

# Fruit Juice Production in Abomey-Calavi and Cotonou Municipalities (Benin): Socio-Professional Profile of Actors and Adoption Level of Hygienic Practices of Enterprises

Agossou P. Noumavo<sup>1,2\*</sup>, Messan A. B. Ohin<sup>1</sup>, d'Avila Y. Dognon<sup>1</sup>, Stéphane K. Houessou<sup>1</sup>, Edmond Sacla Aide<sup>3</sup>, Farid Baba-Moussa<sup>1</sup>

<sup>1</sup>Laboratoire de Microbiologie et des Technologies Alimentaires, Faculté des Sciences et Techniques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin

<sup>2</sup>Laboratoire de Biologie et de Typage Moléculaire en Microbiologie, Faculté des Sciences et Techniques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin

<sup>3</sup>Laboratoire de Biomathématiques et Estimation Forestière, Faculté des Sciences Agronomiques, Université d'Abomey-Calavi, Abomey-Calavi, Bénin

Email: \*pacome.noumavo@gmail.com

**How to cite this paper:** Noumavo, A.P., Ohin, M.A.B., Dognon, A.Y., Houessou, S.K., Aide, E.S. and Baba-Moussa, F. (2022) Fruit Juice Production in Abomey-Calavi and Cotonou Municipalities (Benin): Socio-Professional Profile of Actors and Adoption Level of Hygienic Practices of Enterprises. *Food and Nutrition Sciences*, 13, 649-668. <https://doi.org/10.4236/fns.2022.137048>

**Received:** May 17, 2022

**Accepted:** July 18, 2022

**Published:** July 21, 2022

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## Abstract

Fruit juice production sector is developing in Benin's major cities and appears to have both organisational and technical shortcomings. This study aimed to 1) establish the socio-professional profile of actors in the fruit juice production sector in Abomey-Calavi and Cotonou municipalities and 2) evaluate the adoption level of hygienic practices of enterprises. The methodological approach adopted in this study combined a semi-structured survey with direct observations in fifty enterprises. The statistical analysis was carried out using the R.4.0.0 software. The study revealed that fruit juice enterprises in both municipalities are mainly artisanal (90%) and located in residential areas (94%). They are therefore exposed to contamination risks from domestic and road activities. More than half of these enterprises were created less than five years ago. Three administrative types of enterprises were noted: non-structured (32%), semi-structured (34%) and structured (34%). Almost half of the enterprises belong to at least one professional association. Only a few enterprises have marketing authorization. Women predominate in the positions of director and production assistant. The majority of production managers are men. Most directors and production managers have a university education, but not necessarily in the field of food sciences. The adoption level of hygie-

nic practices is significantly influenced by the level of enterprises structuration and size. The level of hygiene in these enterprises is also very weakly influenced by the female gender. Structured and semi-industrial enterprises have a higher adoption level of hygienic practices. Those with acceptable or good hygiene level enterprises contain slightly more women.

## Keywords

Fruit Juice, Food Hygiene, Socio-Demographic Profile, Gender, Benin

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## 1. Introduction

In the human diet, fruits and vegetables are essential for a balanced nutrition. Their dietetic and therapeutic value is unanimously accepted. They have an indisputable effect on health and contribute to the maintenance of the vital functions of human organism. Fruits and vegetables are rich in proteins, fats and various micronutrients such as pectins, phenolic compounds, minerals, vitamins and others [1]. Several epidemiological studies have shown a positive links between fruits consumption and the improvement of various diseases [2] [3]. It has been shown that consumption of fruits and vegetables can reduce the developing risk of cardiovascular and cerebrovascular diseases, diabetes, osteoporosis, cataract, muscle degeneration and certain types of cancer [3]. In view of the above-mentioned benefits, the World Health Organization (WHO) recommends a daily and diversified consumption of fruits. Unfortunately, there are several obstacles to the adoption of this recommendation, especially by the populations of developing countries, including: 1) their high prices, 2) their fragility and 3) their seasonality and by implication their non-availability throughout the year. Thus, to overcome these difficulties, one of the main ways is to transform fruits into juice. A fruit juice is a drink rich in fiber and vitamins, obtained from a ripe edible fruit [4]. Fruit juices have recently become one of the major products of the food industry. Several companies have specialized in their production and marketing. The fruit juice market in Africa is growing rapidly and the Republic of Benin is no exception to this dynamic. The fruit juice sector in Benin allows the creation of new economic activities that create jobs and consequently fight against unemployment.

However, the production of fruit juice or any other food must comply strictly with agri-food standards. Also, the microbiological quality and physicochemical stability of industrially manufactured juices, must be well defined, as they influence its nutritional, organoleptic and sanitary qualities, particularly in case of ingestion of pathogenic microorganisms [4].

Cosinus conseils [5] was found that processing units are more located in the urban centers in southern Benin (Cotonou, Abomey-Calavi and Porto-Novo). Unfortunately, the lack of reliable data on the fruit juice producing enterprises leads us to question the quality of the juices produced and the professional level

of the human resources employed. Human health being intimately linked to our food, the respect of the good practices of hygiene and production must be a necessity in this sector of major importance, because “Let your food be your medicine and your medicine be your food” stipulated Hippocrates (~2000 years). It is in this context that this study was initiated. Its main objective was to correlate the socio-professional characteristics of actors and enterprises producing fruit juice with the adoption level of hygienic practices. To achieve this, we first established the socio-professional profile of the actors in the fruit juice production enterprises in the municipalities of Abomey-Calavi and Cotonou, and then evaluated the adoption level of hygienic practices of the enterprises.

