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Diagnostic study of the harvest date of mangoes (*Mangifera indica* L.) produced in the Korhogo department, Northern Côte d'Ivoire

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Abstract

In Côte d'Ivoire, mango cultivation offers economic and nutritional advantages for production areas. However, yields are low and are affected by the harvest date, which impacts mango maturity and quality, making it difficult to improve the performance of the cultivation system. This study aims to contribute to improving the quality of harvested 'Kent' mangoes by determining the harvest date and its impact on their physicochemical characteristics. The study was conducted in 28 mango orchards distributed across three main areas: Korhogo-Diarra, Korhogo-Boundiali, and Korhogo-Ferkessédougou. In each area, seven villages were randomly selected. At the fruit level, quality was measured on a sample of 350 mangoes at each harvest. For each harvest date, morphological and physicochemical characterization was performed on the 350 fruits at harvest and after ripening at room temperature. The results showed that the harvest time for mangoes varied from 80 to 115 days after flowering (daf). The harvest date significantly influenced certain characteristics such as initial mass, mass loss, and soluble sugar content after ripening. In contrast, morphological dimensions (length, width, circumference) were not significantly affected. Mangoes harvested at 110 daf exhibited better physicochemical quality with rapid ripening and a high sugar content. In conclusion, the optimal harvest period is between 100 and 110 daf to guarantee optimal commercial quality while minimizing post-harvest losses.

Keywords: Mango; Harvest date; Physicochemical quality; Yield; Côte d'Ivoire

1. Introduction

In most African countries, agriculture is the main economic sector due to its contribution to wealth and job creation. It therefore represents the lifeblood of economic development. In Côte d'Ivoire, the agricultural sector accounts for approximately 22 % of the Gross Domestic Product (GDP), more than 50 % of export earnings, and two-thirds of the population's sources of employment and income [1]. Agriculture is based primarily on the cultivation of industrial crops, including cocoa, oil palm, coffee, rubber, cashew nuts, bananas, citrus fruits, and mangoes.

The mango tree (*Mangifera indica* L.) is one of the world's major fruit crops. It ranks sixth among global fruit production, with 56 million tons, after citrus fruits, bananas, watermelons, apples and grapes [2; 3]. In West Africa, mangoes offer

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numerous nutritional benefits and represent a vital source of income [4]. Mangoes play a significant role in the economic development of production areas. Côte d'Ivoire is one of the leading mango-producing countries in West Africa. National production is estimated at 150,000 tons and is concentrated in the northern part of the country. The country currently exports around 30,000 tons of mangoes per year, making it the leading West African exporter, followed by Mali and Senegal and the third largest supplier to the European market after Brazil and Peru [5]. This crop represents the country's second largest fruit export after bananas, contributing 4 % to the national Gross Domestic Product (GDP) and 10 % to the country's agricultural GDP [1].

Mango cultivation is practiced by approximately 7,000 producers, 98.5 % of whom are men and only 1.5 % women, on an area of nearly 20,000 hectares, distributed across the country's regions favorable to mango production [6]. Mango orchards are primarily concentrated in the northern and north-central parts of the country, particularly in the regions of Korhogo, Sinématiali, Ferkessédougou, Boundiali, Odienné and Bouaké. These areas are highly suitable for mango cultivation due to the favorable alternation between dry and wet seasons.

Each export season generates an average of nearly 7 billion CFA francs for Ivorian producers. The varieties involved include Kent, Keitt and Amélie. Kent variety is particularly valued for its organoleptic qualities and low water content, guaranteeing a longer shelf life [7].

Despite the significant role of the mango sector in the Ivorian economy, its performance is hampered by major problems such as production losses due to fruit flies, and a lack of knowledge or even the absence of reliable tools for estimating orchard yield and the fruit's physiological maturity for harvesting.

Mangoes harvested too early, with an insufficient time between flowering and harvest, do not reach full ripeness with a suitable flavor, even with ethylene treatment. Conversely, fruit harvested late, with a longer flowering-to-harvest period, has a shorter shelf life and is more susceptible to diseases and pests [8; 9; 10]. Therefore, mastering the optimal harvest period is essential to guarantee high-quality mangoes, both in terms of taste and health, and to strengthen the competitiveness of the sector in national and international markets [11]. According to [12], the harvest date directly influences the size, weight, firmness and sugar content of the fruit.

Numerous studies have shown that, for the Kent variety, the recommended harvest date is 100 days after flowering [13; 14]. According to these authors, this period allows for the best physicochemical and organoleptic characteristics of the mangoes. The objective of this study is to contribute to improving the quality of harvested mangoes. Specifically, it aimed to: (i) determine the harvest date for Kent mangoes and (ii) evaluate the morphophysical, physiological, and biochemical characteristics of mangoes produced in the Korhogo department.

