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POST-HARVEST PRACTICES AND ALTERATION RISKS RELATED TO THE SALE OF PINEAPPLE IN ABIDJAN MARKETS

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Abstract

In the context of post-harvest conservation, a diagnosis of the pineapple orchard and risk factors for alterations related to fruit marketing was carried out by conducting a cross-sectional survey in the three major pineapple producing areas and four main areas Markets (Adjamé-Yopougon-Abobo-Plateau) in the Abidjan district (Ivory Coast). A sample of 250 producers and 200 traders was surveyed. The objective was to describe the post-harvest practices and risk factors associated with the commercialization of pineapple fruit. The results showed that the producers are men (100%), mainly illiterate (78.03%) and have an average age between 46 and 60 years (55.1%). Eighty percent (80%) are small growers with orchards under 10 ha. The plant material used by all the producers in the studied areas is composed mainly of 94.13% of discharges and chemical pesticides are used 100%. The harvest is 81.76% manual, unsorted and packaged in bulk (81.77%). Thus only 5.86% recognize that post-harvest losses are due to microorganisms. Also the traders investigated are mostly women (87.1%) and illiterate (70.7%) with a majority of age between 20 and 45 years. 97.73% of the sellers do not protect the fruits during the sale while 22.22% of the sellers carry out a cross-stocking with other fruits. Of all the municipalities investigated, all traders do not recognize the action of microorganisms in the alteration of the fruits. In the absence of sound health education and locally adapted interventions, producers and traders do not pay particular attention to preventing the risk of alterations. This study identified post-harvest practices in Ivorian pineapple plantation and the risk factors for alterations related to commercialization in the markets.

***Key words**: pineapple, alterations, post-harvest, diagnosis, Ivory Coast*

INTRODUCTION

In Ivory Coast, the culture of pineapples is highly developed in the South-East of the country. It occupies an area of 16,000 ha and contributes 0.6% to GDP [10]. With 33,976 tons of fruits exported in 2014, the country ranks first among African exporters a head of Ghana (33,175 tonnes) [17]. About 2,500 small pineapple growers produce 80% of the production in a traditional way. On the other hand, there are industrial-type farms that intensively produce fruit for export. Consumption of fruits and vegetables is recommended in several countries for protection against diseases such as cancer, obesity, cardiovascular diseases and the benefits of their fibers, as well as the good progress of intestinal transit [7,9,19]. Fresh pineapple and crop wastes such as crowns are rich in bromelain. This cysteine protease has numerous therapeutic properties, in particular as anti-inflammatory, anti-thrombic, fibrinolytic and anti-cancer agent [8,11]. It is a highly perishable tropical fruit that must be handled with care and transported under the best conditions to avoid its senescence, its degradation by pathogens or hazardous manipulations. Indeed, the quality of tropical fruits such as pineapple is generally affected by post-harvest diseases such as fruit rot, which is mainly caused by handling and inadequate

storage during transport and marketing [22]. Approximately 20-25% of the harvested fruit is altered by these agents during post-harvest handling, even in developed countries. This has a negative impact on the economic value of the fruit. The cost of post-harvest losses represents about 40-50% of global production annually [16]. Also, there are no data on post-harvest practices in production areas and factors of alteration related to the commercialization of pineapples. The aim of this study was to identify the reality of post-harvest practices in the pineapple production areas and the risk factors for alterations related to the sale of fruit, through a process of interviews with producers and traders. The information gathered will allow establishing a database relating to the practice of the production and marketing of pineapples in Ivory Coast. To this end, it is important to know the characteristics of producers and traders and to identify the environment for post-harvest activities.

MATERIAL AND METHODS

Study area

A survey of different productions and marketing sites identified three main pineapple production sites (Bonoua-Dabou-Tiassalé) and four marketing markets (Abobo-Adjamé-Yopougon-Plateau) for this study.

Preliminary Investigation

The study population is made up of pineapple producers and traders. A file of questions was developed and divided into two sections for each group: the first section concerned age, gender, nationality and level of study of farmers and traders. The second section dealt with the characteristics of production and post-harvest activities for producers and the conditions of sale for traders. The survey lasted twelve months (2016) and covered a total of 150 producers and 200 traders.

