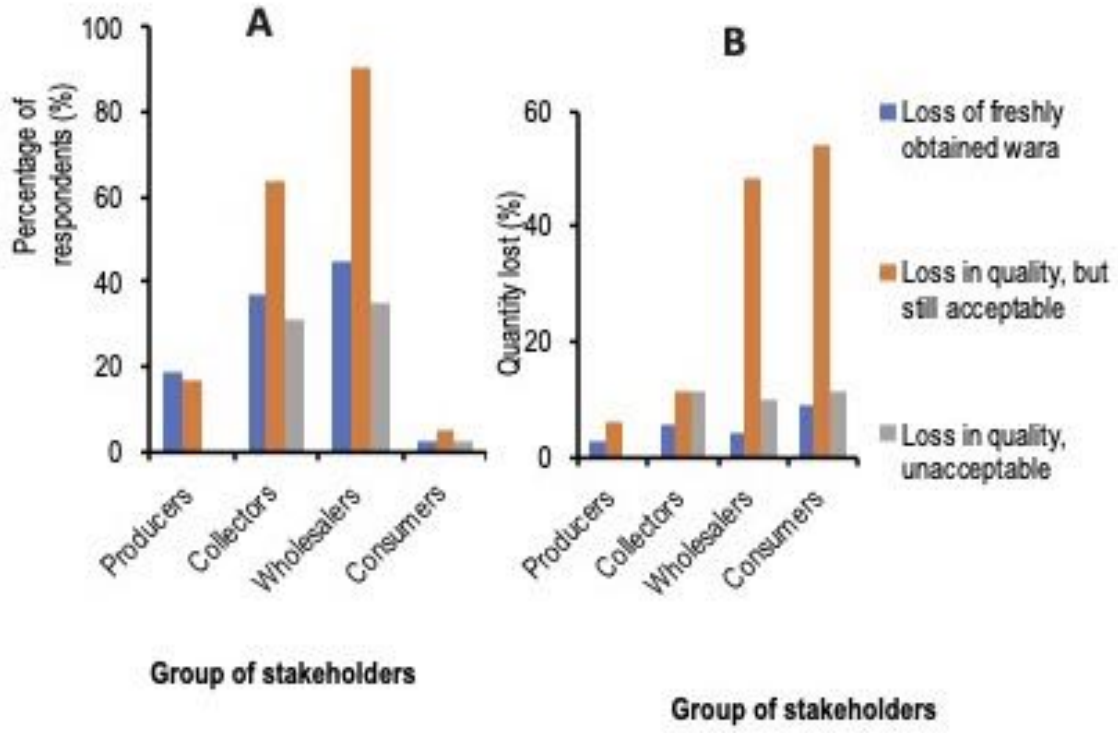

Figure 3: Types of losses in waragashi value chain (A) and quantity of waragashi lost by different groups of stakeholders (B)
[in legend wara = waragashi]

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

As far as the estimation of financial losses is concerned, the associated financial losses are investigated at wholesalers/retailers' level (Table 5). A lot of 228 units of cheese sold fresh (without any sign of spoilage) would bring the seller $319.2 if the average selling price of $1.4 per unit of cheese were considered. Now with 48% of the cheeses in the batch having undergone a partial deterioration of quality and sold at a reduced price of $1 per unit and the remaining 52% sold fresh at the normal price of $1.4 per unit, the batch of 228 cheeses would bring $275.6 to the seller this time.

Therefore, the associated-financial loss for a maximum of 4 days needed to sell the 228 units of *waragashi* is about $43.6; that is approximately, $11 per day (Table 5). This study revealed that *waragashi* with medium quality (reduced price) is sold at 28.6% lower than the fresh product ($1 per unit instead of $1.4 per unit). Like the financial losses, Rees [23] observed that 41–93% of all the roots coming in urban markets in Tanzania were damaged, inducing reduction of 11–36 % of the market value. Besides, Palmar [24] reported that the estimated sweet-potato food losses in Ethiopia was about 11–45%, out of which agricultural production contributed to 5–25 % and distributions 6–25%. The present study showed that food loss observed at wholesalers/retailers level not only prevented this stakeholder group from making more profit, but also hampered consumption of nutritive food by consumers especially the protein. Therefore, there is a need to find appropriate solutions to reduce *waragashi* loss at the wholesaler/retailer level in the value chain.

