# Artificial ripening of mango (*Manguiféra indica*. L) with Calcium carbide (CaC2) and ethephon: Problem of fruit safety in the markets of Abidjan (Côte d'Ivoire).

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## ABSTRACT

**Aims:** Fruit ripening is a natural process that can also be stimulated by various artificial means. In recent years, artificial ripening has become increasingly popular in developing countries. This practice has become questionable due to various health problems associated with the use of its chemicals. A number of direct and indirect health risks are thought to be associated with artificial ripening agents and their impurities, which calls for a critical analysis of the practices and techniques used to ripen fruit.
**Study design:**Mention the design of the study hereDescriptive and analytical cross-sectional study with a single questionnaire passage.
**Place and Duration of Study:**Place and duration of the study: This study was conducted at the Department of Food Science and Technology, Laboratory of Nutrition and Food Safety, Nangui Abrogoua University, Côte d'Ivoire, Abidjan, Côte d'Ivoire, on 1 February 2024

**Conclusion:**The aim of this study was to list the products and techniques used for the ripening in Côte d'Ivoire. The study revealed a variety of products used for mango ripening, the main being calcium carbide (caba) and almephon (cabadji). Caba is used for incubation and Cabadji for spraying.



***Keywords****: Mangoes, Growth Accelerator, Processing, Côte d'Ivoire.*


## 1. INTRODUCTION

Fruit ripening is a natural process in which fruit undergoes various physiological, biochemical and molecular transformations from the mature green stage to commercial maturity [1]. With the advancement of science and technology, various artificial methods of fruit ripening have been observed, mainly to meet consumer demand and other economic factors [2]. During this process, traders use various chemical agents to accelerate the ripening and ripening of the fruit. However, the use of these chemicals on fruit (mango) remains problematic due to possible toxic effects on consumer health.In Côte d'Ivoire, mango production exceeds 180,000 tonnes per year [3]. Mango is mainly grown in the north of the country and is the third most important cash crop in the country after cotton and cashew nuts [4]. Once shipped to markets in the south of the country, the fruit is less processed and consumed directly as a dessert. In fact, consumers like them when they are ripe and use the color of the skin to make their choice. In order to satisfy these consumer demands, some retailers use ripened products, even though these products are banned. This maturing practice is increasingly common in developing countries such as Côte d'Ivoire [5]. However, the products and methods used in this practice are not well known to consumers and pose a serious health risk. Furthermore, these growth accelerators have been the subject of several studies and their ability to cause probable effects (carcinogenic, genotoxic, hepatotoxic) on the health of consumers and traders has been demonstrated worldwide [6,7,8]. In view of this situation, it is essential to shed full light on the use of these products and the various methods used to

accelerate the ripening of mangoes sold on the Abidjan markets. This work aimed at listing the products and techniques used to accelerate mango ripening in Côte d'Ivoire.

## 2. MATERIAL AND METHODS

### 2.1 Area to study

This study was carried out in 5 communities (ABOBO, ADJAME, YOPOUGON, PLATEAU, COCODY) in the city of Abidjan (Côte d'Ivoire). These different areas are shown on the map below (Figure 1).