Statistical analysis

The different data obtained were processed with statistical software SPSS 11.05. Recordings were carried out for their exploitation. Analysis of one-factor variance (ANOVA) was carried out using STATISTICA 8.0 software to compare the parameters (response variables) studied. For the significant differences between these parameters (response variables), the average ranking was done according to the Newmann-Keuls test at the 5% threshold. The differences are considered significant for values of $P < 0.05$.

RESULTS AND DISCUSSIONS

Post-harvest practices in pineapple producing areas

Characteristics of pineapple producers

The characteristics of the pineapple producers are shown in Table 1. Pineapple culture is devoted to 100% men regardless of the areas of production. The owners of the different plantations of the areas investigated are Burkinabes at 62.17%, while the Ivorians represent 37.83%.

Table 1. Characteristics of pineapple producers in the three pineapple production areas

Characteristics of respondents	Distribution of pineapple producers (%)			
	Production areas			Means
	Bonoua	Tiassalé	Dabou	
Gender				
Mens	100[a]	100[a]	100[a]	100±0,0
Womens	0[a]	0[a]	0[a]	0±0.0
Nationality				
Ivoirian	23.5[a]	40[a]	50[a]	37.83±13.38
Burkinabe	76.5[a]	60[a]	50[a]	62.17±13,38
Age (years)				
15-30	11.8[a]	0[a]	0[a]	03.93±6.81
31-45	38.2[a]	20[a]	10[a]	22.73±14.29
46-60	35.3[a]	60[a]	70[a]	55.1±17.86
>60	14.7[a]	20[a]	20[a]	18.23±3.05
Level of study				
No education	94.1[a]	60[a]	80[a]	78.03±17.13
Primary	5.9[a]	0[a]	0[a]	01.97±3.40
Secondary	0[a]	20[b]	0[a]	06.67±11.54
Superior	0[a]	20[a]	20[a]	13.33±11.54
Experience (years)				
3	2.9[a]	0[a]	0[a]	0.97±1.67
4-10	11.8[a]	40[a]	50[a]	33.93±19.80
11-20	11.8[a]	40[a]	30[a]	27.27±14.29
>20	73.5[b]	20[a]	20[a]	37.83±30.88

For each characteristic of pineapple producers, on-line values with the same letters are not significantly different at the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

The majority of these producers (55.1%) are between 46 and 60 years of age. However, no significant differences ($P > 0.05$) exist between the age groups of producers in the three areas

investigated. Few producers are between the ages of 15 and 30 (3.93%).

The education rate of producers is low. For example, 78.03% of producers did not receive any education. The distribution of out-of-school youth in Bonoua, Tiassale and Dabou is 94.1%, 60% and 80%, respectively. However, no significant differences (P> 0.05) exist between the proportions of illiterate producers in the three zones. Of the educated producers, 1.97% have the primary level, 6.67% the secondary level and 13.33% the higher level.

There are no significant differences (P> 0.05) in the proportions of the educated producers in the three areas. The majority of producers (37.83%) have more than 20 years of experience in pineapple culture, followed by those with 4 to 10 years of experience (33.93%) compared to only 0.97% whose production experience is less than 3 years.

Crop descriptions

Table 2 presents the crop description in the three pineapple production areas. In all three areas, more than half of the producers (58.63%) have a plantation of up to 1 hectare in size. This is the case in Bonoua (55.9%), Tiassale (60%) and Dabou (60%). However, no significant difference (P> 0.05) was observed between the three production areas. Producers with a plantation of more than 5 hectares account for 21.17%, followed by those of 2 to 3 hectares (10.60%) and 3 to 4 hectares (9.60%). No significant difference (P> 0.05) was observed between the size of the plantations in the three areas.

In all three areas, MD2 is the most cultivated variety with 92.73% compared to 7.27% for the smooth Cayenne variety. No significant difference (P> 0.05) was observed in each variety from one area to another.

The plant material used by all the producers in the study areas is composed mainly of 100% pesticides and 94.13% of releases compared with 5.87% of rejects and crowns.

However, no significant difference (P> 0.05) was observed in the use of each input from one area to another. None of the producers use biological pesticides in each of the three areas.

Harvest

The distribution of pineapple fruits harvested in the three production areas is presented in Table 3.