Sensory Quality Criteria of *Waragashi* According to Stakeholders

Stakeholders have various perceptions of *waragashi* quality (Tables 6 and 7). Table 6 shows the ranking of the first ten quality criteria used by stakeholders based on their frequency of citations. Among these ten criteria, seven (aftertaste of cow's milk, cow's milk odour, soft and firm texture, medium size, white-ivory colour, and compact apparent surface without air pockets) were common to all stakeholders (Table 7). The firm texture was unanimously the first criterion, whatever the group of stakeholders, followed by compact appearance without air pockets on surface and cow's milk odour for collectors, wholesalers and consumers. Conversely, white-ivory colour and aftertaste of cow's milk, respectively, were the second and the third criteria used by producers. The importance of the seven common criteria for stakeholders was significantly ($p < 0.0001$) linked to the stakeholder groups (Table 7). Medium size was more important for wholesalers than other groups of stakeholders while soft texture and cow milk odours were ranked high by consumers. We know that all the stakeholders of *waragashi* value chain consider texture as a desirable quality criterion as it differentiates an old product from a new one. For example, daily boiling, one of the traditional preservation methods used by *waragashi* stakeholders, decreases the product's freshness progressively until the texture becomes very hard.

In the case of the consumer perception of fruits and vegetables aspect, the texture-related attributes were often cited as contributing most to apple freshness, as previously reported by many authors [25], [26], [27]. In the case of cheese, Wells [28] and Teng *et al.,* [29] reported that the freshness was important among the criteria for consumers' choice of cheese. Besides, Aday and Yucer [30] reported that acceptability of Mihalic

cheese (one of the traditional cheeses of Marmara region in Turkey) depends on several factors including texture and flavour. Lawrence *et al.* [31] also reported that texture and appearance of cheese are as important as the flavour that consumers use to identify and judge cheese varieties. However, to characterize organoleptic properties of untreated and treated cheese during storage at different temperatures, several authors reported texture, flavour, and colour as most important cheese quality attributes [6, 10, 32, 33]. These previous findings confirm those obtained in this study. Flavour and taste of *waragashi,* help consumers to know for example if the product has the cow milk odour or aftertaste, and as the product is an unripened cheese, consumers use this characteristic to judge whether it's freshly produced or not. Contrary to unripened cheeses like *waragashi,* much other cheese varieties undergo proteolysis, which is the most complex and important event that occurs during the ripening, and strongly affects the sensory properties of ripened cheeses [34, 35]. The current findings showed that the *waragashi* consumers appreciate the fresh product. Therefore, there is a need to find appropriate solutions to maintain *waragashi* freshness along the value chain.

CONCLUSION

This study shows that *waragashi* production and sale are important activities held mainly by women, acting as producers, wholesalers and retailers in Benin. Daily boiling is the most common method used by these stakeholders for the preservation of the product. Handling practices lead to important quantity and quality loss along the product value chain, mostly at wholesalers and retailers level. Regarding stakeholders' quality perception, the priority quality attributes of *waragashi* are texture, colour and taste for producers, whereas texture, odours and appearance are the desirable attributes for consumers. There is a need to find appropriate solutions for better *waragashi* quality management along the value chain.

ACKNOWLEDGEMENTS

Authors would like to thank the Germany Federal Ministry for Food and Agriculture (BMEL) for their financial support (Project-ID – FKZ – 2816PROC08).

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 1: Number of stakeholders interviewed in each Department

Departments	Producers	Collectors	Wholesalers/retailers	Consumers	Total
Alibori	38	25	0	0	63
Atacora	26	11	0	0	37
Borgou	60	31	26	45	162
Collines	40	16	0	0	56
Zou	35	17	18	30	100
Atlantique	0	0	55	126	181
Littoral	0	0	57	125	182
Total	199	100	156	326	781

Table 2: **Sensory quality criteria description of *waragashi***

Quality Attributes					
Appearance	**Colour**	**Texture**	**Odour**	**Taste**	**Size**
Rough surface	Red - clear	Friable	Fermented odour	Acid	Small
Compact surface without alveolus	Red-dark	Friable light	Fermented light odour	Salty	Medium
Smooth surface with alveolus	Dirty white	Hard	Cheese odour (cow's milk odour)	Tasteless	Large
	White	Firm		Aftertaste of cow's milk	
		Soft			