## 2. Materials and Methods

### 2.1. Study Area

This study was carried out in two municipalities of southern Benin: Abomey-Calavi (6°26'9112"N; 2°21'3396"E) in the Atlantic Department and Cotonou (6°21'9216"N; 2°25'0998"E) in the Littoral Department. These two municipalities are very close to Allada Department, an area of large pineapple production (a major crop in fruit juice production) and are home to a large number of fruit juice producers.

### 2.2. Questionnaire Design and Conduct of the Survey

The methodological approach adopted during this study coupled direct observation with a semi-structured survey of producers. Additional information was obtained from associations, cooperatives and federations of fruit and vegetable transformers. Fifty (50) enterprises were included in this study. The majority of enterprises were chosen at random from lists of fruit juice producers obtained from the above-mentioned associations, cooperatives and federations. Some enterprises were identified after a census of fruit juices in supermarkets and local shops. The survey started on November 3, 2020 and ended on February 5, 2021. The main sections of survey form are: 1) Geographical location and characteristics of enterprises, 2) Socio-professional characteristics of actors (management team and employees), 3) Design and layout of premises, 4) Cleaning and disinfection of equipments and premises, 5) Wastes management, 6) Supply and storage of raw materials and manufactured products and 7) Water supply.

In this study, “Non-Structured, NS” enterprises are defined as those with a single team responsible for administrative, technical (production) and commercial tasks. “Semi-Structured, SS” enterprises are characterized by an administrative team and a technical team. “Structured, S” enterprises are characterized by an administrative team, a technical team and a commercial team. In “Industrial, I” enterprises, most unit operations are mechanized. In “Semi-Industrial, SI” enterprises, main unit operations are mechanized. In “Artisanal, A” enterprises, almost all unit operations are carried out by hand. Within the artisanal enterprises (A), several sub-groups can be distinguished: A1 enterprise have no me-

chanized equipment except for a manual capper; A2 enterprise have an extractor and/or grinder, all stainless steel or not, and then a manual capper; A3 enterprise have an extractor and/or grinder and a press, a cooker, all stainless steel, and then a manual capper; and finally A4 companies have a cooker, an extractor, a press, a pasteurizer all stainless steel, and then a manual capper.

### 2.3. Data Management and Analysis

Data from the survey forms were encoded using the Microsoft Excel 2013 and analyzed using R software version 4.0.0. The data were subjected to descriptive statistical tests (proportion, mean and standard deviation), Analysis of Variance (probability level of 5%), a mean separation (Student-Newman-Keuls test) and Principal Component Analysis on Classification (ACPC) coupled with Factorial Analysis on Mixed Data (FAMD) [6].

## 3. Results and Discussion

### 3.1. Distribution of Fruit Juice Enterprises Surveyed in the Study Area

Of the fifty fruit juice enterprises surveyed in this study, 37 were in Abomey-Calavi municipality and 13 in Cotonou municipality (**Figure 1**).

In Cotonou, they are distributed in eight districts, namely: Cotonou II (03), Cotonou III (01), Cotonou VI (01), Cotonou IX (03), Cotonou X (01), Cotonou XI (01), Cotonou XII (02) and Cotonou XIII (02). In Abomey-Calavi, they are distributed in six districts namely: Akassato (03), Calavi (15), Godomey (14), Hêvié (02), Ouèdo (01) and Togba (01).