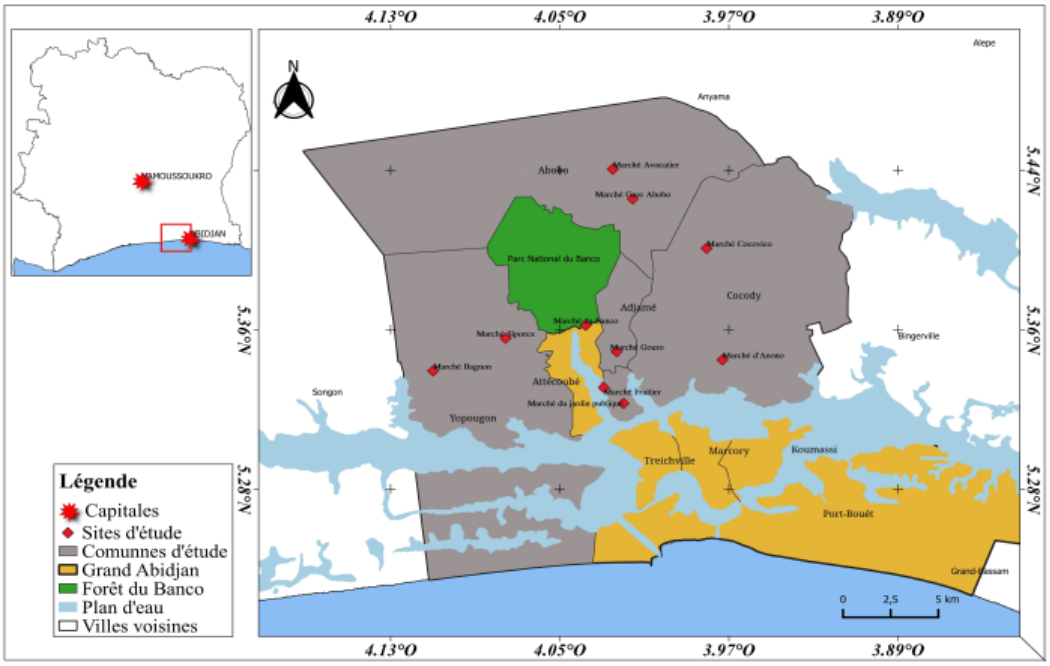


**Figure 1**: Presenting the different markets surveyed according to municipality type and size of the study

### 2.2Study type and size

This study was a cross-sectional descriptive and analytical survey with a single questionnaire that lasted two months: from 1 April to 31 May 2022. The survey involved 225 traders, 45 from each municipality.

### 2.3Criteria for selecting the study population

The markets were selected based on the main mango unloading areas (markets) in the city of Abidjan. In each commune, two (2) wholesale markets were targeted according to the importance of mango trading activities in these areas. Traders were selected based on the size of their business (as wholesalers).

**Table1: Number of respondents per walk, by municipality**

| Municipality | Different markets | Number surveyed |
|---|---|---|
| Abobo | Main Station Abobo | 23 |

| | | |
|---|---|---|
| | New Abobo station | 22 |
| Adjamé | Gouro market | 24 |
| | Banco market | 21 |
| Yopougon | Siporex market | 20 |
| | Gesco market | 25 |
| Plateau | Fruit market | 26 |
| | Public garden | 19 |
| Cocody | Cocovico market | 23 |
| | Anono market | 25 |
| Total workforce | 1O Markets | 225 |

## 2.4Data collection tool

The data collection tool was a questionnaire addressed to local mango sellers in the 5 different target municipalities of Abidjan. The questionnaire covered a number of key points such as: socio-demographic profile, product identification, ripening technique used, health aspects related to the use of ripening products and some environmental aspects related to the use of growth accelerators.Tables should be explanatory enough to be understandable without any text reference. Double spacing should be maintained throughout the table, including table headings and footnotes. Table headings should be placed above the table. Footnotes should be placed below the table with superscript lowercase letters.

## 2.5Statistical analysis of data

The data was analyzed using descriptive statistics. The average number of terms per market and per municipality was determined and their frequencies were calculated to assess the extent of their distribution. The Pearson Chi-square test was used to assess variability.

## 3. RESULTS AND DISCUSSION
## 3.1 Results

### 3.1.1 Sociodemographic profile and sales experience of the people surveyed

Table 2 shows the sociodemographic characteristics of the traders interviewed in the different markets. The majority (97.6%) of the traders interviewed were women, many of them (53.9%) were between 31 and 50 years old. Furthermore, a high proportion (71.9%) of women traders in all markets surveyed were illiterate.

**Table 2: Socio-demographic profile of market traders surveyed**

| Characteristics of those surveyed | Abobo (%) | Adjamé (%) | Yopougon (%) | Cocody (%) | Plateau (%) | Total (%) |
|---|---|---|---|---|---|---|
| | | | **Gender** | | | |
| Masculine | 00 | 12 | 00 | 00 | 00 | 2.4 |
| Feminin | 100 | 88 | 100 | 100 | 100 | 97.6 |
| | | | **Age range** | | | |
| 18-30 Answers | 37 | 16.00 | 33.3 | 16.7 | 36.4 | 27.86 |
| 31- 50 Answers | 51.8 | 64 | 40 | 50 | 63.6 | 53.9 |
| 51- 65 Answers | 11.2 | 20 | 26.7 | 33.3 | 00 | 18.24 |
| 66- Additional | 00 | 00 | 00 | 00 | 00 | 00 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | **Level of teaching** | | | |
| Non-scholarly | 74.1 | 80 | 67 | 66 | 72.7 | 71.96 |
| Primary | 3.7 | 16 | 20 | 9 | 9.1 | 11.56 |
| Secondary | 18.5 | 4 | 13 | 25.0 | 18.2 | 15.74 |
| University | 3,7 | 00 | 00 | 00 | 00 | 0.74 |

### 3.1.2Use of growth-enhancing products for the ripening process

Figure 1 shows the use of ripening agents in the Abobo, Adjamé, Yopougon, Cocody and Plateaux markets. The results showed that in all the markets surveyed, the majority of traders used fruit ripening accelerators to ripen mangoes.