2. Materials and methods

2.1. Study area

The study was conducted in Korhogo department. The Korhogo Department is located in northern Côte d'Ivoire, between latitudes 9°20’ and 9°50’ North and longitudes 5°10’ and 5°40’ West (Figure 1). It is part of Poro Region, within the Savanes District of which it is the capital. The department is bordered by the departments of M'bengué to the north, Sinématiali to the south, Dikodougou to the east and Boundiali to the west.

The Korhogo department is subject to a tropical Sudano-Guinean climate, marked by the alternation of two main seasons: a dry season, from October to March, during which the harmattan, a hot and dry wind, blows, particularly felt in December and January, and a rainy season, from April to September, characterized by more abundant rainfall in June and September [15]. The average annual rainfall is between 1000 and 1200 mm [16].

The dominant vegetation in Korhogo area consists of grassy and wooded savanna, adapted to long periods of drought and seasonal rainfall.

The soils of Korhogo region are predominantly tropical ferruginous, with a sandy-clay texture and a relatively low organic matter content. Their composition, rich in iron and aluminum, can sometimes lead to moderate acidity, requiring organic or mineral amendments to maintain adequate fertility [17].

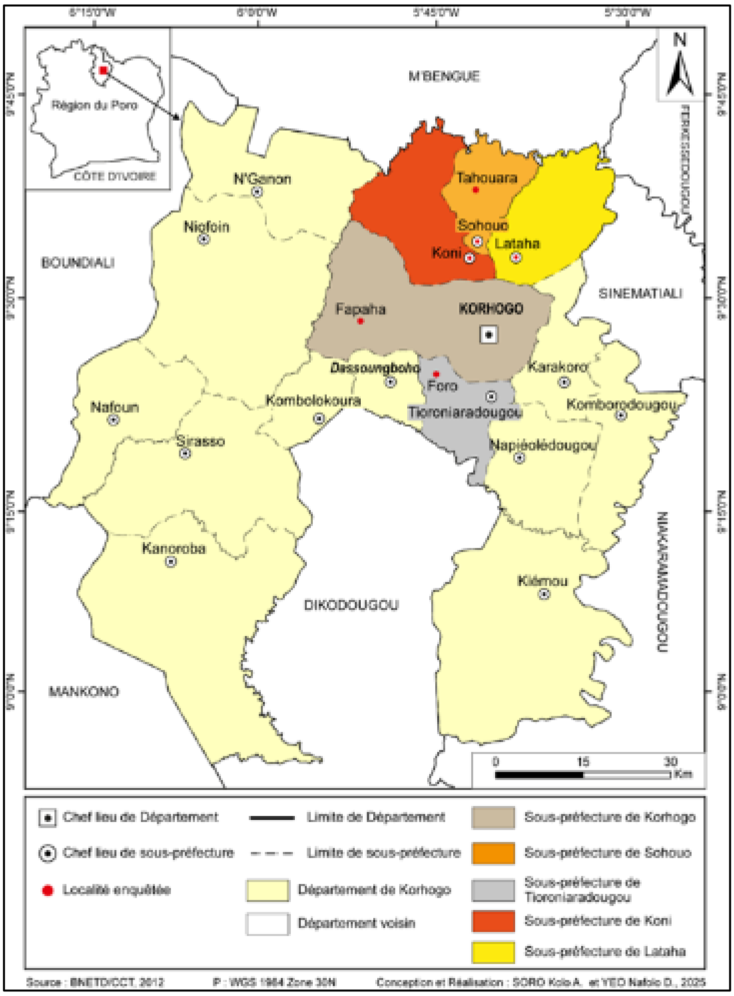

Figure 1 Location map of the Korhogo department

3. Material

3.1. Plant material

For this study, only one variety of mango (*Mangifera indica* L.) was chosen as plant material: the 'Kent' variety. This variety, highly prized for export and local consumption, is distinguished by its vibrant color, long shelf life, and remarkable nutritional and organoleptic qualities. Mango orchards in production were selected for data collection.

3.2. Technical equipment

The technical equipment consisted primarily of:

- Spray paint, for marking the trunks of the mango trees;
- Precision scales, for weighing the fruit;
- Containers, for collecting the mangoes;
- Measuring tape, for measuring the length, width, and diameter of the mangoes;
- Calipers, for measuring the fruit's dimensions (length, width);
- Color chart, for evaluating the skin color of the kent mango;
- Benchtop refractometer, for determining the sugar content of the mango pulp;
- Digital camera, for photographing the fruit in the field and in the laboratory.

3.3. Methods

3.3.1. Experimental design

The study was conducted in three major mango-producing areas of the Korhogo department. Specifically, these were the Korhogo-Diarra, Korhogo-Boundiali, and Korhogo-Ferkessédougou areas. In each of these areas, seven mango orchards in full production and in good health were selected from seven randomly chosen villages, one orchard per village. The area of each orchard ranged from 5 to 10 hectares. In total, 28 orchards were selected for this study.