Table 2. Crop descriptions in the three pineapple production areas

Crop description	**Distribution of pineapple producers (%)**			
	Production areas			**Means**
	Bonoua	**Tiassalé**	**Dabou**	
Planting (Ha)				
0-1	55.9[a]	60[a]	60[a]	58.63±2.36
2-3	11.8[a]	0[a]	20[a]	10.60±10.05
4-5	8.8[a]	20[a]	0[a]	9.60±10.02
> 5	23.5[a]	20[a]	20[a]	21.17±2.02
Variety				
MD 2	88.2[a]	100[a]	90[a]	92.73±6.53
Smooth cayenne	11.8[a]	0[a]	10[a]	7.27±6.35
Inputs				
Pesticides	100[a]	100[a]	100[a]	100±0
Bio pesticides	0[a]	0[a]	0[a]	0±0
Rejects	82.4[a]	100[a]	100[a]	94.13±10.16
Rejects and crowns	17.6[a]	0[a]	0[a]	5.87±10.16

For each characteristic of pineapple producers, on-line values with the same letters are not significantly different at the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Table 3. Distribution (%) of pineapple fruits harvested according to production areas

Productions areas	Distribution of pineapple producers (%)	
	Mature Fruits	Immature Fruits
Bonoua	100[a]	0[a]
Tiassalé	100[a]	0[a]
Dabou	100[a]	0[a]
Means	100±0.0	0.0±0.0

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

The survey revealed that all producers (100%) harvest the fruits of pineapple when mature after treatment with ethephon.

However, no immature fruits are harvested in any area of production. No significant difference (P> 0.05) was observed in fruit maturity from one area to another.

Means of harvesting

The distribution of the method of harvesting pineapple fruits is presented in Table 4.

Irrespective of the area of pineapple production, hand-harvesting (81.77%) is the most widely used method for producers. However, 18.23% of producers use the knife for harvesting. The results obtained differ

significantly (P <0.05) according to the harvesting method used in the three production areas.

Table 4. Distribution (%) of the harvesting method according to the production areas

Productions areas	Distribution of pineapple producers (%)	
	Manual harvesting (hand)	Mechanical harvesting (knife)
Bonoua	85.3[a]	14.7[a]
Tiassalé	80[a]	20[a]
Dabou	80[a]	20[a]
Means	81.77±3.05	18.23±3.05

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Table 5. Distribution of producers (%) of fruit of pineapple fruit sorting prior to sale according to production areas

Productions areas	Distribution of pineapple producers (%)	
	Sortng fruit	No sorting fruit
Bonoua	1[a]	99[a]
Tiassalé	0[a]	100[a]
Dabou	0[a]	100[a]
Means	0.33±0.58	99.67±0.58

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Table 5 presents the distribution of producers who sort fruit from pineapple before being put up for sale.
In most cases, all producers (99.67%) do not sort fruits before they are placed on the market. This is the case for the producers of Bonoua (99%), Tiassalé (100%) and Dabou (100%). No significant differences (P> 0.05) exist between the different production areas for the sorting of the fruits before the sale.
However, some producers (0.33%) sort the fruits of pineapple during the harvest before the sale.

Conditioning of pineapple fruits after harvest
The method of packaging used by producers for the storage of pineapple fruits according to the production areas is given in Table 6.
The bulk packaging is mainly used by producers at 81.77% against 18.23% of Cardboard packaging. However, statistical analyzes show that these variations in the type of containers used are significant (P <0.05).

Modes of conservation of pineapple fruits after harvest

Table 6. Distribution (%) of the mode of conservation of pineapple fruits according to the production areas

Productions areas	Distribution of pineapple producers (%)	
	Cardboard packaging	Bulk packaging
Bonoua	14.7[a]	85.3[a]
Tiassalé	20[a]	80[a]
Dabou	20[a]	80[a]
Means	18.23±3.05	81.77±3.05

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Table 7 shows the method of conservation used by producers during storage of pineapple fruit. In all production areas, all producers (100%) use no means of conservation.

Table 7. Distribution (%) of conservation according to the production areas

Productions areas	Distribution of pineapple producers (%)	
	Conservation	No conservation
Bonoua	0[a]	100[a]
Tiassalé	0[a]	100[a]
Dabou	0[a]	100[a]
Means	0.0±0	100±0.0

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Post-harvest losses
The distribution of post-harvest losses of pineapple fruits by producers is given in Table 8. Post-harvest losses are mostly due to injuries or shocks during the harvest, such as in Bonoua (82.4%), Tiassale (100%) and Dabou (100%). There was no significant difference (P> 0.05) between post-harvest losses of pineapple fruit from one production area to another.
Of all the areas investigated, 94.13% of producers acknowledge that crop losses are caused by injuries or shocks, compared to 5.87% of producers who report the action of micro-organisms.