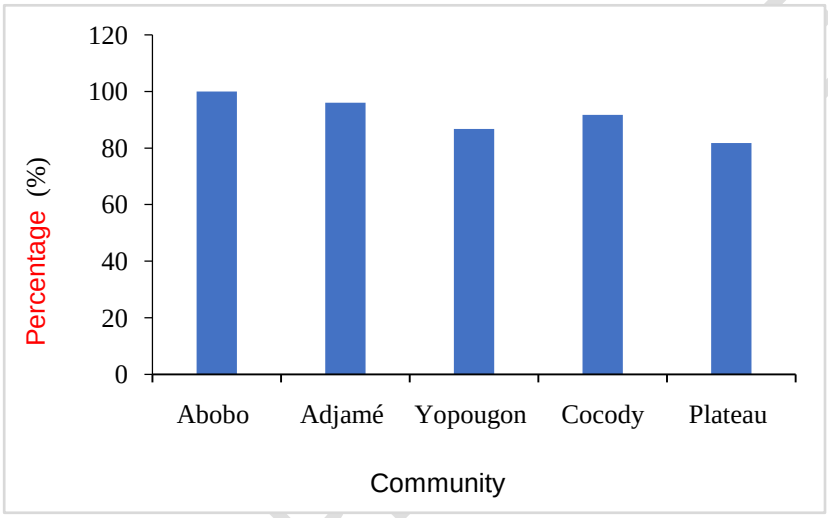


**Figure 2**: Percentage use of ripening products

### 3.1.3 Identification of growth accelerators for ripening

Figure 3 shows the products used to accelerate fruit ripening in the surveyed markets. The results showed that the products used were different in all markets (*P*= 0.05). Most traders (70%) used calcium carbide (Figure3), commonly known as "caba"(Photo 1). The remaining minority (30%) used the ethephon (Photo 2), commonly known as "cabadji".

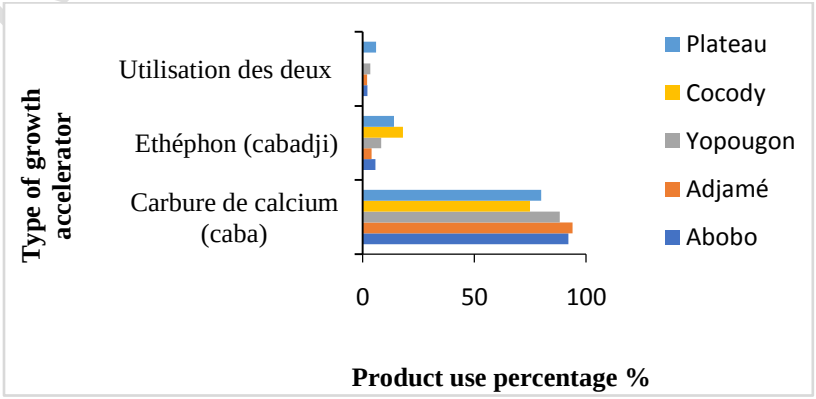

**Figure 3:** Type of product used for ripening Merchants' assessment of ripening results


**Photo 2:** Ethephon-based products

**Photo 1:** Calcium carbide

### 3.1.4 Identification of growth accelerators for ripening

Table 3 shows a general evaluation of the ripening results. These results show that the majority (72.2%) of growers use these products because of their effectiveness and (74.38%) of those who use them are satisfied with the ripening results (color, taste, time after ripening) of the fruit.



**Table 3: Identification and selection characteristics of ripening products used**

| Product characteristics | Abobo (%) | Adjamé (%) | Yopougon (%) | Cocody (%) | Plateau (%) | Total | Chi 2 | *P* |
|---|---|---|---|---|---|---|---|---|
| **Product selection** | | | | | | | | |
| Efficiency | 70.4 | 72 | 80 | 75 | 63.7 | 72.2 | 9.802 | **0.63** |
| Prize | 18.5 | 24.00 | 20 | 16.7 | 27.3 | 21.3 | | |
| Habitus | 11.1 | 4 | 00 | 8.3 | 9.1 | 6.5 | | |
| **Effectiveness of the product** | | | | | | | | |
| Satisfaction | 81.5 | 76 | 66.7 | 75 | 72.7 | 74.38 | | |
| Not very | 18.5 | 16 | 26.7 | 8.3 | 9.1 | 15.72 | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| satisfied | | | | | | | 7.011 | **0.53** |
| Dissatisfaction | 00 | 8 | 6.7 | 16.7 | 18.2 | 9.90 | | |
| | | | **Curing time** | | | | | |
| 1 Day | 6.7 | 6 | 7 | 6.6 | 19.6 | 9.18 | | |
| 2 Day | 60.0 | 78 | 59.7 | 76.7 | 62.2 | 67.32 | 13.65 | **0.32** |
| 3 Day | 33.3 | 16 | 33.3 | 16.7 | 18.2 | 23.5 | | |

