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Comparative Study of Producer's Post-Harvest Practices and Quality of Cashew Nuts (*Anacardium occidentale* L.) Produced in Five Localities of Sub-prefecture of Katogo, Far North of Côte d'Ivoire

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Post-harvest practices of cashew nuts by producers are essential for improving the quality of cashew nuts. This study was carried out to contribute to improving the quality of cashew nuts produced in 5 localities in the Katogo sub-prefecture. Socilogical survey and post-harvest practices were carried out among producers in Sologneugo, Kaniéné, Koliani, Nidienkaha and Tiorotieri in order to evaluate these practices on the quality of cashew nuts. Quality parameters of the cashew nuts produced were determined according to the quality criteria defined by the Ivorian standard. Study revealed non-compliance with certain CCA (cotton council cashew) instructions. In the 5 localities, 44% of producers stored nuts in homes compared to 56% in stores. In addition, 30% of floor storage was achieved compared to 52% on boards and 18% on bricks. Drying carried out for 3 days was carried out by 55% of producers while those who carried out beyond 3 days represented 45%. Determination of the quality parameters of the 5 localities revealed values varying from 7 to 8.55%; 65 to 143 nuts/Kg; 3 to 61% and 48.40 to 49.80 Ib respectively for humidity, graining, defect rate and KOR. Non-compliance with the application of post-harvest operations has negatively impacted the quality of cashew nuts produced in the 5 localities. Producers in these localities must be made aware of respecting post-harvest operations in order to improve their income.

Keywords: Katogo; cashew nuts; post-harvest treatments; survey; quality.

1. INTRODUCTION

Cashew tree is a fruit tree whose cultivation contributes to the socio-economic development of several countries around the world [1]. West Africa is the main production area with 49% of global cashew production [2]. Since 2015, Ivory Coast has become the world's leading producer and exporter of cashew nuts with more than 700 thousand tonnes, ahead of India, Vietnam and Brazil [3].

This production has increased over the last six years, going from 702,000 tons in 2015 to more than 900,000 tons in 2021, making Côte d'Ivoire the world's leading producer and exporter of cashew nuts [4,5]. Today, cashew is the most dynamic crop in the Central and Northern regions, surpassing the traditional export crop of cotton in terms of production volumes and export earnings [6]. Cashew nut exports generated more than $961 million in 2021 [7].

Despite these positive results, producers face a quality issue with raw cashew nuts that affects their market price. This decline in quality and low yield is attributed to the immaturity of the nuts, which is associated with nutritional deficiency [8]. In 2022, the marketing of the product of Ivorian origin saw a decline (20 to 25%) on the cashew market due to the poor quality of cashew nuts and especially poor post-harvest practices such as short drying time, unsuitable drying medium as well as storage conditions [9]. Of a significant number of trucks arriving at the port, many were turned away due to the quality of the nuts below 44 lb [10]. Actors rely on the external appearance of the nut to set the price. This practice is very uncertain, because the real barometer for setting cashew nut prices is the Kernel output ratio KOR [11].

Faced with this, it is up to Côte d'Ivoire to produce good quality nuts, a determining factor in their purchase and sale price [12]. Controlling the quality of cashew nuts is essential for producers to obtain good quality nuts which would depend on post-harvest treatments in particular drying, storage and packaging before their export or processing [13,14] Also, it is essential to know the post-harvest operations carried out by producers to contribute effectively to improving the quality of this product.

Thus the objective of this study is to contribute to improving the quality of cashew nuts produced in the sub-prefecture of Katogo after a sociological survey.

2. MATERIALS AND METHODS

2.1 Materials

Biological material used in this survey consisted of cashew nuts collected from March to May

2024, from producers in five localities in the Katogo sub-prefecture: Solognougo, Kaniene, Koliani, Nidienkaha and Tiorotieri. The target population was producers in 5 localities.