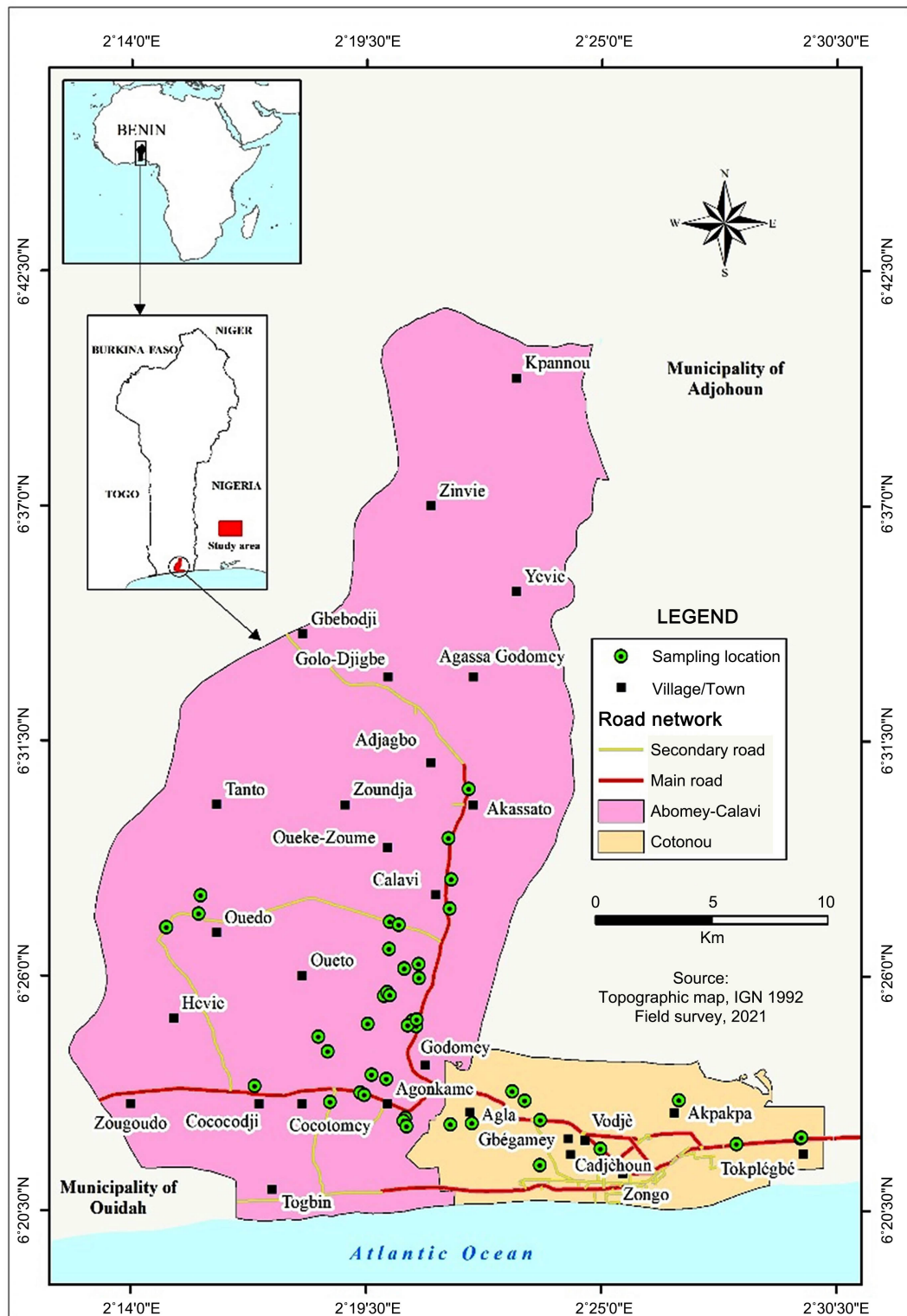
The choice of these two municipalities is justified by their proximity with Allada municipality (Atlantic Department), the preferred area for pineapple (*Ananas cosmosus*) production in Benin [7]. The Allada municipality is home to 33% of pineapple producers in Benin [8]. This proximity allows fruit juice producers to reduce expenses related to the transportation of the raw material. Note that 74% of the enterprises surveyed are located in the Abomey-Calavi municipality. This result can be explained by the large area of Abomey-Calavi municipality (539 km<sup>2</sup>) compared to Cotonou Municipality (79 km<sup>2</sup>) [9]. Also the houses are mostly spacious in Abomey-Calavi.

The geographical location of the surveyed enterprises (**Figure 1**) reveals a strong proximity to main roads due to they are mostly (94%) located in residential areas. The multiple comparison test of proportions shows that the number of enterprises varies significantly by areas ( $p < 0.001$ , highly significant difference) (**Figure 2**).

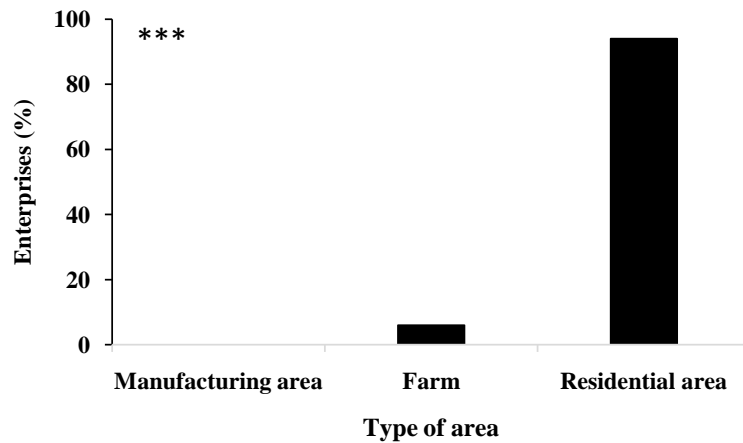
### 3.2. Professional Characteristics of Fruit Juice Production Enterprises

On the basis of administrative structure, the enterprises involved in this study present different types of profiles. These are non-structured (32%), semi-structured

(34%) and structured (34%) enterprises. Considering the mechanization level of these enterprises, some of them are semi-industrial (10%) while the majority is artisanal (90%).



**Figure 1.** Geographic map of the study area showing fruit juice enterprises location.



**Figure 2.** Types of areas where fruit juice enterprises are located. \*\*\* =  $p < 0.001$  (highly significant).

Among the artisanal enterprises, those of type A2 (42%) were the most prevalent. In contrast, there were very few A4 artisanal enterprises (12%). A4 enterprises, although small-scale require significant financial resources. The others artisanal enterprises have not the necessary financial resources to recruit qualified people to carry out the various functions (administrative, production and marketing) and to purchase modern production equipment. This explains, as shown above, the fact that almost all of them are located in residential areas (Figure 1 and Figure 2), more precisely in dwellings. These results corroborate those obtained by Cosinus Conseils [5], which reported that manufacturing in many regions in Benin is still artisanal, with units concentrated in the large urban centers in southern Benin (Cotonou, Abomey-Calavi and Porto-Novo).

We note an increase in the number of enterprises producing fruit juices from the 1990s to the current day. Half of them (54%) were created about five years ago. This increase can be explained, among other things, by the valuation of the pineapple sector, a major fruit for fruit juices production in southern Benin. National pineapple production has experienced a marked increase from 51,000 t (in 2000) to 316,000 t (in 2014). Since 2016, this growth, although unstable, has always exceeded 300,000 t and reached 345,000 t in 2017 [7]. As a result, the Beninese State has taken initiative measures for the promotion of the pineapple sector as one of principal agricultural sectors [10].