### 3.1.5 Ripening techniques for mangoes in the markets under reviewμ

The ripening techniques used and the quantities of products used are shown in Figures 3 and 4. The majority of the respondents used two techniques (wrapping or brooding and spraying). The wrapping or brooding method was used with calcium carbide, while ethephon was used by spraying. In Adjamé, Yopougon, and Cocody, the majority (80%) of people used ½ kg of calcium carbide to ripen 2 cartons, except in Abobo and Plateau where the majority (73%) used 1 kg to ripen 3 cartons of mangoes. In terms of liquid products, traders in Adjamé and Yopougon used 250 ml of dilute ethephon solution to ripen 2 cartons, while traders in Abobo, Plateau and Cocody used 100 ml of dilute solution to ripen 2 cartons.

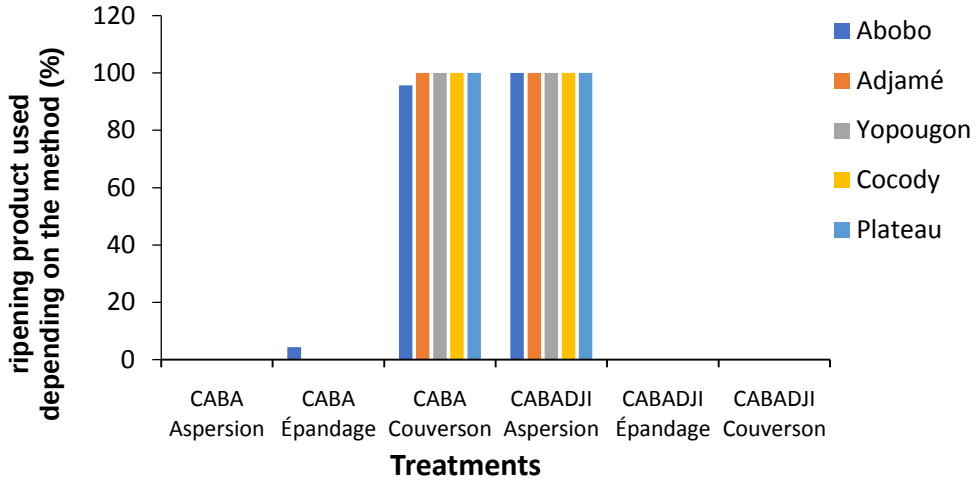


**Figure 4**: Techniques used to process mangoes

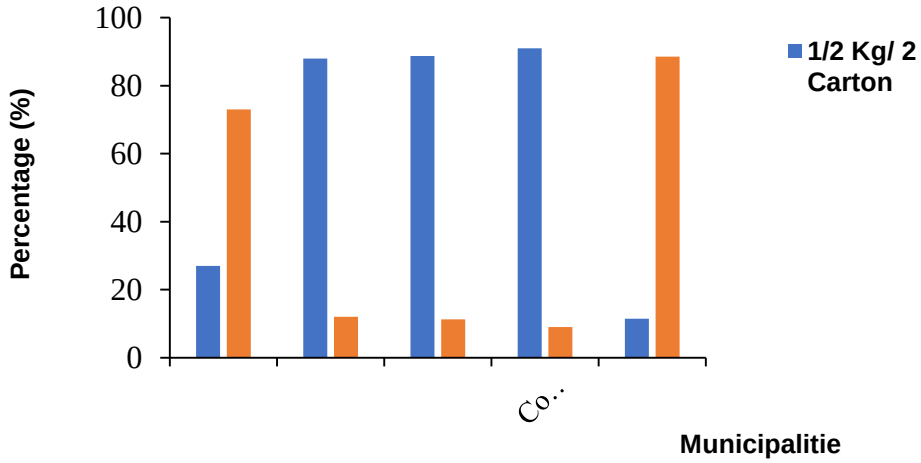

**Figure 5**: Quantity of products per proportion of mango

### 3.1.6 Mango ripening conditions at Abidjan markets

The results of the ripening conditions are depicted in Table 4. The majority (87.7%) of operators applied the products themselves. Moreover, most of them didn't consider the time of day or the weather when applying the products. All participants in this study (100%) applied the products outdoors and did not consider any disinfection measures prior to sale.