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 3: **Socio-demographic profile of *waragashi* value chain stakeholders**

Category	Variables	Frequency of citation (%)				Chi-square	p-value
		Producers (n = 199)	Collectors (n = 100)	Wholesalers/retailers (n= 156)	Consumers (n = 327)		
Gender	Male	1.5	3	0.6	27.8	68.1	<0.0001
	Female	98.5	97	99.4	72.2		
Age (years)	<25	0.5	3	7.6	19.6	137.8	<0.0001
	25 – 29	14.1	7	9.6	33		
	30 – 34	21.1	22	0.6	25.4		
	35 – 39	21.1	32	21.7	10.1		
	40 – 44	14.1	18	29.9	4.6		
	45 – 54	14.1	12	9.6	2.8		
	55 – 60	0.5	4	14	3.1		
	> 60	4.5	2	0	1.5		
Education level	None	99.5	79	44.6	11.6	283.4	<0.0001
	Primary	0.5	14	29.3	13.1		
	Junior secondary	0	5	17.8	11.6		
	Senior secondary	0	2	6.4	19.6		
	University	0	0	1.9	44		

Table 4: Marketing strategies for *waragashi*

Stakeholders (%)	Face-to-face market	Phone	Chi-square	p-value
Producers	63.8	36.2	24.9	<0.0001
Collectors	79	21		
Wholesalers/retailers	75	25		
Consumers	92.9	7.1		

figures represent percentage of each stakeholder group using face-to-face market and phone as marketing strategies for *waragashi*

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 5: Estimation of financial losses of *waragashi* at wholesalers' /retailers' level

Quality and financial indicators of waragashi	Quantity	Price ($ US)	
		Unit	Total
No quality deterioration, i.e., fresh *waragashi*	100% (228)	1.4[a]	319.2
No quality deterioration, i.e., fresh *waragashi*	52% (119)	1.4[a]	166.6
Partial quality deterioration, i.e., non-fresh *waragashi* (medium quality)	48% (109)	1.0[b]	109
Financial losses ($ US) for 4 days			43.6
% of financial loss of *waragashi;* lower expensive than fresh *waragashi*			28.6

[a] Price of fresh *waragashi*; [b] reduced price of *waragashi* with medium quality

Table 6: Top 10 of sensory quality criteria desired by stakeholders along *waragashi* value chain

		Ranking priority			
Attributes	**Criteria**	**Producers**	**Collectors**	**Wholesalers/ retailers**	**Consumers**
Appearance	Compact surface without alveolus	4	2	2	2
	Smooth surface with alveolus		7	6	4
Colour	White-ivory	2	5	7	9
	Dirty white	10			
	Red clearly / Red dark		8	9	8
Size	Small	9	9		
	Medium	7	6	4	6
	Large	6		10	10
Texture	Firm	1	1	1	1
	Soft	8	9	8	7
Odour	Cow milk odour	5	3	3	3
Taste	Aftertaste of cow's milk	3	4	5	5

Numbers represent the ranking priority of attribute criteria of *waragashi*

https://doi.org/10.18697/ajfand.112.21565

ajfand SCHOLARLY, PEER REVIEWED AFRICAN JOURNAL OF FOOD, AGRICULTURE, NUTRITION AND DEVELOPMENT Volume 22 No. 7 September 2022 PUBLISHED BY AFRICAN SCHOLARLY SCIENCE COMMUNICATIONS TRUST ISSN 1684 5374

Table 7: **Frequency of citations of common quality attributes of *waragashi* used by all stakeholders**

Attributes / criteria	Producers		Collectors		Wholesalers/retailers		Consumers		Chi-square	p-value
	FC	adj.R^2	FC	adj.R^2	FC	adj.R^2	FC	adj.R^2		
Compact appearance without alveolus on surface	41.2	**-2.3**	60.0	0.9	52.6	1.1	49.4	0.3		
White-ivory colour	61.3	**7.5**	22.0	-1.7	12.8	**-2.9**	12.6	**-3.1**		
Size medium	6.5	**-3.4**	17.0	-0.5	25.6	**2.8**	20.9	1.3	121.0	<0.0001
Texture firm	64.8	-1.6	89.0	**2.1**	68.6	0.7	58.3	-1.3		
Texture soft	1.5	**-2.4**	2.0	**-2.2**	8.3	1.2	13.2	**3.5**		
Cow milk odour	28.6	**-2.8**	43.0	-0.1	36.5	-0.1	53.0	**3.1**		
Aftertaste of cow's milk	56.8	**4.5**	32.0	-0.9	21.2	**-2.1**	23.9	-1.7		