In each selected orchard, 25 mango trees were chosen along the four cardinal directions, and also, in the center of the orchard, four mango trees were chosen in each direction. On each mango tree, three ~~(3)~~ well-developed inflorescences without visible damage were randomly selected from each of the five ~~(5)~~ sides (north, south, east, west, and top), for a total of 15 inflorescences per tree. Observations were made on 75 inflorescences per selected plot. In each of the study areas (Korhogo-Diarra, Korhogo-Boundiali, and Korhogo-Ferkessédougou), 375 inflorescences were used for the study. These inflorescences were labeled, and the date of appearance of the terminal flower was recorded. The development of these inflorescences was monitored until the mangoes ripened.

The harvest dates of the mangoes were defined and recorded during the study. Mangoes produced by the selected inflorescences were collected for observation, and measurements were taken in the laboratory. To create a sample for each harvest date, four ~~(4)~~ mangoes were harvested from each side of a studied mango tree, resulting in two ~~(2)~~ mangoes per side. For each plot in the study, 10 mangoes were harvested per date from each tree, yielding 50 mangoes per plot, for a total of 350 mangoes per location, to constitute a sample for each of the two studies (morphological observation and laboratory analysis). The mangoes were harvested manually using poles equipped with knives, at a state of physiological maturity, without fruit falling.

The harvest dates of the mangoes were defined and recorded during the study. Mangoes produced by selected inflorescences were collected for observation, and measurements were performed in the laboratory. A sample of 350 mangoes per location was collected. The mangoes were harvested manually using poles equipped with knives, at physiological maturity, without fruit falling.

The collected mangoes were used to create two batches of fruit. On the first batch (350 mangoes per location), morphophysical and chemical measurements and observations were performed at harvest time. The second batch (350 mangoes per location) was kept in a well-ventilated room at ambient temperature until morphological ripening. Morphophysical and chemical measurements and visual observations were also performed on the fruit of this second batch.

3.4. Parameters measured

3.4.1. Time frame for harvesting mangoes from flowering

To determine the time between the start of flowering and harvesting mangoes, the dates of floral initiation and harvest were recorded. Thus, for each harvest of mangoes from selected inflorescences, both dates (floral initiation and harvest) were noted. On each date, 20 mangoes were harvested per chosen tree, to create a sample of 10 mangoes. The number of days between flowering and harvest was then calculated. The result is expressed in days after flowering (daf).

3.4.2. Dimensions or measurements of mangoes

The length, width, and circumference of the harvested mangoes were measured to assess their morphology. Measurements of length, width and circumference were taken from 350 mangoes per area using calipers and a tape measure at harvest.

3.4.3. Appearance of mango skin

The wrinkled or smooth appearance of the mango skin was noted by observation at the end of ripening. This observation was made on a sample of 350 mangoes, harvested on each date and stored for ripening.

3.4.4. Density of mangoes

The flotation test was used on each mango to assess its density. For this study, a sample of 175 mangoes per plot was used to determine density. This test consisted of immersing each mango in a container of water and noting whether it floated or sank. Following this test, the flotation rate of the mangoes from each harvest was calculated.

3.4.5. Mass loss rate

The mass of each mango was determined at harvest and after ripening using a scale. The mass loss rate was calculated according to the following formula:

$$Ml = \left(\frac{mi-mf}{mf} \right) \times 100$$

With:
Ml = Mass loss
mi = Mass of the mango at harvest before ripening
mf = Mass of the mango after ripening

3.4.6. Measurements of organoleptic parameters

Ripening time was determined for each batch of mangoes, stored at room temperature, from the day of harvest until the mangoes changed color from yellow to orange-yellow and the pulp softened. This study included 350 mangoes per plot and per fruit harvest date. The average ripening time for each batch of harvested mangoes was calculated from the ripening time of the first to the last ripe mango.

3.5. Chemical measurements of mangoes

The soluble sugar content was determined, using a benchtop refractometer, at harvest (Brix 1) and at ripening (Brix 2).

The mangoes were cut lengthwise with a knife, and the pulp was scraped to obtain a representative paste containing all the pulp. The juice from the pulp was extracted using a white cloth. Three drops of the juice were placed on the refractometer prism. After 30 seconds, the soluble sugar concentration of the sample was read on the scale. The soluble sugar concentration is expressed in Brix. Three measurements were taken for each sample.

3.6. Data processing

In this study, statistical methods were used to analyze the collected data. Descriptive statistics (means, standard deviations) were used to summarize the characteristics of the mangoes. An analysis of variance (ANOVA) was used to compare the effects of harvest dates, followed by Student-Newman-Keuls (SNK) test to identify significant differences. Graphical representations were created to visually illustrate the results.

4. Results

4.1. Mango harvest time

The harvest time for mangoes, expressed in days after flowering (daf), was determined in the three surveyed areas (Table 1). The results showed that in the Korhogo-Diarra area, mangoes were harvested 98 to 100 daf. In the Korhogo-Boundiali area, harvest times ranged from 80 to 105 daf. In contrast, in the Korhogo-Ferkessédougou area, harvest times ranged from 89 to 115 daf.