**Table 4: Conditions for ripening process**

| Technique used | Abobo (%) | Adjamé (%) | Yopougon (%) | Cocody (%) | Plateau (%) | Total (%) | Chi 2 | *P* |
|---|---|---|---|---|---|---|---|---|
| **How to apply** | | | | | | | | |
| Professional | 00 | 00 | 00 | 00 | 00 | 00 | 16.27 | **0.25** |
| Yourself | 96.3 | 88 | 80 | 83.4 | 90.9 | 87.7 | | |
| Colleagues | 3.7 | 12 | 20 | 16.7 | 9.1 | 12.3 | | |
| **Period to apply** | | | | | | | | |
| Morning | 7.4 | 8.00 | 26.7 | 25 | 9.1 | 15.24 | 18.03 | **0.32** |
| Middle | 7.4 | 20 | 20.0 | 8.3 | 18.2 | 14.78 | | |
| Evening | 7.4 | 4 | 00 | 00 | 00 | 2.28 | | |
| Any time of day | 77.8 | 68 | 53.3 | 66.7 | 72.7 | 67.7 | | |
| **Area of treatment** | | | | | | | | |
| In the open air | 100 | 100 | 100 | 100 | 100 | 100 | 4.704 | **0.42** |
| Aging room | 00 | 00 | 00 | 00 | 00 | 00 | | |
| **Sanitation Fruit** | | | | | | | | |
| Disinfecting to sell | 00 | 00 | 00 | 00 | 00 | 00 | 8.155 | **0.42** |
| No sanitation | 100 | 100 | 100 | 100 | 100 | 100 | | |

### 3.1.7 Risk of exposure of retailers to residues of ripening products

In the pictures (6, 7, 8), we see the dangers faced by traders while ripening mangoes. Most traders (74.38%) do not guard themselves against the risk, while even for those who do, merely using a glove is not enough. More worrying is that personal hygiene remains a neglected concern even when up to 65.98% of traders handle harmful chemicals. An overwhelming 71.34% of product users report having experienced an impact, be it feeling dizzy or experiencing skin rashes. The main visible trends are breathing difficulties (42.76%), headaches (24.66%), and skin irritation (10.16%).