Sixty-eight percent (68%) of the fruit juice enterprises have a commercial register. Only six percent have a marketing authorization issued by the Benin Food Safety Agency (BFSA). More than half of the precedent enterprises (66%) are currently engaged with BFSA in the process of obtaining this authorization. The complexity of the process of obtaining this marketing authorization is the major problem faced by most enterprises. Indeed, obtaining this certificate requires a significant financial investment and the provision of administrative documents, which also require fees. This process can take several months or even years. Another demotivating factor is the less significance of this marketing certificate

in regional trade, as many enterprises export their fruit juices to other countries without this certificate.

Fifty-two percent of fruit juice production enterprises do not belong to any professional organization (association, cooperative, federation, etc.). These professional organizations help the enterprises for better production and marketing of products on national, regional and international markets. It should be noted that some enterprises refuse to join the professional organization because they will be forced to improve their technical production process and formalize their businesses.

### 3.3. Socio-Professional Characteristics of Fruit Juice Production Actors

The socio-professional characteristics of the actors in fruit juice production sector are very diverse (**Table 1**). A total of 64.77% (n = 474) of people (employers and employees) involved in this study are women. Specifically, we note a slight predominance of women (56%) in the position of director and production assistants (69%). This women predominance of in the director position can be explained by the similarities between fruit juice production and the culinary activities for which women are responsible in our society. Also, as employers, women have a freedom in the management of their agenda, which allows them to reconcile their professional and marital lives more easily. The fact that most enterprises are home-based contributes to this situation. The high proportion of women, especially those who are not educated, working as production assistants is explained by the fact that these women, who are in a precarious situation, are looking for a subsistence activity that will enable them to meet their basic daily needs. The juice production sector is therefore a sector that mobilizes women who are excluded from the education system and the formal labor market and enhances their skills.

**Table 1.** Socio-professional profile of the actors.

Parameter	Specification		Frequency (n*)	Percentage (%)
Gender	Director	M	22	44
		F	28	56
	Production head	M	21	84
		F	04	16
	Production assistant	M	124	31
		F	275	69
Age	Director	[20 - 30[	14	28
		[30 - 40[	20	40
		[40 - 50[	11	22
		[50 and more [	5	10

## Continued

		[20 - 30[	10	40
	Production head	[30 - 40[	11	44
		[40 - 50[	3	12
		[50 and more[	1	04
		U	37	74
	Director	S	08	16
		P	04	08
Education level		NS	01	02
		U	21	84
	Production Head	S	04	16
		P	00	00
		NS	00	00
	Director	Yes	18	36
Basic training in food science		No	32	64
	Production Head	Yes	17	68
		No	08	32
	Director	Yes	34	68
Principal work		No	16	32
	Production head	Yes	21	84
		No	04	16

\*: frequencies/numbers vary according to parameters and specifications; M: Male; F: Female; U: University; S: Secondary; P: Primary; NS: No Schooling.

The position of production manager is mainly occupied by men (84%) young (32 years old), although 50% of these enterprises do not have a production manager. This position requires enough vigilance and physical effort. Male and juvenile labor is therefore the most solicited according to our respondents.

Most directors (74%) and production managers (84%) have a university education, but not necessarily in the food sciences field. Thirty-six percent (36%) of managers and 68% of production managers have basic training in food science.

Several graduates specializing in food processing have been increasingly available on the job market in recent years. They are the result of professional training in food sciences created in the national universities of Benin since the beginning of the 2000s (Bachelor and Master in Food Microbiology and Biotechnology, Bachelor in Food Technology Engineering, Bachelor and Master in Nutrition and Food Science, License in Sciences and Techniques of Conservation and Transformation of Agricultural Products, etc.) and in some private establishments without forgetting agricultural high schools. This is reflected in the growing number of fruit juice production enterprises in our study area (**Table 2**). It should be noted that several projects and programs funded by national and



**Table 2.** Professional characteristics of the enterprises.

Parameter	Specification	Frequency (n = 50)	Percentage (%)	
Structuration	Non-structured	16	32	
	Semi-structured	17	34	
	Structured	17	34	
Industrial level	A1	10	20	
	Artisanal	A2	21	42
		A3	8	16
		A4	6	12
		Semi-industrial	5	10
	Industrial	0	00	
	Date of enterprise creation	[1995-2000[	01	02
[2000-2005[		01	02	
[2005-2010[		08	16	
[2010-2015[		13	26	
[2015-2020[		27	54	
Registration in the commercial register	Yes	34	68	
	No	11	22	
	In progress	05	10	
Marketing authorization	Yes	03	06	
	No	14	28	
	In progress	33	66	
Membership in a professional association/organization	Yes	24	48	
	No	26	52	

international institutions offer capacity building training to the staff of agri-food enterprises in order to help them reduce technical and hygienic deficiencies and to be able to comply with the standards applicable in the sector because health and development begins on our plates. Processing fruit into juice is the primary occupation of business managers (68%) and production managers (84%).