2.2 Methods

2.2.1 Sampling of cashew nut producers and survey

Random survey was carried out in 5 localities in the Katogo sub-prefecture. These localities were selected on the basis of stakeholder availability and local accessibility. In these different localities, 50 producers (10 producers/locality) with plantations in production were met randomly, taking into account their willingness to be interviewed.

Survey consisted in submitting to the selected producers a questionnaire consisting of closed and open questions. Closed questions allow for concise and precise answers. As for open questions, they were used to gather broader opinions. Questionnaire focused on the sociological profile of producers (gender, age of producers, age of orchards and mode of acquisition) and post-harvest practices of cashew nuts (drying media, drying time and storage mode).

2.2.2 Cashew nut sampling

Sampling consisted in taking 0.75 kg of cashew nuts from three different batches of bags from each producer. Cashew nuts collected from producers in the same locality were mixed to make up the local sample (7.50 kg). Thus, analyzes were carried out on 4 samples, that is, one sample per locality.

2.2.3 Nut quality analysis

2.2.3.1 Determination of moisture content

Moisture content of cashew nuts was determined using the humimeter FSG. It consisted in filling the humidity meter with a volume of 2 L of cashew nuts and the humidity value displayed was read.

2.2.3.2 Determination of graining content

Graining and the level of foreign matter in the cashew nuts were determined following the method described by [15]**.** 1 Kg of sample (P) was weighed and the cashew nuts were placed in small piles of ten. The number of lots of ten and the extra nuts were counted. Foreign matter present (wood debris, leaves, sand) in the weighed sample was removed and then weighed.

To restore the initial weight (1 Kg) of the sample, the weight of foreign matter was compensated by other nuts before the final count. Graining was calculated using the following formulas:

$$\text{Graining} = N/P$$

N: number of cashew nuts counted; P: sample weight

2.2.3.3 Determination of defect rate and kernel output ratio

Defect rate and Kernel Output Ratio (KOR) of cashew nuts were determined gravimetrically according to the method described by [16]. 1 Kg of sample cashew nuts (P1) were delicately cut into two halves lengthwise using a hornbill beak. Good-quality nuts (white, healthy kernels with no visible defects) that can be used in full (100%) are placed on a green plate. Then, the partially usable (50%) immature nuts (crumpled kernels) and pitted nuts (black spot on the kernel) are grouped together in a blue plate. Finally, the buttered, moth-eaten, stunted, moldy and empty nuts rejected (100%) are placed on a red plate.

Healthy kernels of the nuts contained in the green plate were separated from their shells using a needle or point. Kernels obtained were weighed (P2). Nuts contained in the blue plate were weighed (P3) then the kernels were removed from the shells and weighed (P4). Finally the nuts contained in the red plate were weighed (P5). The defect rate was calculated using the following formula:

$$\text{Defect rate (\%)} = (P3 + P5)/P1 \times 100$$

P1: the total weight of the sample; P3: the weight of nuts rejected at 50%; P5: the weight of nuts rejected at 100%.

Kernel yield (%) was calculated by the formula below:

$$\text{Ra (kernel yield)} = ((P2 + P4/2)/ P1) \times 100$$

KOR (in lbs) was calculated using the following formula:

$$\text{KOR (lb)} = (Ra/100) \times 80 \times (1/0.45359)$$

P2: weight of healthy kernels; P4: weight of 50% rejected kernels; 1/0.45359: coefficient for converting Kg to lb.

2.2.4 Statistical analysis

Quality parameters are expressed as mean ± standard deviation. Analysis of variations were carried out to verify the existence of significant differences between the means. This was followed by Tukey's HSD test to classify the means. The chi-square test ($\chi 2$) was then applied to assess the significance of the difference between the calculated proportions. All statistical tests were carried out using XLSTAT 2014 software, and statistical significance was set at $p < 0.05$.