4.2. Morphological parameters of mangoes

During the study, the length, width and circumference of the mangoes were evaluated as morphological parameters (Table 2). Analysis of variance revealed no significant difference ($P > 0.05$) between the means obtained for all the morphological parameters measured at the different harvest times, namely length, width and circumference. Thus, the circumference of the mangoes varied between 19.65 cm (94 days after flowering) and 29.50 cm (100 and 110 daf) depending on the harvest date. As for the length of the mangoes, it ranged from 12.50 cm (105 daf) to 16.60 cm (100 and 110 daf). The widths of the harvested mangoes varied from 9.80 cm at 94 daf to 14.75 cm at 100 and 110 daf.

Regarding the visual appearance of the mangoes, the results showed that the percentage of wrinkled mangoes was a function of the harvest time. These values varied from 100% to 0% wrinkled mangoes. Thus, at 80 daf, 100 % of the harvested mangoes were wrinkled during the ripening period, while from 96 to 110 daf, no mangoes were wrinkled during ripening (Figure 1).

Table 1 Mango harvest time

Area surveyed	**Mango harvest time (daf)**					
Korhogo-Diarra	98	100				
Korhogo-Boundiali	80	85	95	105		
Korhogo-Ferkessédougou	89	94	96	100	110	115

Table 2 Morphological characteristics of mangoes

Harvest time (daf)	**80**	**85**	**89**	**94**	**96**	**98**	**100**	**105**	**110**	**115**	**P-value**
Cir	23.87 ±5.06a	25.73 ±3.53a	26.40 ±4.84a	19.65 ±4.47a	23.55 ±3.46a	22.70 ±4.53a	29.50 ±3.12a	21.82 ±3.22a	29.50 ±4.53a	25.17 ±0.42a	0.22
Length	14.13 ±2.38a	13.88 ±2.71a	14.86 ±2.84a	12.98 ±2.57a	14.40 ±4.81a	12.75 ±2.05a	16.60 ±2.60a	12.50 ±1.43a	16.60 ±0.49a	4.67 ±2.63a	0.20
Width	11.56 ±2.72a	12.86 ±1.75a	12.96 ±2.85a	9.80 ±2.25a	11.78 ±1.73a	11.35 ±2.26a	14.75 ±1.56a	10.82 ±1.71a	14.75 ±2.26a	12.58 ±0.21a	0.23

On each line, values followed by the same letters do not differ significantly from each other at the 5% level according to the Strudent-Newmen-Keuls test. Length: mango length, Width: mango width, Cir: mango circumference

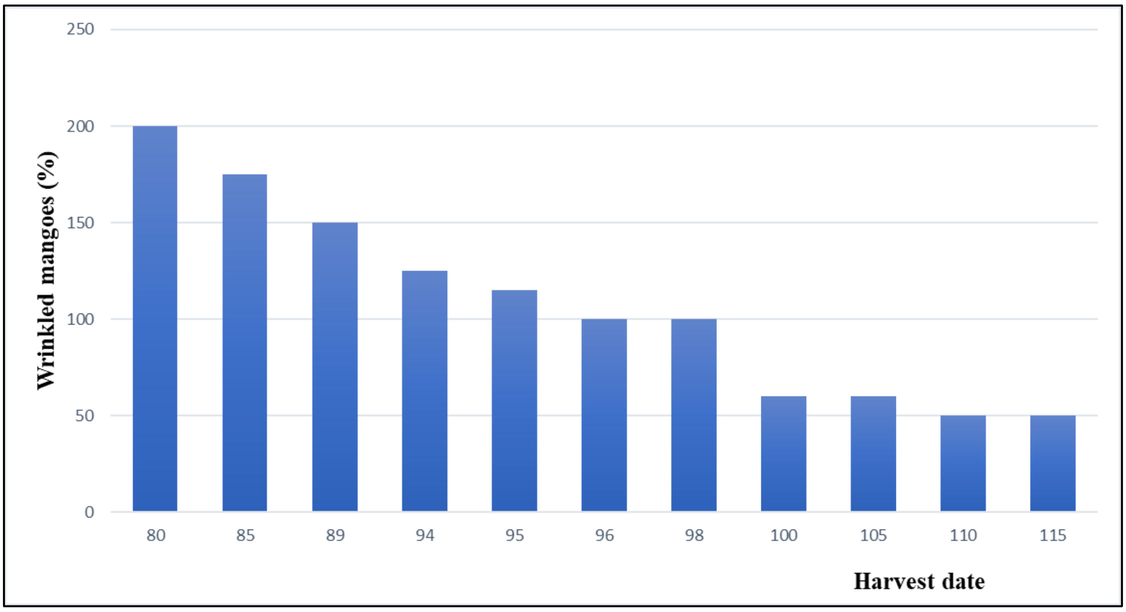

Figure 1 Proportion of wrinkled mangoes according to harvest date

4.3. Physical Parameters of Mangoes

The density, mass, and mass loss of mangoes were studied as physical parameters according to different harvest dates.