### 3.4. Adoption Level of Hygienic Practices by Fruit Juice Production Enterprises

The location of a production unit in the food industry and the premises and equipments design have a very important impact on the mastery of hygiene and manufacturing practices. In this study, the fifty (50) enterprises involved were evaluated on their level of adoption of the good hygiene practices (**Table 3**). This assessment shows that the majority of these enterprises (94%) are located in residential areas. Thirty-eight percent (38%) and 32% of them are respectively installed in a flood zone and near interstate roads. The promoters of fruit juice

**Table 3.** Adoption level of hygienic practices.

Parameter	Specification	Frequency (n = 50)	Percentage (%)	
Area of implementation	Residential	Yes	47	94
		No	03	06
	Industrial	Yes	00	00
		No	50	100
	Farm	Yes	03	06
		No	47	94
	Proximity to the road	Yes	16	32
		No	34	68
	Flooded	Yes	19	38
		No	31	62
	Delimitation	Yes	47	94
		No	03	06
Adequacy of the internal structures	Floor	Yes	12	24
		No	38	76
	Wall	Yes	07	14
		No	43	86
	Junctions	Yes	00	00
		No	50	100
	Ceiling	Yes	22	44
		No	28	56
	Opening	Yes	20	40
		No	30	60
Availability of changing rooms	Yes	22	44	
	No	28	56	
Appropriate clothing	Yes	21	42	
	No	29	58	
Posting of hygienic practices	Yes	09	18	
	No	41	82	
Water supply sources	SONEB(*)	Yes	35	70
		No	15	30
	Drilling	Yes	16	32
		No	34	68
	Well	Yes	06	12
		No	44	88
Water treatment before use	Yes	16	32	
	No	34	68	

**Continued**

Hand washing station	Available	Yes	44	88
		No	06	12
	Process display	Yes	07	14
		No	43	86
Covid-19 prevention device		Yes	41	82
		No	09	18
Separation of sectors		Yes	19	38
		No	31	62
Walking forward		Yes	22	44
		No	28	56
Adequate number of access doors to the production hall		Yes	23	46
		No	27	54
Adequate work plan		Yes	11	22
		No	39	78
Presence of footbath		Yes	02	04
		No	48	96
Arrangement of equipment for easy cleaning		Yes	35	70
		No	15	30
Availability of cleaning-disinfection equipment		Yes	35	70
		No	15	30
Production equipment maintenance program		Yes	37	74
		No	13	36

\*SONEB: National Water Company of Benin.

production enterprises not having the financial resources necessary to settle in industrial zone. They prefer to transform their home into production units. This approach exposes both the by-products and fruit juices to chemical, physical and microbiological contamination due to domestic activities, dust and exhaust gases from vehicles and motorcycles. In addition, stagnant bodies of water in the yard of the home and the foliage of any trees can attract birds, insects and other harmful vermin which will be vectors of pathogenic germs from their faeces. Indeed, the production units should be far from 1) polluted areas and industrial activities area representing a serious threat of food safety, 2) areas subject to flooding, 3) areas subject to pest infestations and 4) areas where solid or liquid waste disposal is ineffective [11]. Also, the walls (86%), floors (76%), openings (60%) and ceilings (56%) of the enterprises surveyed do not respect the standards relating to the design and layout of industrial agri-food premises. None of these enterprises have rounded junctions (wall-wall, wall-floor, wall-ceiling). The right-angled junctions constitute nests for microorganisms and make it a

little more difficult to clean the premises. Work plans are mostly inadequate (78%).

Indeed, the peeling and cutting operations are done on non-stainless work-tops such as wood, tables painted with oil paint and benches covered with tiles. The erosion of these work surfaces constitutes a permanent source of physical and chemical contamination of the fruit juices. Also, the embedding of production residues, water and other waste in the crevices generated by the crumbling of materials creates an environment favorable to the proliferation of pathogenic microorganisms that can affect the health and safety of the finished product.

It should be noted that detergents (powder or liquid), caustic soda, sodium benzoate, sodium hypochlorite and other chemical products are used for cleaning and disinfecting equipment, materials, worktops and premises. Most of these products are used inappropriately, ignoring or minimizing the risks that their residues may have on the health of consumers. According to [11], for an effective cleaning, it is necessary to take into account the contact time between the equipment and the product, the product concentration, the temperature of the product and finally the physical effort required for its cleaning. Indeed, caustic soda and its aqueous solutions, when used in high concentrations, can cause corruptions of the skin, eyes and respiratory and digestive mucous membranes of the people in charge of cleaning and disinfection [12]. Also, ingestion of sodium hypochlorite can cause irritation of the digestive tract. Eye and skin contact also causes burns [13]. The cleaning-disinfection process should therefore include a series of rinses to ensure the complete elimination of cleaning product residues.

To facilitate this, it is necessary to ensure a suitable layout of the equipment that can facilitate cleaning, and then to have an effective program of maintenance of equipments. It should be noted, however, that the majority (70%) of the enterprises surveyed in this study have a good layout of the equipments.

Half of the enterprises do not have adequate locker rooms, and most of their employees are dressed in irregular clothing. The access to the production hall should be forbidden to anyone wearing street clothes. Also, any food enterprises must have locker rooms and clean and adequate work or protective clothing, namely: the blouse, mouth and nose masks, caps, shoes and gloves. The enterprises must also have facilities for personal hygiene [14]. It is preferable that these garments be washed on the enterprises. Also, half of the enterprises surveyed have only one production hall where all unit operations are carried out, without necessarily respecting the principle of forward movement. The second half of the enterprises have at least two access doors to the production hall (entrance and exit door).