Table 8. Distribution (%) of post-harvest causes by production area

Productions areas	Distribution of pineapple producers (%)	
	Microorganisms	Injuries or shocks
Bonoua	**17.6[a]**	**82.4[a]**
Tiassalé	0[a]	100[a]
Dabou	0[a]	100[a]
Means	5.87±10.16	94.13±10.16

For each characteristic of the producers of pineapples, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

Alteration risk factors related to the sale of pineapple in abidjan markets

General characteristics of pineapple sellers

The characteristics of the sellers of pineapple fruits are presented in Table 9. The sale of fruit in the markets is exclusively carried out by women (87.1%) compared with 12.9% of men.

Table 9. Distribution (%) of the characteristics of pineapple sellers in the markets of Abidjan

Characteristics of sellers	Municipalities investigated (%)				
	Abobo	Adjamé	Yopougon	Plateau	Means
Gender					
Men	16.7[a]	16.7[a]	0[a]	18.2[a]	12.9±8.62
Women	83.3[a]	83.3[a]	100[a]	81.8[a]	87.1±8.62
Ages (years)					
20-30	50[a]	58.3[a]	53.3[a]	45.5[a]	51.76±5.39
30-45	25[a]	16.7[a]	40[a]	27.3[a]	27.25±9.64
45-60	25[a]	25[a]	6.7[a]	18.2[a]	18.72±8.63
>60	0[a]	0[a]	0[a]	9.1[a]	2.27±4.51
Level of study					
No	66.7[a]	83.3[a]	66.7[a]	63.6[a]	70.08±8.93
Primary	16.7[a]	16.7[a]	33.3[a]	36.4[a]	25.78±10.55
Secondary	8.3[a]	0[a]	0[a]	0[a]	2.07±4.15
Superior	8.3[a]	0[a]	0[a]	0[a]	2.07±4.15
Experience (years)					
< 2 ans	33.3[a]	16.7[a]	13.3[a]	9.1[a]	18.1±10.59
2-5	33.3[a]	50[a]	66.7[a]	72.7[a]	557±17.74
6-11	8.3[a]	25[a]	20[a]	0[a]	13.32±11.30
12-17	16.7[a]	8.3[a]	0[a]	18.2[a]	10.9±8.41
18-23	8.3[a]	0[a]	0[a]	0[a]	2.08±4.15

For each characteristic of pineapple sellers, on-line values with the same letters are not significantly different at the 5% threshold according to the Newmann-Keuls test.
Source: Own calculation

The majority of sellers are between 20 and 45 years of age. However, there was no significant difference (P> 0.05) between the sellers age according to the municipalities investigated. Few sellers are older than 60 (2.27%). The rate of school attendance of female sellers is low. As a result, 70.7% of female sellers received no education. Of the female school-leavers, 25.77% have the primary level, 2.07% the secondary level and 2.07% the higher level. There is no significant difference (P> 0.05) between the rate of schooling of female sellers by municipalities.

The majority of sellers (55.7%) have a 2 to 5 years of experience in selling pineapple fruits, followed by those with less than 2 years of experience (18.1%) versus only 2.08 % With a business experience of between 18 and 23 years. No significant difference (P> 0.05) was observed in the commercial experience of the actresses according to the municipalities under investigation.

Pineapple Fruit Supply Areas

Table 10 shows the supply areas for pineapple fruits according to the markets of the municipalities.

Table 10. Distribution of Fruit Supply Areas by Municipalities

Municipalities investigy	Supply areas (%)	
	Bonoua	Dabou
Abobo	100[a]	0[a]
Adjamé	91,7[a]	8,3[a]
Yopougon	80[a]	20[a]
Plateau	100[a]	0[a]
Means	92.92±9.46	7.08±9.46

For each characteristic of the pineapple sellers, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test
Source: Own calculation

The fruits sold in the markets mainly come from the town of Bonoua (92.92%). All Abobo (100%) and plateau (100%) sellers get their supplies from Bonoua. In the municipalities of Adjamé and Plateau, 8.3% and 20% of salespeople source their fruit from Dabou. The results do not differ significantly (P> 0.05) according to the areas of supply of the municipalities.