3. RESULTS AND DISCUSSION

3.1 Survey

Fig. 1 presents the representation of producers by gender and age. In the 5 localities, the producers are mainly men. Localities of Kaliani (90%) and Tiorotieri (90%) come first, followed by the localities of Solognego (80%), Nidienkaha (80%) and Kaniene (70%) which records more women (30%). These results are in agreement with those of [17] in Cameroon which recorded a rate of 98.04% men. This low rate of women in cashew cultivation would be due to the fact that agricultural land generally belongs to men as well as the lack of mastery of good agricultural practices by women and the restrictive customary rules of land rights on land for women. [18].

Regarding the age of producers, the age group of 41 to 60 years is more represented in the different localities with the exception of the locality of Kaliani. This percentage varies from 30 to 90%. Concerning the age group of 21 to 40 years, it oscillates between 10 and 50% unlike the group of less than 21 years which varies from 0 to 30%. These results agree with those of [14] who obtained percentages of 45.10%, 21.57% and 15.69% respectively for age groups from 41 to 60 years, 21 to 40 years and less than 21 years and [19] in Senegal where the average age is 51 years. This observation was also observed by [20] in the cashew producing regions of Senegal. High rate in the age group of 41 to 60 years can be explained by the lack of interest of young people in perennial plantations and especially the flight of young people towards large cities [17].

Fig. 2 shows the age of the orchards and their mode of acquisition. Orchards whose age varies from 20 to 30 years are the majority (20 to 90%), followed by those whose age varies between 10 and 20 years (10 to 60%) and finally those less than 10 years old (0 to 30 %). Locality of Kaniene has no orchards less than 10 years old but records the highest percentage of orchards whose age varies from 20 to 30 years. Old age of orchards was also observed in Cameroon with a percentage of 45% of orchards over 15 years old [17]. Old age of the orchards would be due to the non-renewal of the plants. Concerning the mode of acquisition of plantations, the study showed that it is done either by inheritance or by acquisition at the level of the five localities. In the locality of Koliani and Nidienkaha, land is acquired from the producer at a high rate of 50% compared to that of Kaniené which has a low rate of 30%. In the locality of Kaniené, land is inherited at a rate of 90% compared to the localities of Koliani and Nidienkaha which have a rate of 50%.

Fig. 3 shows the distribution of producers according to drying media and drying time. In terms of walnut drying support on tarpaulins, the locality of Nidienkaha has the highest rate (90%) while the locality of Tiorotieri has the lowest rate (40%). Concerning drying on bare ground, the locality of Tiorotieri recorded the highest rate (60%) followed by the localities of Kaliani (50%), Kaniene (50%), Slognougo (40%) and Nidienkaha (10%). Results are in the same direction as those of [21] who stated that producers dry their nuts before storage on the ground or on tarpaulins. Use of tarpaulins would be due to their cost and accessibility. No-use of racks by producers can be justified by the fact that the racks would be difficult to install. For producers with very large areas, they will need to make several large racks to be able to properly dry their nuts. Racks also take up space permanently. Regarding the drying time, 90% of producers in the locality of Koliani dry their cashew nuts for less than 3 days followed by the localities of Nidienkaha (80%), Solognougo (60%), Tiorotieri (60%) and Kaniene (20%). On the other hand, 80% of producers in Kaniene dry the nuts for more than 3 days unlike those in Koliani (10%).

Fig. 4 shows the distribution of producers according to location and storage medium. In the locality of Kaliani producers stored cashew nuts in stores (90%), while that of the locality of Tiorotiéri recorded the lowest percentage (30%).

Regarding storage in houses, the locality of Tiorotiéri recorded the highest percentage (70%) compared to that of the locality of Koliani (20%). Regarding storage media, three types of storage media were used. In terms of ground storage, 90% of producers in the locality of Nidienkaha stored their nuts on the ground compared to that of the localities of Solognougo and Tiorotieri which recorded a rate of 10%. On the board, the locality of Sologneugo has the highest rate (90%) compared to that of the locality of Nidienkaha where producers do not store the nuts on the board (0%). In terms of brick storage, the locality of Tiorotiéri recorded a rate of 50% compared to 10% for the locality of Nidienkaha. These results are in the same direction as those of [21] stated that placing bags directly on the ground is an inappropriate practice which could have a negative impact on the quality of cashew nuts.