In the current context of the Covid-19 pandemic, most enterprises have taken recommended measures against this pandemic. Thus, 82% of them have a hand washing station. Few enterprises have posted the hand washing process (14%) and the hygiene practices to be respected during production (18%). Hand hygiene remains a major personal hygiene practice in the food industry [15]. In-

deed, hand washing significantly reduces the risks of diarrheal disease and respiratory infections [16]. Man being a major vector of contamination of foodstuffs in an agri-food enterprise. It is therefore recommended to regularly wash the hands after unclean operations (waste disposal, going to the toilet, etc.), after any contaminating gesture (blowing your nose, sneezing, coughing, etc.) and before any preparation of products particularly critical.

### 3.5. Correlation between Some Parameters Evaluated

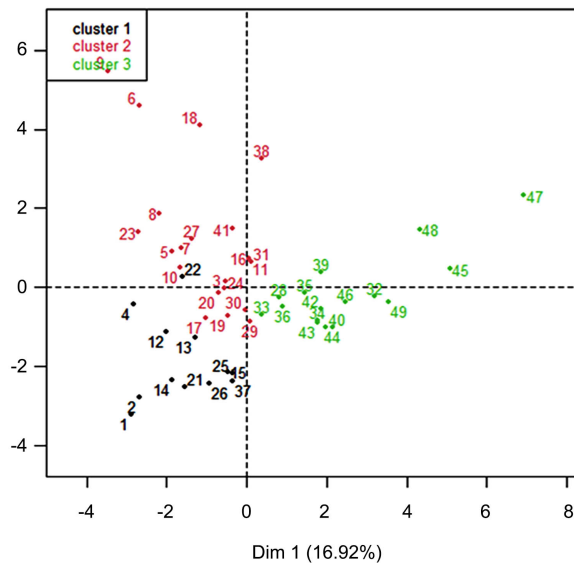
#### 3.5.1. Technical and Administrative Diversity of the Enterprises

During this study, several quantitative and qualitative variables relating to the socio-professional profiles of employees and employers, to the professional characteristics of enterprises and finally to the technical characteristics of fruit juice producing enterprises were evaluated. The Principal Component Analysis on Classification coupled with the Factorial Analysis on Mixed Data on the data of these variables have allowed the grouping of enterprises with specific characteristics. Three main groups (Clusters) of enterprises emerge (**Figure 3**). Enterprises belonging to group 1, group 2 and group 3 are respectively written in black, red and green colors.

**Table 4** presents the most characteristic parameters of each enterprises group. The most characteristic parameters of a group are those for which the v-test of the associated values is greater in absolute value than two. If the v-test of a parameter is positive, this parameter positively characterizes the group. Also, when the v-test is higher, it can be deduced that the corresponding parameter is more characteristic of the group than a parameter with a lower v-test.

In view of the above, the enterprises in cluster 1 are recent (about 5 years), non-structured and mostly manage by young people with basic training in food science. The production managers are also young. Cluster 2 contains semi-structured enterprises, mostly artisanal type A1, not belonging to any professional association. The managers are adults with a primary education. The production of fruit juice is a secondary activity for them. The production managers have no basic training in food science and are not primarily involved in fruit juice production. Cluster 3 contains semi-industrial and artisanal type A4 enterprises, structured and belonging to at least one professional association and managed by older people. The production of fruit juice is the main activity of the directors and production managers of these enterprises. These enterprises are registered in the trade register and most of their products have been granted marketing authorization by the Benin Food Safety Agency.

It should be noted that the group 3 enterprises best up to administrative, organizational and technical requirements. They are the only ones registered in the Beninese trade register and have marketing authorization for most of their products. This performance is easily understood. These enterprises are the oldest in our sample. Indeed, when an enterprise is well structured, the different employees know their positions and responsibilities. This positively impacts productivity and makes the enterprises more competitive and successful [17]. These



**Figure 3.** Projections of enterprises in the plane formed by the first two axes of the FAMD.

**Table 4.** V-test statistics for system description.

Variables	p-value	V-test
<b>Group 1</b>		
Director = Young	<0.001	5.27
Level of structuration = Unstructured	<0.001	4.27
Basic training of Director in Food Science = Yes	<0.001	4.21
Age of companies = [2015-2020[	<0.001	3.88
Head of production = Young	<0.001	3.86
Level of structuration = Semi-structured	0.029	-2.19
Level of structuration = Structured	0.029	-2.19
Age of Companies = [2010-2015[	0.014	-2.47
Head of production = Adult	0.001	-3.38
Basic training of Director in Food Science = No	<0.001	-4.21
Director = Adult	<0.001	-4.21
<b>Group 2</b>		
Head of production = Adult	<0.001	4.19
Director = Adult	0.003	3.01
Principal occupation of Head of production = No	0.005	2.78
Level of structuration = Semi-structured	0.006	2.76
Basic training of Director in Food Science = No	0.014	2.45
Principal occupation of Director = No	0.014	2.45
Type of company = artisanal A1	0.020	2.32
Membership in a professional association = No	0.020	2.32

**Continued**

Education level of Director = Primary	0.028	2.19
Membership in a professional association = Yes	0.020	-2.32
Basic training of Head of production in food science = Yes	0.014	-2.45
Principal occupation of Director = Yes	0.014	-2.45
Education level of Director = Secondary	0.007	-2.70
Principal occupation of head of production = Oui	0.005	-2.78
Head of production = Young	<0.001	-4.10
<b>Group 3</b>		
Membership in a professional association = Yes	<0.001	4.03
Level of structuration = Structured	<0.001	3.96
Registration in the commercial register = Yes	0.001	3.41
Principal occupation of Head of production = Yes	0.002	3.06
Director = Old	0.002	3.05
Type of company = Semi-industrial	0.002	3.05
Type of company = artisanal A4	0.011	2.53
Principal occupation of Director = Yes	0.016	2.41
Marketing authorization = Yes	0.030	2.16
Marketing authorization = No	0.030	-2.16
Principal occupation of Director = No	0.016	-2.41
Principal occupation of Head of production = No	0.002	-3.06
Director = Young	0.001	-3.24
Age of Company = [2015-2020[	0.001	-3.28
Registration in the commercial register = No	0.001	-3.41
Level of structuration = Unstructured	0.001	-3.41
Type of company = Artisanal A2	<0.001	-3.66
Membership in a professional association = No	<0.001	-4.03

Prob = Probability value; V-test = Test value.