Duration of sales of pineapple fruits

Table 11 shows the duration of sales of the quantities of fruit according to the municipalities. On average, 67.77% of sellers sell their retail stock for a minimum of 2 days. On the other hand, 32.23% of the sellers sell their stock over a period of 3 days until exhaustion. The fruits of Abobo sellers sell faster (2 days), 100% of the stocks, followed by those of Adjamé (83.3%) and Plateau

(54.5%). The municipality which has difficulty in selling its fruit stock is Yopougon (66.7%) for a maximum of 3 days. There is a significant difference (P <0.05) between the time of sale according to the communes. No sellers take more than 3 days to sell the available stock.

Table 11. Distribution of the period of sale of fruit in the markets of the various municipalities

Municipalities investigated	Term of sale (%)	
	2 days	3 days
Abobo	83.3^{bc}	16.7^{ab}
Adjamé	100^{c}	0^{a}
Yopougon	33.3^{a}	66.7^{c}
Plateau	54.5^{ab}	45.5^{bc}
Means	67.77±29.68	32.23±29.68

For each characteristic of the pineapple sellers, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test
Source: Own calculation

Conditions of sale of pineapple fruits

Table 12, which presents the sales conditions for pineapple fruit, shows that 97.73% of sellers do not protect fruit during sale in markets. In Abobo, 100% of sellers do not cover fruit during the sale, as do those of Adjamé and Yopougon. No significant difference (P> 0.05) was observed between fruitless sellers during sale in all communes. However, 2.27% of sellers protect the fruit during the sale. Thus, in the Plateau, the sellers (9.1%) protect the fruit during the sale. However, there is no significant difference (P> 0.05) between the sellers who protect the fruit during the sale in all the municipalities.

Table 12. Distribution (%) of the mode of sale of pineapple fruits in the markets of the different municipalities

Municipalities investigated	Mode of sale (%)	
	Covered pineapple	Pineapples not covered
Abobo	0^{a}	100^{a}
Adjamé	0^{a}	100^{a}
Yopougon	0^{a}	100^{a}
Plateau	9,1^{a}	90,9^{a}
Means	2.27±4.55	97.73±4.55

For each characteristic of the pineapple sellers, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test
Source: Own calculation

Storage Conditions

In most of the municipalities investigated, the majority of sellers (77.78%) store pineapple fruits alone, while 22.22% sell pineapple fruit with other fruits. Most of the sellers in the municipalities of Adjamé (100%), Abobo (83.3%) and Yopougon (73.3%) practice a non-cross-storage of pineapple fruits. However, the statistical analyzes showed no significant difference (P> 0.05) regarding the storage mode of pineapple fruits (Table 13).

Table 13. Distribution (%) of the mode of storage of pineapple fruits in the markets of the different municipalities

Municipalities investigy	Storage mode (%)	
	Cross-storage	Non-cross-storage
Abobo	16,7^{ab}	83.3^{ab}
Adjamé	0^{a}	100^{b}
Yopougon	26.7^{ab}	73.3^{ab}
Plateau	45.5^{c}	54.5^{a}
Means	22.22±19.02	77.78±19.02

For each characteristic of the pineapple sellers, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test
Source: Own calculation

Table 14 shows the distribution of alteration of pineapple fruit in markets according to the municipalities. Of all the municipalities investigated, not all sellers recognize that the alteration of pineapple fruit could be due to microorganisms. No significant difference (P> 0.05) was observed between traders who did not recognize the alteration of pineapple fruit in each municipality investigated.

Table 14. Distribution (%) of the alteration of pineapple fruit in the markets of the different municipalities

Municipalities investigated	Distribution of pineapple sellers (%)	
	Recognition microbial alteration	Non-recognition microbial alteration
Abobo	0^{a}	100^{a}
Adjamé	0^{a}	100^{a}
Yopougon	0^{a}	100^{a}
Plateau	0^{a}	100^{a}
Means	0±0	100±0

For each characteristic of the pineapple sellers, columns, values bearing the same letters are not significantly different from the 5% threshold according to the Newmann-Keuls test
Source: Own calculation

Information obtained on post-harvest practices showed that pineapple culture is a male activity in Ivory Coast. Indeed, it is 100% dedicated to the men whatever the zone of production. From

one production area to another, the proportions of men and women do not differ significantly.