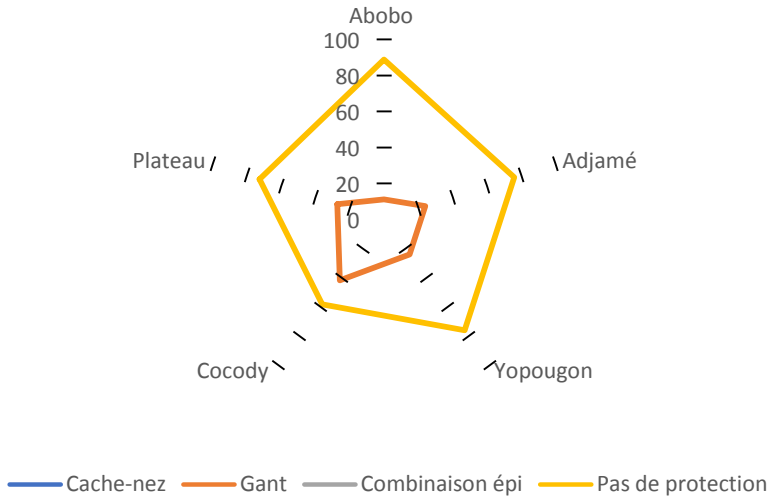


**Figure 6:** Protection tools (%)

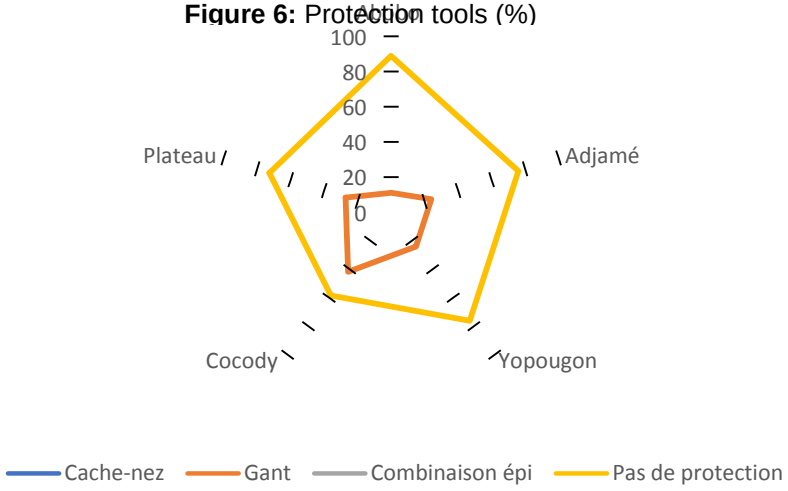


**Figure 7:** Personal cleanliness following product usage (%).

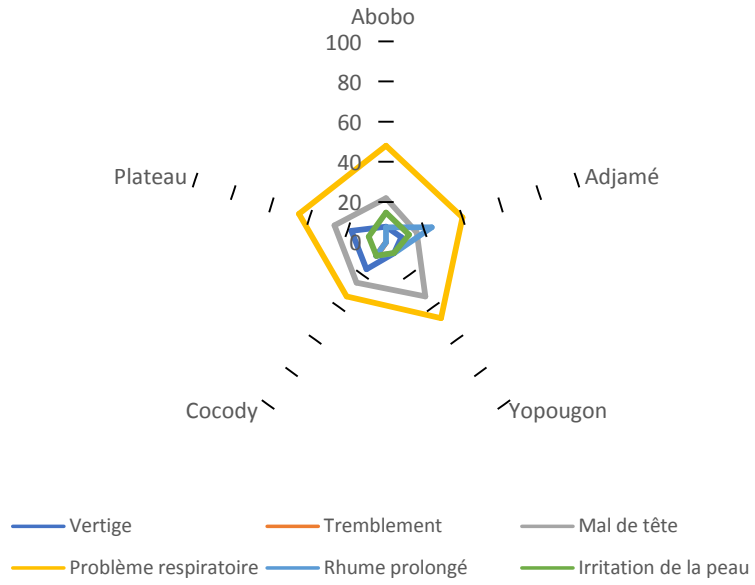


**Figure** 8: Effects felt after treatment (%)

### 3.1.8 Risk of consumer exposure to artificially ripened mangoes

In Figure 9, data reveal that accelerating mango ripening increases the risk of consumer exposure. Ki2 testing confirmed that the identical risks apply to all communes. Every trader surveyed, 100% in total, failed to take any precautions to sanitize fruits prior to sale. Furthermore, all traders (100%) neglected to implement a safety waiting period after treatment before fruit can be sold.

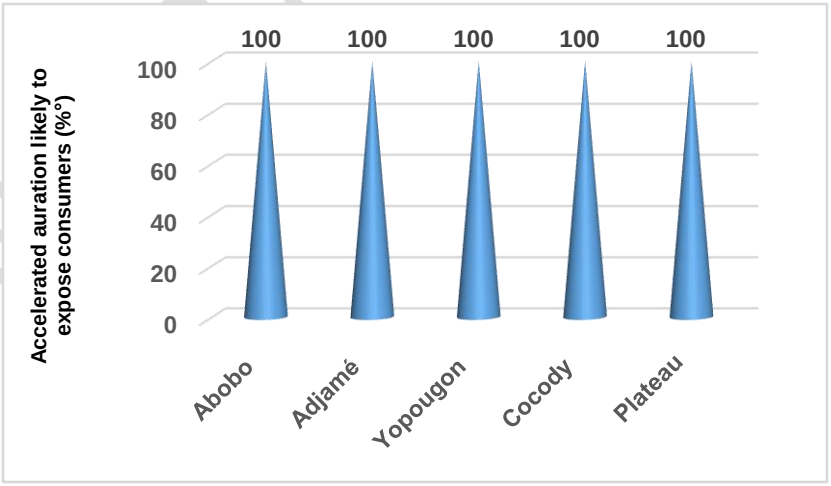


**Figure**9: Health risk of consumer exposure

### 3.1.9 Environmental exposure and degradation associated with accelerated mango ripening

In Table 5, we can see the details about how the environment affects the ripening of mangoes. The survey results indicate that 81.08% of people surveyed had no clear plan for handling chemical treatment residues. A significant 71.6% of traders disposed of these residues directly on market premises without attempting to safeguard the area from environmental

**Table 5: Risk of environmental degradation linked to the use of mango ripening products**

| Technique used | Abobo (%) | Adjamé (%) | Yopougon (%) | Cocody (%) | Plateau (%) | Total | Chi 2 | *P* |
|---|---|---|---|---|---|---|---|---|
| **Residue handling** | | | | | | | | |
| Yes | 17 | 12 | 19.7 | 24.3 | 21.6 | 18.92 | 3.030 | **0.553** |
| No | 83 | 88 | 80.3 | 75.7 | 78.4 | 81.08 | | |
| **Getting started** | | | | | | | | |
| Packing | 17.2 | 11.9 | 20 | 24.7 | 22 | 19.16 | 3.908 | **0.42** |
| No dragging | 82.8 | 88.1 | 80 | 75.3 | 78 | 80.84 | | |
| **Waste disposal** | | | | | | | | |
| Inside the market | 74.7 | 78 | 70.7 | 66 | 68.6 | 71.6 | 10.135 | **0.60** |
| In a waste bin | 00 | 0.0 | 9.6 | 18.3 | 15 | 8.58 | | |
| Getting closer to the market | 25.3 | 22.0 | 19.7 | 15.7 | 16.4 | 19.82 | | |