Regarding density, the proportion of mangoes floating after immersion increased with harvest delays (Figure 2). At 80 days after flowering (daf), 0 % of the harvested mangoes floated, while from 100 daf onward, the value reached 100 % after immersion in water. However, at 115 daf, the proportion of harvested mangoes floating after immersion was 80 %.

Regarding mass at harvest and at ripeness, the analysis of variance showed significant differences between the means obtained for these parameters measured according to harvest time (Table 3).

Regarding the initial fruit mass, the highest value was obtained during the harvest at 115 daf. The harvested mangoes yielded average masses of 583.33 ± 125.83 g per fruit. The mangoes harvested at 80 daf, with average harvest masses of 451 ± 83.99 g, recorded the lowest values.

As for the masses measured at fruit ripening, at 320 ± 28.28 g, the mangoes harvested at 98 daf yielded the lowest masses, compared to those harvested at 115 daf, which had the highest masses of 463.33 ± 63.51 g.

Concerning mass losses, the values ranged from 200 g at 80 daf to 50 g at 100 and 115 daf (Figure 3). These losses amounted to 125 g for mangoes harvested at 94 daf and 100 g for those harvested at 96 and 98 daf. The loss of mango mass after harvest decreases as the harvest date increases.

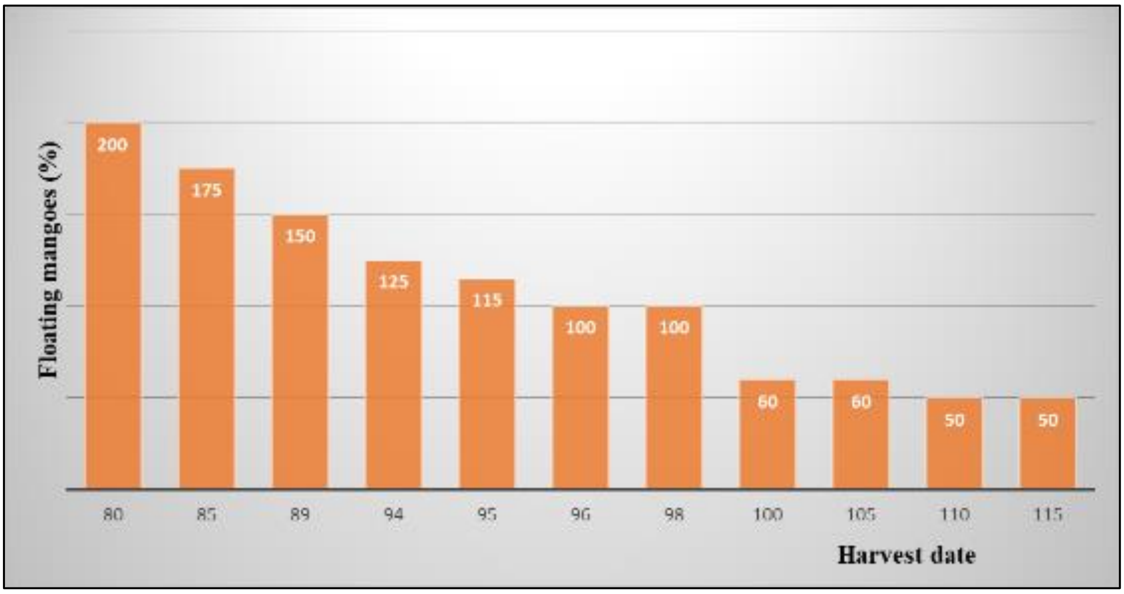

Figure 2 Proportion of floating mangoes according to harvest date

Table 3 Mass of mangoes according to harvest time

Harvest time (daf)	80	85	89	94	96	98	100	105	110	115	P-value
mh (g)	451.00 ±83.99a	501.67 ±109.98b	498.89 ±152.27c	517.50 ±71.36d	525.00 ±176.78e	450.00 ±70.71f	433.33 ±57.74g	422.00 ±94.97h	433.33 ±70.71i	583.33 ±125.83j	0.02
mr (g)	347.00 ±105.31a	351.67 ±64.94b	387.78 ±98.33c	337.50 ±75.00d	325.00 ±106.07e	320.00 ±28.28f	373.33 ±40.41g	324.00 ±84.44h	373.33 ±42.43i	463.33 ±63.51j	0.03

On each line, values followed by the same letters do not differ significantly from each other at the 5% level according to the Strudent-Newmen-Keuls test; mh: mass at harvest; mr: mass at ripening