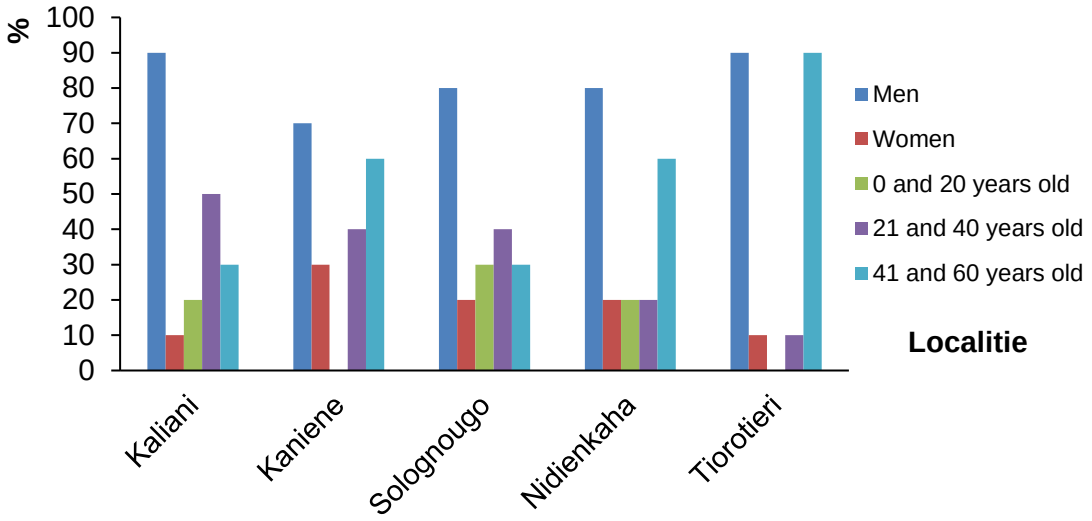

Fig. 1. Distribution of farmers by gender and age in the different localities

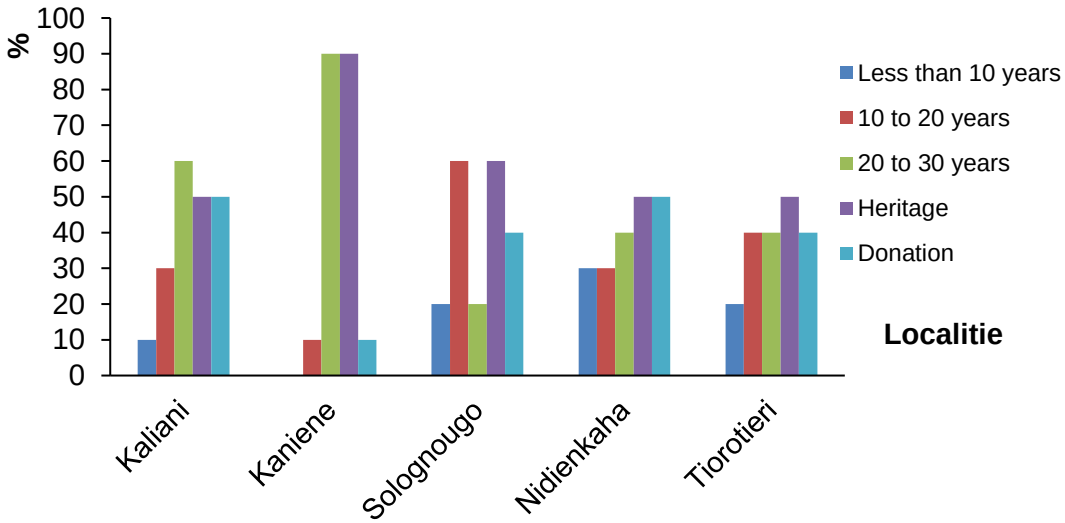

Fig. 2. Distribution of farmers according to plantation age and land acquisition method in different localities