**Photo 3**:Carbide ($CaC_2$) crushing sites in the banco market

**Photo 4:** Pouring of calcium carbide on the ground in contact with water at the Abobo market

**Photo 5:** Open-air market rubbish bin at the Anono market

**Photo 6:**Carbide ($CaC_2$) paid into the Siporex market

## 3.1 Discussion

In all the markets surveyed, two (2) mango ripening accelerators were identified. Traders use calcium carbide and ethephon, commonly known as caba and cabadji. The use of these products in fruit ripening is not limited to Côte d'Ivoire, even though they are not registered. Other similar studies have reported the use of these products in Burkina Faso, Ghana, Cameroon, Nigeria, India, Bangladesh and Pakistan [9,10,11,12,13].

Their use is thought to be related to their low cost on the market compared to registered products. Traders use two (2) main methods: the wrapping or brooding technique and spraying. The technique used depended on the nature of the product. Caba is solid and cabadji liquid. Caba is used for incubation and cabadji is used for spraying. The weighed calcium carbide is wrapped in paper and packed in a container with the fruit. The calcium carbide at the bottom of the container comes into contact with the moisture in the ambient air and decomposes, producing acetylene, a gas similar to ethylene, which triggers the fruit ripening process[9,14,15].

When it comes to the health risks associated with the use of these ripening accelerators, retailers are largely unaware. They limit themselves to the effects felt (breathing problems, headaches, skin irritation and gastritis) directly on application. In fact, these products contain other impurities in the form of heavy metals (As, Pb, Sulphur) and other toxic gases (Arsine, Phosphine, and Vinyl) [16,17]. According to[18,19] these compounds present a.

They can cause cancer, metabolic disorders, stomach ulcers, and certain mental disorders. Most shopkeepers are illiterate and unaware of the health risks. They apply their products in the open without any protective measures. These products can expose not only the applicator but also consumers and local residents. Some of the compounds in these products are nonvolatile and are likely to end up in [16,20,21,22,23]. This is the case for arsenic and ethephon residues, which have been reported on both the peel and pulp of treated bananas.

In addition to the above, the marketing of artificially ripened mangoes is causing a real environmental problem. The results showed that 82% of respondents did not have a residue management plan in place following the use of these growth accelerators. These products could therefore end up in the air and water, exposing the population even more and seriously damaging all the components of the environment. Studies carried out in Mali (Koutiala) and Côte d'Ivoire (Grand-Lahou, Yamoussoukro, Abidjan) have revealed the pollution of well water by pesticides (malathion, deltamethrin) in agricultural areas [24,25].

## 4. CONCLUSION

The aim of this study was to list the products and techniques used for the ripening in Côte d'Ivoire. The study revealed a variety of products used for mango ripening, the main being

calcium carbide (caba) and almephon (cabadji). Caba is used for incubation and Cabadji for spraying.

## REFERENCES


1. Oguntade BK, Fatumbi TC. Effects of Three Ripening Methods on the Proximate and Mineral Composition of plantain fruits. European Journal of Engineering and Technology. 2019;7(4):1-5.

2. Mursalat M, Islam Md and Khan M. S. A review on the legislative aspect of artificial fruit ripening. Agric & Food Secur. 2016, 5 :8. DOI 10.1186/s40066-016-0057-5

3. FAOSTAT, Investir en Côte d'Ivoire, 2021, Consulté sur: http://www.afrikaforward.com/

4. Hala N, Kehe M, Allou K. Incidence de la cochenille farineuse du manguier Rastrococcus invadens Williams, 1986 (Homoptera; Pseudococcidae) en CÔTE D'IVOIR, Agronomie Africaine. 2004,16 (3): 29 -36.

5. Cissé M, Silue Y, Cissé M, Kouadio S, Nindjin C. Effect of Calcium Carbide Treatment on Ripening Time and Physicochemical Properties of Mango (Mangifera indica L.) Variety "Kent", Côte d'Ivoire. Current Journal of Applied Science and Technology. 2020, 39(38): 24-30. DOI: 10.9734/CJAST/2020/v39i3831092.

6. Okeke O, Aniobi CC, Akagha IC, Okoro MU, Nwosu D. Proximate, phytochemical and heavy metal levels of selected ripened fruits sold in market outlets within Enugu metropolis, Enugu State, Nigeria. Discovery, 2022, 58(320), 914-920

7. Gbakun SA, Ubwa TS, Ahilem UJ, Obochi OG, Nwannadi IA, Yusufu MI. Traitement au carbure de calcium sur certaines caractéristiques physicochimiques des fruits de mangue cassés et momifiés. Journal américain de la technologie alimentaire. 2018,13(1), 23-31.