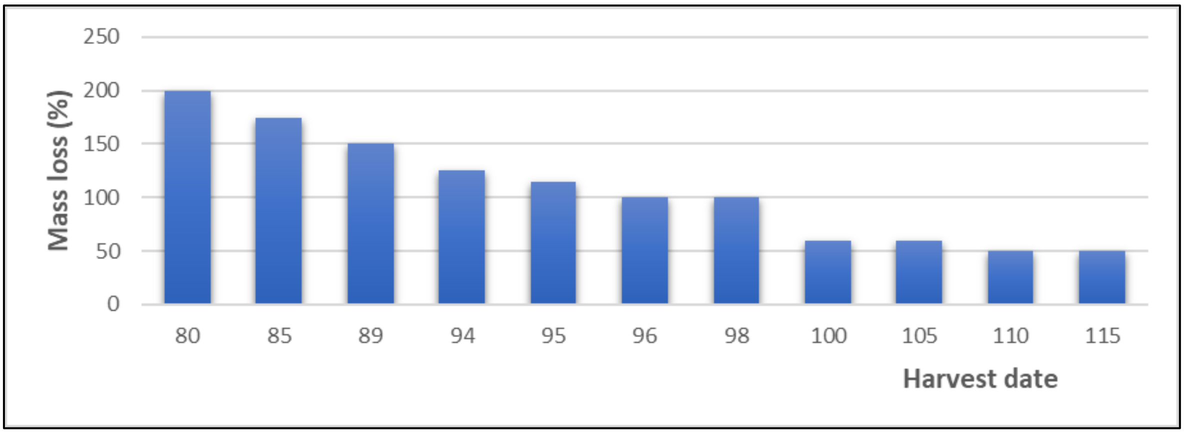

Figure 3 Curve showing the evolution of mass loss as a function of harvest time

4.4. Ripening time of harvested mangoes

During the study, the time taken by mangoes to reach morphological ripeness was evaluated (Figure 4). The results showed that mango ripening times varied according to harvest dates. Analysis of variance revealed significant differences (P = 0.006) between the means obtained with the different harvest dates. The longest ripening times were recorded with harvest dates of 80 and 85 daf, with respective means of 12 and 9 daf. The shortest ripening times were obtained with harvest dates of 105, 110 and 115 daf, yielding respective means of 3.2, 3, and 2.6 daf.

4.5. Soluble sugar content of mangoes

The soluble sugar content of mangoes was determined at harvest (Brix 1) and at the ripening stage (Brix 2) in this study (Table 4).

Analysis of variance revealed no significant difference between the mean soluble sugar content obtained at the different harvest dates for Brix 1 (at harvest). These sugar contents ranged from 7.53 % (80 daf) to 8.02 % (115 daf). These contents were, on average, very low.

Regarding sugar content, or Brix 2, recorded at the ripening stage of the mangoes, the analysis of variance revealed significant differences between the means obtained at different harvest dates. The results led to the formation of four groups using the Student-Newman-Keuls (SNK) test. The first group, with the lowest sugar content, consisted of the means recorded at 80, 85, and 89 daf, with respective values of 14.66 %, 15%, and 15.33 %. The fourth group, with the highest sugar content, comprised the means from mangoes harvested at 105 daf (10.77%), 110 daf (19.86 %) and 115 daf (19.91 %). The soluble sugar content of mangoes varied depending on the stage of harvest.

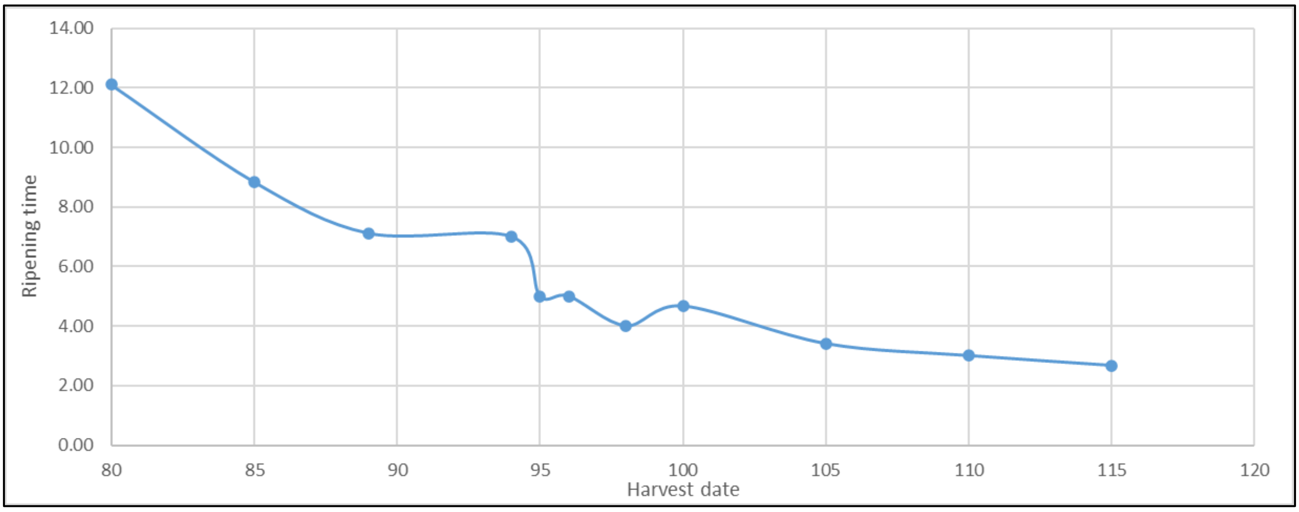

Figure 4 Curve showing the evolution of ripening time as a function of mango harvest dates