FC: frequency of citations (%); adj. R^2: adjusted residuals highlight in bold are significant at 0.05

REFERENCES

1. **Egounléty M, Edema M, Yehouessi B and EA Ahouansou** Production et qualité du fromage Peulh (waragashi) en République du Bénin. Rapport de Recherche. Département de Nutrition et Sciences Alimentaires, Faculté des Sciences Agronomiques, Université Nationale du Bénin, Abomey-Calavi, 1994 ; 11-29.

2. **Aworh OC and M Egounlety** Preservation of West African soft cheese by chemical treatment. Journal of Dairy Research, 1985; **52:**189-195.

3. **Kees M** Le fromage peulh: Facile à produire et bien apprécié. Une technologie à vulgariser. Rapport de Recherche/GTZ, 1996 ; 10-23:59-70.

4. **Appiah F, Ellis OW, Mathias J and I Oduro** Studies on traditional cheese (woagashie) production in Ashanti Region. 1998. https://doi.org/10.4314/jgsa.vlil.17790

5. **Alaofè H, Burney J, Naylor R and D Taren** Prevalence of anaemia, deficiencies of iron and vitamin A and their determinants in rural women and young children: a cross-sectional study in Kalalé district of northern Benin. Public Health Nutrition, 2017; **20**:1203-1213.

6. **Food and Agriculture Organization, International Fund for Agricultural Development, Fonds des Nations Unies pour l'Enfance, World Food Programme, and World Health Organization.** *The State of Food Security and Nutrition in the World. Building resilience for peace and food security*. Rome, FAO. 2017.

7. **Egounlety M** Studies on preservation of West Africa soft cheese by chemical treatment and gas packaging, Thesis, Ibadan, Nigeria, page 1–7. 1982.

8. **Adetundji VO and OT Salawu** West African soft cheese ''wara'' processed with *Calotropis procera* and *Carica papaya*: A comparative assessment of nutritional values. *African Journal of Biotechnology*, 2008; **7**:3360–3362.

9. **Mazou M, Tchobo PF, Degnon RF, Mensah AG and MM Soumanou** Effect of temperature and salt on the quality of waragashi cheese during storage in Benin Republic. African Journal of Food Science, 2012; **6**:494–499.

10. **Dossou J, Montcho JK, Londji S, Atchouké GDL and S Odjo** Procédé Amélioré de conservation et de stabilisation du fromage Peuhl par effet combiné du traitement thermique et du conditionnement sous vide. European Scientific Journal, 2016; **12**:36.

11. **Aworh OC** Upgrading traditional techniques of food processing and preservation, cheesemaking In: Cultural resource management: an African dimension. *Edited by B.W. Andah*, Ibadan, Nigeria, 1990; **20**:232–238.

12. **Kèkè M, Yèhouénou B, de Souza C and DCK Sohounhloué** Evaluation of hygienic and nutritional quality of peulh cheese treated by Sorghum vulgaris (L) and Pimenta racemosa (Miller) extracts. Scientific Study & Research, 2009; **10**:29–46.

13. **Sessou P, Farougou S, Azokpota P, Youssao I, Yehouenou B, Ahounou S and D Sohounhloué** Endogenous methods for preservation of waragashi, a Beninese traditional cheese. African Journal of Agricultural, 2013; **8**:4254–4261.

14. **Institut National de la Statistique et de l'Analyse Economique.** Cahier des villages et quartiers de ville des départements du Bénin (RGPH, 2013). 2016. [accessed 04 march 2018].

15. **Dagnelie P** Statistiques the´oriques et applique´es. Inference statistique à une et à deux dimensions Tome 2. De Boeck et Larcier, Brussels. 1998.

16. **Dabadé DS, den Besten HMW, Azokpota P, Nout MJR, Hounhouigan DJ and MH Zwietering** Quality perceptions of stakeholders in Beninese export-oriented shrimp chain. Journal of Food Protection, 2014; **77** :1642–1648.