One of the fundamental reasons is that the virtual absence of women in this activity could be due to the painfulness, that is to say, to the immense physical effort which must be provided for the creation of a field of study, pineapple. Indeed, courageous women, capable of clearing a dense forest up to development are not possible. This may explain the absence of women in the production of pineapple fruit. This situation may also be explained by the fact that in rural areas, women are all considered as housewives. Nevertheless, it is important to emphasize that women are essential aids alongside their spouses, as they are an essential link in the pineapple production chain. Indeed, producers reported that women generally take an active part in harvesting fruit during harvesting.

At the time of this study, the majority of producers in the three investigated areas with experience in pineapple production were between 46 and 60 years of age or more. This means that there are elderly people among the pineapple producers. The aging of producers results in a decline in their rural activities and inevitably a decrease in yield.

The majority of producers in the study areas testified that they had not attended school. The high rate of literacy would come from the low level of education of the Ivorian population in the 1970s. This could also be explained by the fact that pineapple was initially cultivated only by illiterates [4]. On the other hand, in recent years "intellectuals" and some "pensioners" have begun to invest in agriculture [4]. This observation is similar to that of Assa et al. (2006) [3] on the coconut plantation of the Ivorian coastline concerning the age and intellectual level of producers.

In general, over half of all pineapple producers in the three areas studied have more than 10 years experience, most of them Burkinabe. This implies that these producers have some experience in the culture of pineapples. This may be explained by the migration of populations from Burkina Faso to these areas of the South and South-East (Dabou-Tiassale-Bonoua) Main production areas of pineapple. Migration was politically supported and accelerated from 1960 [24, 17].

The cultural descriptions showed that the size of the plantations of not more than one hectare represents more than half of all the pineapple crops of the areas investigated. This result reflects the disinterestedness of the peasants with respect to this culture as reported by Colin in 2012 [12]. The MD2 variety developed in the 1990s is now mainly cultivated in all three zones. This latter variety has much more advantages in terms of organoleptic qualities than the smooth Cayenne originally representing the totality of Ivorian production [18]. In most cases, the releases constitute the plant material of production as reported by Agrisol in 1992 [1] in similar studies. The high costs of vitroplants could be one of the reasons for the use of discharges. Also, the discharges present an increased susceptibility to the diseases in contrast to the vitroplants. The exclusive use of chemical pesticides could be explained by the fact that these substances have always been considered the most effective weapons against phytopathogens [25] and the lack of a national research policy in biological control.

The fruit must be harvested at the right ripeness, in order to avoid possible rotting of the fruit. Voluntarily, no producer collects immature fruits. The presence of immature fruits in the crops is usually the result of accidental picking.

The exclusive use of the hand for the harvest would be due to its speed in this operation, but it could cause the fungal alteration of the fruits. Effect, according to FruiTrop (2013) [17], the use of the hand presents enormous inconveniences such as the contamination manuported which are causes of alteration of the fruits. Also the section of the peduncle constitutes a gateway for fungal strains when not soaked in fungicide solutions [15].

Almost all growers do not sort fruits before they go on sale. This observation confirms the observation by several authors [2, 23] that fruit sorting is the first step in post-harvest treatment of fruit during which mold may develop. Therefore, eliminating poor quality fruits, such as injured, altered or immature fruits, means

avoiding sites of abundant mold growth and cross-contamination.

Out of the three production areas, the packaging is mainly made in bulk. This mode of conditioning and storage leads to a high risk of fungal infections in the environment. Indeed, according to FruiTrop (2013) [17], harvested pineapple is a perishable commodity that deteriorates rapidly if storage conditions are not adequate. The use of this method of packaging would be due to the absence of the technical supervision structures which should regularly raise the awareness of producers on good post-harvest practices. Also, the high cost of the cardboard would be at the origin of this choice.

In the different production areas, there is no means of preserving the aggressors, like insects and harmful microorganisms of the fruits. This would mean that besides good post-harvest practices, no other effective means exists to annihilate these fruit aggressors. Because the lack of conservation means is a handicap in the fight against fungal alterations (especially sporulated forms of mold).