Table 4 Soluble sugar (Brix) content of mangoes according to harvest dates

Harvest time (daf)	**80**	**85**	**89**	**94**	**95**	**96**	**98**	**100**	**105**	**110**	**115**	**P-value**
Brix 1 (%)	7.53 ±0.41a	7.66 ±0.29a	7.7 ±0.1a	7.8 ±0.26a	7.5 ±0.5a	7.66 ±0.29a	7.7 ±0.26a	7.83 ±0.76a	7.85 ±0.73a	8 ±0.50a	8.02 ±0.50a	0.182
Brix 2 (%)	14.66 ±2.51a	15 ±2a	15.33 ±2.51a	16.3 ±2.17b	16.5 ±2.17b	17.66 ± 1.5c	17.85 ± 3.53c	18.7 ±0.51e	19.77 ± 0.39f	19.86 ± 0.4f	19.91 ± 0.5f	0.001

5. Discussion

This study focused on determining the harvest date of mangoes and highlighting the influence of the harvest date on several physical, morphological and chemical characteristics of mangoes grown in the Korhogo department.

The results showed that the mango harvest time in the Korhogo department varies from 80 to 115 days after flowering (daf). However, several studies have revealed that the recommended harvest time is between 94 and 100 daf [13; 14]. Consequently, this recommended period does not always appear to be respected in the Korhogo-Boundiali and Korhogo-Ferkessédougou areas. This is probably due to the fact that, in these areas, market traders sell the mangoes on the local or national market. They are therefore not bound by the requirements of the international market. They set the harvest date according to local or national market demand. For financial reasons, the field owner has no choice but to accept the trader's terms. In contrast, in the Korhogo-Diarra area, the harvest time is respected. This would be due to the fact that in this area mangoes are bought in the field by exporters who pick them in compliance with international market conditions.

Analysis of variance revealed statistically significant differences in the mass of the harvested fruit. Indeed, the initial and final masses of the mangoes increased progressively with the harvest dates. Fruits harvested 115 days after flowering (daf) had an average initial mass of 583.33 g, compared to 451 g at 80 daf. This variability indicates that the mangoes did not have the same level of maturity and growth at harvest. The longer the fruit remains on the tree, the more assimilates it accumulates until a certain stage of enlargement and physiological maturity. These results could be explained by the consequences of competition between fruits for assimilates such as carbon and nitrogen [18].

These results corroborate those of [19], who showed that mango mass increases as the fruit progressively fills until full physiological maturity. [13] also observed a similar trend in the Kent variety in Côte d'Ivoire, highlighting the importance of controlling harvest stages to optimize fruit size. Indeed, fruit volume and mass increase with the amount of available assimilates. Consequently, the final mass and composition of the fruit depend on the availability of carbon and nitrogen, which in turn depend on the photosynthetic activity of the leaves, their number, and especially the fruit load, which leads to competition among the fruits for assimilates [20; 21].

In contrast, the morphological parameters (length, width, and circumference of the mangoes) did not show significant differences according to harvest dates. This stability suggests that these parameters are primarily genetic, as demonstrated by the results of Drouillard et *al*. [22]. These authors showed that fruit shape is no longer influenced by external conditions once the optimal growth phase is reached and physiological maturity has begun. The evolution of fruit length, width, and circumference occurs in the early stages of growth. These results would explain why the mango size does not change significantly in the later stages of growth.

The flotation test and visual assessment of the mangoes revealed that the fruit's morphological maturity directly influences its density and skin texture. The results showed that at 80 days after flowering (daf), 100% of the harvested mangoes were wrinkled and floated, while at 96 and 110 daf no mangoes wrinkled during the ripening process. These observations are consistent with those of [23], who considered the flotation capacity of mangoes to be an important indicator of relative density and, therefore, of the evolution of the fruit's internal components. The flotation characteristics and wrinkled appearance of the fruit are due to tissue softening resulting from water loss during ripening. Water content therefore influences fruit preservation. Indeed, a high-water content is the reason for the perishability of mangoes [24], as it promotes microbial, enzymatic, and chemical activity. This activity is responsible for post-harvest losses and the degradation of the mangoes' commercial quality. Fruit firmness is linked to the evolution of the mangoes' physiological maturity. Mangoes with a ripeness level of 100 days after flowering or higher have the firmest tissues, allowing them to float after immersion in water. The flotation test, therefore, appears to be one of the characteristics of physiological maturity in mangoes.