8. Dibagha IJ, Ogoun TR. Évaluation de la toxicité des papayes mûries au carbure de calcium sur les paramètres hématologiques des rats Wistar. Sch Bull. 2022, 8(7): 212-216.

9. Bawa, MH, Eleke, Patience N, Abubakar, Fatim. Effect of Calcium Carbide on Concentration of Trace Elements in Fruits Grown Within Kaduna Metropolis. International Journal of Science and Engineering Applications. 2020, 9(01): 08-11, ISSN: -2319–7560

10. Premaseela HD, Perera MG, Hewajulige IG, Gunasekera MM, Madage SS, Weerasekara RA, Ganege, Don KK. Fruit ripening: importance of artificial fruit ripening in commercial agriculture and safe use of the technology for consumer health. Sri Lanka Journal of Food and Agriculture (SLJFA). 2020, 6(1): 57-66.

11. Markose B, Bhargavan R et Devassy BT. Chronic exposure of industrial grade calcium carbide and ethylene glycol exert genotoxic effect in Wistar albino rats. J Basic Clin Physiol Pharmacol. 2021,15(7): 1–7.

12. Abhishek RH, Venkatesh N, Manjunath K, Mohana D. C. artificial ripening of fruits misleading ripe and health risk Sci. 2016, 6:364–9.

13. Nura A, Dandag MA, Wali N. RNurasmat MS, Noor ZM, Nur FK, Faizuan A. Voltammetric technique for determination of arsenic residues in calcium carbide ripened climacteric fruits. Journal of Postharvest Technology. 2021, 25(2): 268 – 285

14. Paola L, Grosmaire L, Ricci J, Wisniewski C, Loukac N, Dahdouha L. Innovative non-destructive sorting technique for juicy stone fruits: textural properties of fresh mangos and purees. Food and Bioproducts Processing. 2020, 2 3: 188–198. https://doi.org/10.1016/j.fbp.2020.06.013

15. Ashraf-ur-rahman, Fazle R, Alam B. Artificial ripening: what we are eating. journal medicin 2008; 9(1): 42-44

16. Reena C, Sharma PC, Anil G. Method for detection and removal of arsenic residus in calcium carbide ripened mangoes. Journal of Food Processing and Preservation. 2017, 42(2): 9. DOI:10.1111/jfpp.13420

17. Orisa CA, Usoroh C. I. The Effect of Selected Ripening Agents on the Physico-Chemical Properties and Sulphide/Sulphate Distribution of Banana (Musa Sapientum) Fruit. Asian Research Journal of Agriculture. 2021,14(1): 10-17. DOI: 10.9734/ARJA/2021/v14i130114.

18. López F, Rodríguez-Bencomo JJ, Orriols I, Pérez-Correa JR. Fruit brandies. Science and Technology of Fruit Wine Production. 2017, 12(2): 10. http://dx.doi.org/10.1016/B978-0-12-800850-8.00010-7 531

19. Hayden MS, Ghosh S. Signaling to NF-kappaB. Genes Dev. 2004 Sep 15;18(18):2195-224. doi: 10.1101/gad.1228704. PMID: 15371334.

20. Siddiqui Md, Wasim, Dhua RS. “Eating Artificially Ripened Fruits Is Harmful.” Current Science. 2010, 99, no. 12: 1664–68. http://www.jstor.org/stable/24073490.

21. Aikpitanyi-Iduitua RO, Falodun A, Ebeigbe AB. Vascular effects of 3-carbomethoxypyridine on rabbit aortic smooth muscle. Journal of African Association of Physiological Sciences. July 2015 3 (1): 18-21. http://www.jaaps.aapsnet.org

22. Essien EB, Onyegeme-Okerenta BM, Onyema JO. Calcium Carbide as an Artificial Fruit-Ripening Agent and its Physiological Effects on Wistar Rats. Clinical and Experimental Medical Sciences. 2018, 6(1), 47 – 61. https://doi.org/10.12988/cems.2018.865

23. Thiam A, Sagna MB. Monitoring des pesticides au niveau des communautés à la base. Ed. Pan Africa. 57p. 2005. http://www.pan-afrique.org/fr/Rapports/Etudes/Rapport_Af_CBM_Fr.pdf; French

24. Traore SK, Kone M, Dembele A, Lafrance P, Mazellier P, Houenoup P. Contamination de l'eau souterraine par les pesticides en régions agricoles en Côte d'Ivoire, J. Afr. Sci. Environ. 2006, Vol. 1, 1-9.24.