The vast majority of producers don't know the harmful effects of microorganisms on the alteration of pineapple fruit. This could be explained by the high rate of illiteracy recorded among them. This ignorance could also fall to the technical management structures which do not fully play their role as trainer of producers. Thus, extensive producer training campaigns should be launched by the managers of the sector. Production can only be of quality if the producers themselves are of good quality, that is to say well trained and conscientious.

This study also showed that the marketing of pineapple fruits in the Abidjan markets is essentially devoted to women. This observation is in line with that of Onuorah (2013) who reported that the marketing of fruit in African markets is an activity mostly practiced by women. This could be explained by the fact that this activity is considered as a female task as much as domestic tasks. According to Yiriwa, (2001) [27], fruit sales are an income-generating activity for many urban women. One of the main reasons supporting the practice of this informal activity in these women would certainly be the lack of employment. According to Dieye (2006) [13], this informal activity is proving to be an important factor in the food security of urban populations and the creation of jobs for vulnerable groups.

The survey revealed a low level of education among pineapple fruit sellers. The low level of education of sellers in markets may be due to the fact that selling fruit is an activity that does not require special skills. This partly justifies the strong representativeness of those not enrolled in this informal sector. This assertion supports the report of Boli et al. (2016) on the processing and marketing of Mostly dominated by low-educated women. In addition, Baba and Ehui, 2008 [5] reported that in Ivory Coast, in the informal sector, it is the experience gained on the ground that counts for most women to emancipate themselves economically and realize gains capitalized.

This study also showed that the sale of fruit in the markets of Abidjan regressed with the age of the sellers gradually in time. One of the main reasons for the decline in this activity is due to the replacement of these sellers by persons close to whom they learn the business of trade for the succession in time. In urban areas, the majority of female food processors and food sellers are supported by their daughter as a priority and then other family members (nieces, sisters and cousins) who replace them later.

The main areas of supply of pineapple fruits in Ivory Coast were the Southern and South-Eastern areas, confirming the work of Guyot et al. (1974). Indeed, these authors have indicated that the main areas of pineapple production in Ivory Coast are those covering the whole Southern and South-Eastern part of the country from which supplies are made to large cities, especially Abidjan. The fruits marketed in the markets of the various municipalities are largely produced in Bonoua. This could be explained by the fact that Bonoua was long and remains the stronghold of the pineapple culture [12].

The investigation revealed that the fruit is sold for a period of 2 to 3 days at room temperature until the stock is exhausted. This short period

of fruit sales can be explained by the intrinsic characteristics of the fruit. Indeed, the fruits received are showing signs of alterations after a period of three to four days. A long period of sale could be a source of fruit contamination, including fungal contamination and mycotoxin production. Indeed, according to Barro et al. (2006) [6], the risk of fruit contamination increases with long-term marketing due to poor practices and manipulation. In addition, according to other authors [14, 20], poor storage and storage of fruits within stores contribute to contamination by aflatoxins and pathogenic fungi.

The majority of sellers do not protect the fruits during the sale in the markets. Indeed, according to the latter, the exposure of fruits during the sale allows customers to see them from a distance. This means that fruits are permanently exposed to the open air During marketing in the markets. According to Koffi-Nevry et al. (2012) [21], the immediate environments of sales outlets in the marketing markets of Abidjan are real sources of contamination of all kinds. According to the same authors, various sources of contamination in or near the markets include flies, water points on cemented soil, sewers, public toilets, garbage dumps or open channels. In addition, pineapple fruits are sold close to other fruits and other foods in markets. Fruits are often the destination of flies (potential reservoirs of pathogenic microorganisms) from the surrounding pollution sites as reported by (Koffi-Nevry et al., 2012) [21]. Also, the mode of exposure of fruits during sale could attract flies and be a determining factor in the spread of many foodborne diseases.

CONCLUSIONS

This study of the Bonoua, Tiassale and Dabou producers shows that post-harvest practices are poor in most cases and are similar in all these areas. Thus, harvesting which is manual can lead to a contamination man ported. Bulk packaging results in shocks and bruises that are entryways to microorganisms. Also the absence of means of conservation is a notable fact. All these practices can have a consequence both on the quality of the fruits and on that of the finished products that result from them. This study made it possible to identify the factors of risk of alteration of the fruits of pineapples. Poor hygiene practices and conditions for the sale of pineapple fruits are the main factors of alterations.

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