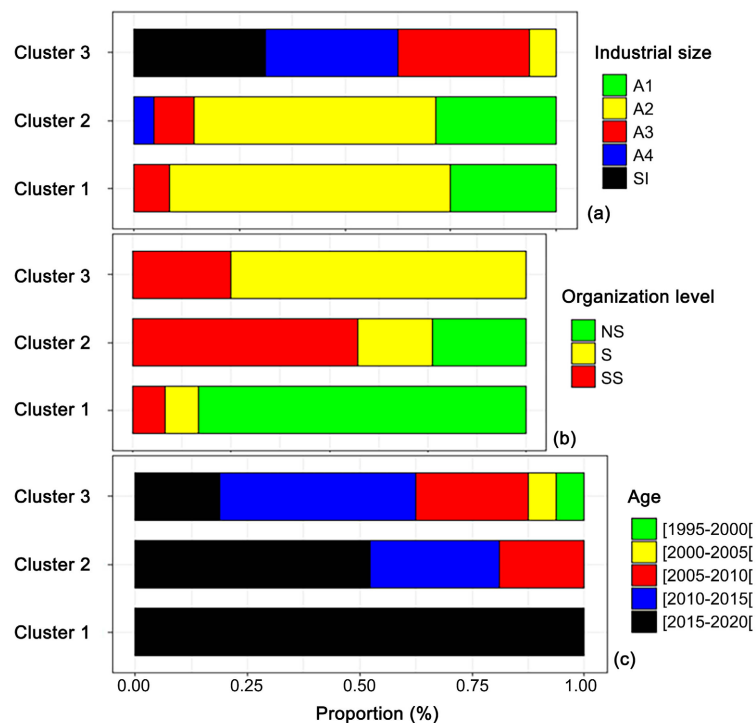
cluster 3 enterprises have therefore had time to structure themselves with distinct internal sections: administrative section, production section and marketing and communication section. It cannot be otherwise, because fruit juices production remains the main activity of the different section managers. They devote most of their time to this and strive to meet the normative requirements. Membership of at least one professional association is a major asset. Indeed, these associations often have training and support programs for producers, often financed by international organizations, and are therefore demanding from a normative point of view. The group 3 enterprises have a much higher level of hygienic practices adoption than the others.

These previous observations are confirmed by the Barplot outputs of the clusters according to the size, level of structuring and enterprises age (Figure 4). Thus, the enterprises in group 3 are predominantly semi-industrial and artisanal types A4 and A3 (Figure 4(a)). This means that they are the most mechanized. These enterprises are essentially structured (Figure 4(b)) and have been in existence for an average of eleven years (Figure 4(c)).

### 3.5.2. Influence of Size and Structuration on Hygienic Practice Level and Women Proportion in Enterprises

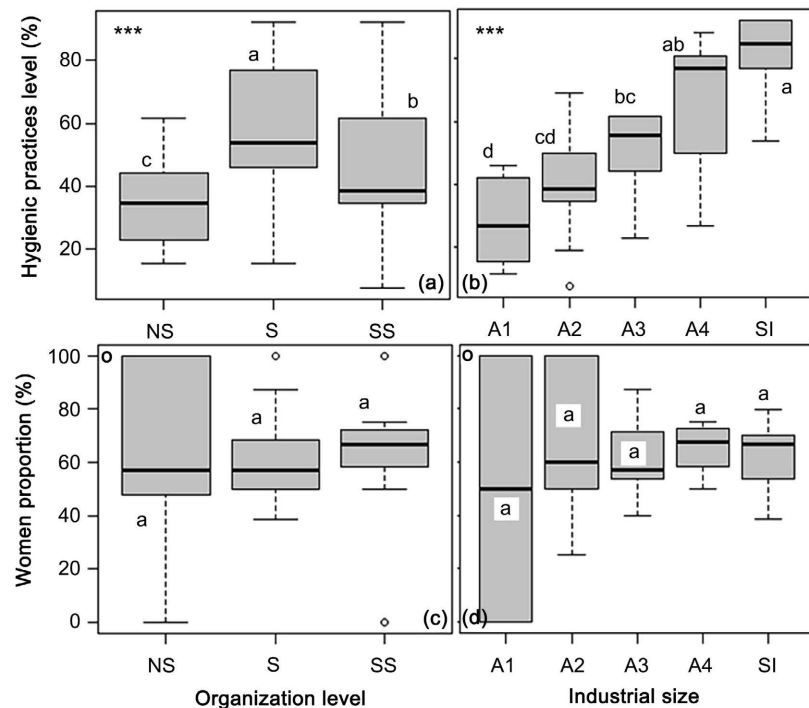
Figure 5 presents the Boxplot of hygienic practices level and women proportion according to structuration level and size of the enterprises.