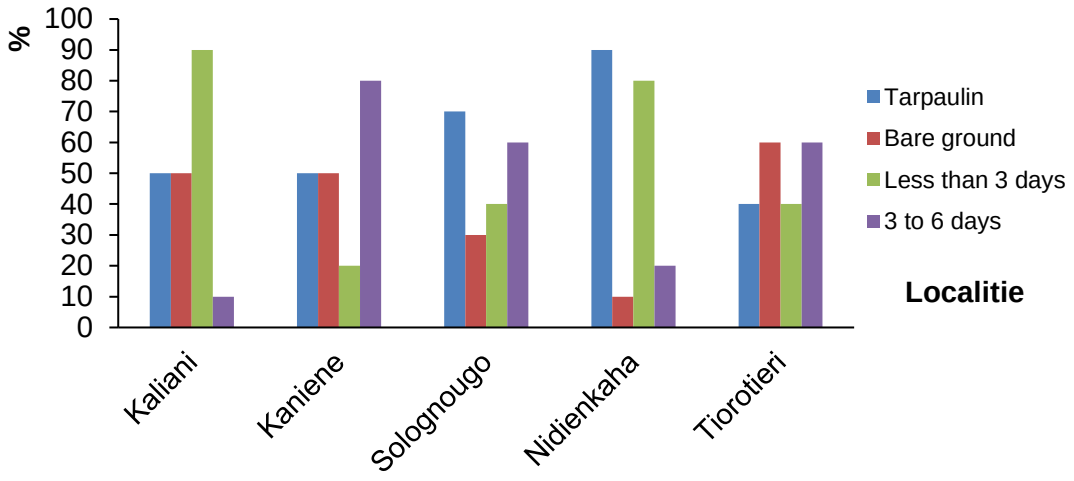

Fig 3. Distribution of according to drying method and drying time in different localities

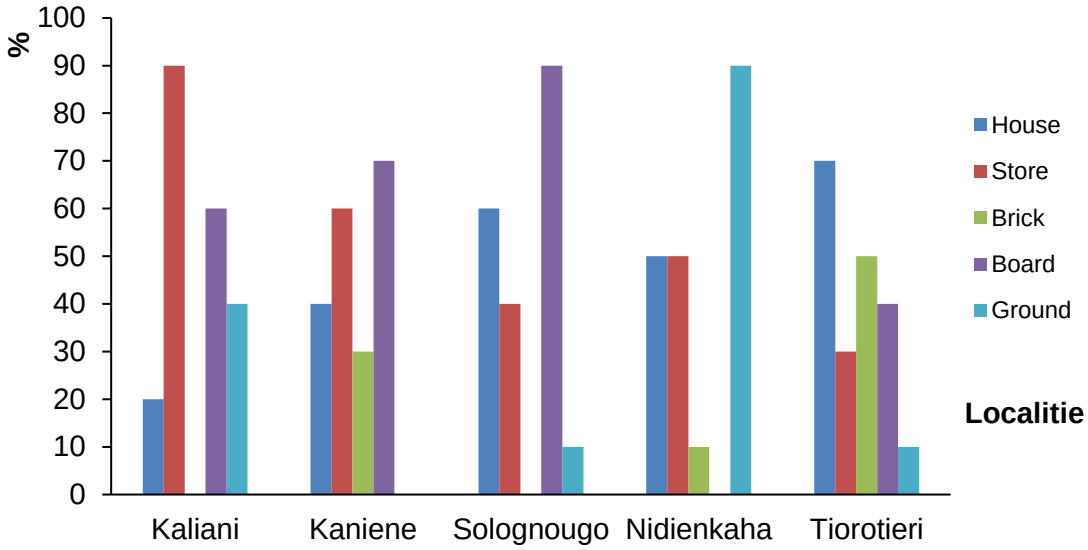

Fig. 4. Distribution of farmers according to storage location and storage facilities for cashew nut bags in different localities