17. **Houngbédji M, Padonou SW, d'Auchamp AM, Akissoé N, Mengu MD, Jespersen L and DJ Hounhouigan** Improving food value chains for cereal doughs in West Africa: Case study of mawè in Benin. Food Chain, 2019; **8**:1 – 21.

18. **Gómez M and KD Ricketts** Food value chain transformations in developing countries: selected hypotheses on nutritional implications. Food Policy, 2013; **42**:139–50.

19. **Nout R, Hounhouigan DJ and T van Boekel** Les Aliments: Transformation, Conservation et Qualité. Backhuys Publishers: Leiden, Netherlands; 279 pages. 2003.

20. **Food and Agriculture Organization.** Food Wastage Footprint-Full-Cost Accounting - Final Report.Rome: FAO. 2014.

21. Timmermans AJM, Ambuko J, Belik W, and J. Huang **(2014). Food losses and waste in the context of sustainable food systems.** CFS Committee on World Food Security HLPE, 2014 ; **8**.

22. **Lipinski B, Hanson C, Lomax J, Kitinoja L, Waite R and T Searchinger** Reducing Food Loss and Waste. Working Paper, Installment 2 of Creating a Sustainable Food Future. Washington, DC: World Resources Institute. 2013.

23. **Rees D, Westby A, Tomlins KI, van Oirschot QE, AChemma MU, Cornelius E and M Amjad** Tropical root crops, in: D. Rees, G. Farrel, J. Orchard (Eds.), Crop Post-Harvest Sci. Technol. Perishables, first ed., Wiley Blackwell Publishing Ltd, UK, pages 392–396. 2012.

24. **Palmar A, Hensel O and B Sturn** Post-harvest handling practices and associated food losses and limitations in the sweetpotato value chain of southern Ethiopia. *NJAS-Wageningen J. Life Sci*, 2016. https://doi.org/10.1016/j.njas.2016.12.002

25. **Fillion L and D Kilcast** Concept and measurement of freshness of fruit and vegetables. Leatherhead Food R A Research reports, No. 770, Leatherhead, 2000.

26. **Péneau S**, **Hoehn E, Roth HR, Escher F and J Nuessli** Importance and consumer perception of freshness of apples. Food Quality and Preference, 2006; vol. 17: 9–19.

27. **Péneau S**, **Linke A, Escher F and J Nuessli** Freshness of fruits and vegetables: consumer language and perception. British Food Journal, 2009; **111:**243-256.

28. **Wells GD** The demand side of farmers markets in Kitchener-Waterloo: an examination of the Waterloo, St. Jacob's and Kitchener farmers markets. Unpublished Thesis. Waterloo: Wilfred Laurier University. 1994.

29. **Teng D, Wilcock A and M Aung** Cheese quality at farmers markets: Observation of vendor practices and survey of consumers' perceptions. Food Control, 2003; **15**:579–587.

30. **Aday S and KY Yucer** Physicochemical and sensory propertises of Mihalic cheese. *International Journal of Food Properties*, 2014; **17**:2207–2227.

31. **Lawrence RC, Creamer LK and J Gilles** Texture development during cheese ripening. Journal of Dairy Science, 1987; **70**:1748-1760.

32. **Magalhaès KT, Dias DR, De Melo Pereira GV, Oliveira JM, Domingues L, Teixeira JA, De Almeida Silva JB and RF Schwan** Chemical composition and sensory analysis of cheese whey-based beverage using kefir grains as starter culture. International Journal of Food Science and Technology, 2011; **46**:871–878.

33. **Hailu Y, Hansen EB, Seifu E, Eshetu M, Petersen MA, Lametsch R, Rattray F and R Ipsen** Rheological and sensory properties and aroma compounds formed during ripenin of soft brined cheese made from camel milk, International Dairy Journal, 2018; ***81*** **:** 122-130..

34. **Fox PF and L Stepaniak** Enzyme in cheese technology. International Dairy Journal, 1993; **3**:509–530.

35. **Grappin R, Rank TC and NF Olson** Primary proteolysis of cheese proteins during ripening: a review. *Journal of Dairy Science*, 1985; **68**:531–540.