First, it should be noted that the adoption level of good hygienic practices varies considerably according to the structuration level of the enterprises (Figure 5(a)) and the size of these (Figure 5(b)). This difference is very highly significant ( $p < 0.001$ ) in both cases. Thus, structured enterprises have a higher adoption level of hygienic practices (46.15%) while non-structured enterprises have the lowest hygiene level (32.69%). Thirty percent (30%) of structured enterprises presented a hygiene score above 75%. With regard to size, semi-industrial enterprises show a higher adoption level of hygienic practices (80%) than that of artisanal enterprises whose scores decrease from A4 enterprises (66.66%) to A1 enterprises (27.3%). Eighty percent (80%) of semi-industrial enterprises obtained a hygiene score higher than 75% while 40% of them have a score higher than 90%.



**Figure 4.** Clusters barplot according to size, organization level and age of enterprises. NS = Non-Structured; SS = Semi-Structured; S = Structured. A = Artisanal; SI = Semi-Industrial.





**Figure 5.** Boxplot of hygienic practices level and women proportion according to organization level and industrial size of enterprises. ° =  $p > 0.05$  (not significant); \* =  $p < 0.05$  (significant); \*\* =  $p < 0.01$  (highly significant); \*\*\* =  $p < 0.001$  (very highly significant). On the same graph, the means with different letters are significantly different with probability level of 5% according to Student-Newman-Keuls test. NS = Non-Structured; SS = Semi-Structured; S = Structured. A = Artisanal; SI = Semi-Industrial.

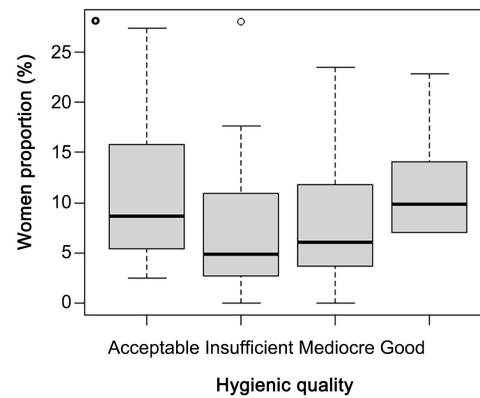
We therefore deduce that the staff structuration positively influences and improves the adoption level of the good hygienic practices level in fruit juice production enterprises. Indeed, when enterprises are structured (administrative team, technical team and commercial team) with clearly defined tasks and objectives for each category of staff, employees are less dispersed and focused on specific tasks. This makes it possible to achieve the objectives more effectively. Also, the positive correlation observed between the hygiene level and the enterprises size reveals that in the food industry, improving the level of enterprises mechanization requires adoption levels of hygienic practices to match ambitions.

Secondly, although the women proportion in enterprises varied slightly according to the structuration level (Figure 5(c)) and enterprises size (Figure 5(d)), the women proportion could not be linked to the above parameters, as these differences in proportions were hardly significant ( $p > 0.05$ ).

It should be noted that the hygienic practices level is very highly influenced by the structuration level and enterprises size, while the structuration level and size have no effect on the women proportion.

### 3.5.3. Impact of Women Proportion on Hygiene Quality

Figure 6 shows the correlation between women proportion (gender ration) and



**Figure 6.** Proportion women boxplot according to hygienic practices level of companies. ° =  $p > 0.05$  (not significant); \* =  $p < 0.05$  (significant); \*\* =  $p < 0.01$  (highly significant); \*\*\* =  $p < 0.001$  (very highly significant).

hygiene quality in the enterprises. There is no significant difference ( $p > 0.05$ ) between women proportions in enterprises with poor, insufficient, acceptable, or still satisfactory hygiene quality. However, we find that the women proportion in enterprises with acceptable or satisfactory hygiene quality is slightly higher than those with poor or insufficient hygiene quality. This result should not be surprising. Indeed, in African societies and in Benin in particular, women are responsible for household tasks, including keeping the home clean and tidy. Gorre-Dale [18] has asserted that in African cultures, women are responsible for managing water resources and home cleanliness.

#### 4. Conclusion

This study revealed that fruit juice enterprises in Abomey-Calavi and Cotonou municipalities are mostly located in residential areas close to main roads. These enterprises are exposed to contamination risks related to domestic and road activities. Three administrative types of enterprises were noted namely non-structured, semi-structured and structured. They are essentially artisanal, with more than half created less than five years ago. Almost half of the enterprises belong to at least one professional association. Only a few of them have marketing authorization. There is a slight predominance of women in the positions of director and production assistant, in contrast to the position of production manager, which is mainly held by men. Most of the directors and production managers had a university education, but not necessarily in the field of food sciences. Factor analysis of data generated three enterprise groups with particular characteristics. Group 3 includes semi-industrial and artisanal type A4 enterprises belonging to at least one professional association, registered in the commercial register, having a marketing authorization and better qualified personnel with about ten years of existence. Unfortunately, these enterprises are the least numerous. The adoption level of good hygienic practices is very highly influenced by the structuration

and size of enterprises. Structured and semi-industrial enterprises have a higher hygiene quality. The women proportion in enterprises with an acceptable or satisfactory level of hygiene is slightly higher than in those with poor or insufficient hygiene level.

### Acknowledgements

The authors thank the fruit juice enterprises involved in this study and researchers of Laboratory of Microbiology and Food Technology (Abomey-Calavi University) for their assistance.

### Funding

This study was funded by the authors.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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