3.2 Nuts Quality

Quality parameters of cashew nuts from different localities are shown in Table 1. Moisture content of cashew nuts from different localities are statistically identical ($p > 0.05$). These values range between 7 and 8.55%. The contents recorded in the localities of Kaliani, Kaniene, Sologhougo, Nidienkaha and Tiorotieri are respectively 7.00; 7.02; 8.55; 8.00 and 8.42%. These contents are higher than those of [22] who recorded contents oscillating between 5.5 and 5.8% in cashew nuts from the Korhogo department. Contents of the nuts studied comply with Ivorian standards which allow humidity of between 7 and 10% [23,24]. These low contents could be explained by well-conducted drying by producers in different localities. Under proper storage conditions, cashews may not be exposed to mold which could extend shelf life [4].

Table 1. Cashew nut quality parameters by localitie

Parameters	Kaliani	Kaniene	Solognougo	Nidienkaha	Tiorotieri
Moisture (%)	7.00 ± 0.23a	7.02 ± 1.35a	8.55 ± 0.46a	8.00 ± 0.46a	8.42 ± 1.10a
Graining (Nuts/Kg)	76,50 ± 5.44b	65.00 ± 6.50b	74.00 ± 5.15b	143.00 ± 6.00a	72.00 ± 5.01b
Defect rate (%)	3.00 ± 1.96c	61.00 ± 6,10a	6.00 ± 1.03c	11.00 ± 1.46b	6.00 ± 0.95c
KOR (Ib)	48.40 ± 1.03a	49,20 ± 1.23a	48.60 ± 1.09a	49,80 ± 1.41a	48.80 ± 0.91a

Averages in the same colonn bearing the same letter show no material difference at risk p=0.05

Regarding walnut graining, the values are statistically identical with the exception of the locality of Nidienkaha. These values for different localities vary from 65.00 ± 6.50 to 143.00 ± 6.00 Nuts/Kg. These values are much lower than those of [19] and [25] who recorded respective values of 179 to 182 Nuts/Kg in Côte d'Ivoire and 171 to 200 Nuts/Kg in Burkina Faso. Nuts from the different localities studied could be considered poor quality according to the assessment criteria (180 to 190 nuts/kg) defined by [26]. This poor quality could be explained by poor agricultural practices carried out by producers in these different localities. This is confirmed by the survey results which reveal that the majority of producers stored nuts on bare ground [27].

Regarding the default rate, the different localities recorded values between 3.00 and 11% with the exception of the locality of Kaniene which recorded 61% default rate. These values for the different localities, with the exception of Kaniene, are less than 15% which is the reference value of the Ivorian standard [24] but higher than the UEMOA standard which is 8% [24]. High rate of defects in the locality of Kaniene could be explained by poor agricultural practices by producers, particularly during harvest and post-harvest [28].

Concerning the KORs of the different localities, they are statistically identical. They vary from 48.40 to 49.20 Ib. These values are higher than those of [19] in Korhogo and [25] in Burkina Faso which recorded respective values varying from 44.87 to 45.90 Ib and 40, 91 to 47.34 Ib. On the other hand, our values are lower than those [28] who recorded an average value of 51.12 Ib with nuts from selected trees. Nuts from different localities have KORs of between 48 and 50 Ib so could be of good quality according to these same assessment criteria [26].

4. CONCLUSION

This study was initiated with a view to improving the quality of nuts in five localities in the sub-prefecture of Katogo. The investigation revealed that producers did not correctly practice the post-harvest operations recommended by the cotton and cotton council cashew (CCA). Drying locations and storage media for the nuts were inappropriate and did not comply with CCA requirements. Determination of quality parameters revealed that the nuts produced are well dried with a low defect rate and a good KOR. On the other hand, the graining was not good. Ultimately, non-compliance with post-harvest practices had a negative effect on the quality of the cashew nuts produced. We recommend that the CCA raise awareness among producers in these localities about respecting post-harvest operations. CCA must install racks for drying and build stores suitable for storing cashew nuts in order to improve the quality of cashew nuts.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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