Regarding ripening time, the results showed a highly significant effect of the harvest date. Mangoes harvested at 80 days after flowering took an average of 12.1 days to ripen, compared to only 3 days for those harvested at 110 days after flowering or higher. The differences in ripening times between fruits could be due to the relatively large difference in their level of physiological maturity at harvest.

These data confirm that fruits harvested later had reached greater physiological maturity, which accelerated their post-harvest processing [13]. This dynamic is all the more important to consider as it influences the planning of the distribution chain and the quality of fruit for consumption.

The loss of mass during ripening is also affected by the harvest date. Fruits harvested early suffer greater losses, up to 200 g for mangoes harvested at 96 days after flowering. The significant loss of mass and the high proportion of mangoes with wrinkled skin observed in mangoes harvested at 90 and 95 days after flowering could be the logical effect of prolonged storage due to late ripening and physiological immaturity of the mangoes at harvest. According to [25] and [26], the loss of mass of fruits during storage is a consequence of the loss of food reserves stored in the fruit during respiration and an acceleration of senescence when the reserves that provide the energy needed to maintain the living state of the fruit are exhausted. Also, less mature mangoes have fewer reserve substances and are therefore much more susceptible to higher rates of transpiration and water loss during storage. Furthermore, [8] and [27] observed that mangoes with insufficient physiological maturity at harvest will develop partially or completely whitish pulp during ripening and will certainly lack good organoleptic qualities and have lower vitamin content.

Chemical analysis revealed a significant variation in sugar content (Brix 2) after ripening, with values ranging from 14.66% at 80 days after flowering to 19.91% at 115 days after flowering. The Brix level increased and even doubled for the same harvest dates, with the highest levels observed at later harvest dates. This result suggests a low production of soluble sugars from the starch stored in the mango before harvest, regardless of its ripeness level. The sugar content after ripening is higher when mangoes are harvested late, even though the ripening period after harvest is shorter. The measured sugar content appears to increase proportionally with the length of the interval between flowering and harvest.

Sugar content depends on the degree of ripeness of the mangoes and the storage time. This sugar content was higher in late-harvested mangoes compared to early-harvested ones. Indeed, according to [24], the total sugar content, around 5% in young fruits, increases to an average of 13%, then stabilizes at around 17% in fully mature mangoes. The results show that mango sugar content is linked to the harvest date. Harvest dates are perfectly correlated with the stages of maturity.

According to [27] and [28], fruits harvested a few days later between flowering and harvest are richer in soluble sugars, dry matter, and starch than those harvested earlier, as is the case in this study. These authors indicated that the harvest of mangoes intended for export must be determined based on the type of market, the distance from the orchard or packing center, and the type of transport to be used. Mangoes must be harvested at the ideal time to allow for the development of their optimal organoleptic and nutritional qualities and the longest possible post-harvest shelf life. However, excessively high sugar levels present a risk of degradation by yeasts if stored improperly [11]. Hence the need to find a suitable interval of days between flowering and harvest that guarantees better preservation of the mango during ripening.

Overall, these results showed that the harvest date strongly influences the overall quality of mangoes, both in terms of weight and sensory characteristics. Harvesting too early prolongs ripening time, increases weight loss, and limits sugar content, while harvesting too late can lead to excessive softening or a degraded visual appearance. The optimal harvest window appears to be around 100 to 110 days after flowering, a period at which the fruit reaches a good size, a high sugar content, and sufficient maturity to reduce post-harvest losses while maintaining good commercial quality.

6. Conclusion

This study, conducted in the Korhogo department, aims to determine the harvest date of mangoes and analyze its impact on mango quality, particularly for those intended for export. Through observations carried out in different production areas (Korhogo-Diarra, Korhogo-Boundiali, Korhogo-Ferkessédougou), the survey highlighted the various mango harvest dates and the significant variations in the morphological, physiological, and chemical characteristics of the mangoes according to these harvest dates.

The results showed that fruit mass, sugar content (Brix), mass loss during ripening, and ripening time are strongly influenced by the harvest date. Harvesting too early results in less sweet, lighter fruit, requiring a longer ripening time and leading to greater post-harvest losses. Conversely, harvesting too late can compromise the visual appearance of the mangoes and their shelf life. It therefore appears that the optimal harvest period is between 100 and 110 days after flowering to obtain balanced mangoes with high commercial and nutritional value.

This study has therefore highlighted the importance of a well-planned harvest, based on rigorous phrenological monitoring and appropriate maturity indicators. It also underscores the need to train producers in these practices and to support local initiatives in post-harvest management. By improving knowledge of these parameters, the mango sector in Côte d'Ivoire, and particularly in Korhogo region, will be able to increase its competitiveness and effectively meet the demands of national and international markets.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare no conflict of interest.

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