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# Preparation and quality control of a product for seasoning made with the kernels of *Ricinodendron heudelotii* or "akpi" from Côte d'Ivoire

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***Ricinodendron heudelotii*** **kernels, which are used in food because of their aroma and very pronounced taste, are very popular in Africa, specifically in Côte d'Ivoire. That is why we have developed a solid seasoning product from its kernels. The dough was compacted and molded into small longitudinal shapes in the form of bricks, and slightly dried. The taste of the product was evaluated and the averages obtained were above 7/10. The aroma of the product stored in the refrigerator remained intact until the 12$^{th}$ month (significant probability = 0.175 higher than the risk α = 0.05). At room temperature, the product retained its flavor and this was confirmed by the statistics (probability of significance = 0.079 higher than the risk α = 0.05). The microbiological study done showed that the product was of good quality and safe for consumption after 48 weeks of storage.** ***R. heudelotii*** **can therefore be considered as an interesting plant for humans and for food that needs to be tamed.**

**Key words:** *Ricinodendron heudelotii*, kernels, aroma, taste, seasoning product, Côte d'Ivoire.

## INTRODUCTION

Throughout the world, many plants contribute to food. Among these, the wild plants occupy a prominent place (Grivetti et al., 1987). Nevertheless, it appears that most studies on plants are reduced to more crops. Researches done on wild plants are somewhat limited and generally focus on a simple inventory. Several species are unexploited in Côte d'Ivoire. This is the case of *Ricinodendron heudelotii*.

*R. heudelotii* is a big tree of the Euphorbiaceae family that grows in the forests of Central Africa, Western Africa and Madagascar. It is a part of multipurpose plants in many agroforestry technologies and has undergone several systematic designations namely *Jatropha mahafalensis* jum (Maheu and Husson, 1920) *Ricinodendron africanum* (Pieraerts, 1971). These kernels, called "akpi" in local language in Côte d'Ivoire, are characterized by their flavor which is quite pronounced and very popular in sauces (Weiss, 1983; Mosso et al., 1997).

The *R. heudelotii* kernels are used in Africa and especially in Côte d'Ivoire because of their aroma which is very pronounced. Busson (1965) studied a number of plants in West Africa where *R. heudelotii* is grown, and its importance in the diet was shown. Similarly, Herzog (1992) and Mosso et al. (1997) showed that the sauce prepared with the kernels of *R. heudelotii* is very important in the diets of people of Côte d'Ivoire. Saki et al. (2005) also showed in his last work that kernels of *R. heudelotii* are rich in proteins (24%), lipids (48.7%), phosphorus (1693 mg/100 g), calcium (1013 mg/100 g), potassium (811.4/100 g) and magnesium (528.6 mg/100 g).

The objectives of our study were therefore to develop a solid and flaky product from *R. heudelotii* kernels that can

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**Figure 1.** *R. heudelotii* dried kernels.

be used for flavoring sauces and test for the organoleptic and microbiological qualities of this product during its storage for 48 weeks. This will help to reduce the difficulties in preparing *R. heudelotii* kernels for consumption and also show the importance of accelerating the domestication of this wild plant, which was initially started by the National Center for Agricultural Research (CNRA) Station of Azaguié in Côte d'Ivoire.

## MATERIALS AND METHODS

### Plant material

The plant material is mainly the kernels of *R. heudelotii* (Figure 1) from the markets of Abidjan. Several ingredients were used for the preparation of the product: salt for palatability, vegetalin for improving the fat content, cassava flour as a carrier and caramel for color.

### Materials for microbiological studies

It consisted of a crusher stomacher model 400, Pasteur pipettes and graduated pipettes, 2 ml sterile test tubes, Petri dishes and culture media.

### Method for preparing the solid dressing

*R. heudelotii* kernels were used to prepare the flaky solid seasoning product. 20 g of *R. heudelotii* kernels were finely ground. The following ingredients were added to the ground sample: 40 g of cassava flour, 12 g of salt, 8 g of vegetalin, 10 ml of caramel (0.13 g/ml) and 10 ml of water. These different proportions of the various components of the seasoning product were obtained after several trials.

The mixture was compacted using a mold to form small bricks. These bricks were dried in a room for 12 h at 50 to 60°C.

### Process

The kernels paste was put in a porcelain mortar. Cassava flour, vegetalin, salt, caramel and water were added and stirred. The brick-like shapes were formed using a mold partitioned into small units. The brick-like shapes obtained were dried in an oven at 50 to 60°C for 12 h.

### Evaluation of the seasoning product

The taste evaluation focused on the shape, the flakiness and the best yellow colour obtained after several trials. The test was conducted with a control sauce (no seasoning added) and a sauce made with solid seasoning prepared from *R. heudelotii* kernels.

The evaluation of these sauces was made according to the method described by Ribereau-Gayon and Peynaud (1961) in collective tasting. According to this method, each sensory characteristic (aroma, taste, etc) is assigned a score from 0 to 10. The marks on the scale are defined as follows: 9 and 10 correspond to very good quality, 7 and 8 to good quality, 4 to 6 to acceptable quality and below 4, poor quality.

### Microbiological study of the seasoning product

Microbiological studies were made on the normal flora for conservation and contamination. The following were assayed: Mesophilic aerobic germs (GAM); total coliforms (C.); thermotolerant coliforms (C.Th); Salmonella (S); sulfite-reducing anaerobic bacteria (ASR); mold (M).

This research was done every 8 weeks for 48 weeks. This seasoning product was kept at room temperature and in the refrigerator.

#### *Preparation of the stock solution*

25 g of seasoning product prepared with *R. heudelotii* kernels were collected using a sterile beaker and placed in a stomacher bag. 225 ml of peptone water (physiological medium composed of 20 g Bactopeptone, 5 g sodium chloride, 9 g disodium phosphate, 1.5 g potassium dihydrogen phosphate and 1000 ml of distilled water) were added and put into the mill stomacher 400 for 30 s. The resulting solution was the stock solution.

#### *Detection of GAM on plate count agar (PCA)*

After preparation of the stock solutions and subsequent dilutions, the detection and enumeration of GAM were made on Petri dishes on sterile agar PCA after 72 h of incubation at 30°C.

#### *Detection of fungi on agar OGA*

Glucose agar containing 10% of oxytetracycline was prepared for this count. The incubation temperature was 30°C for 24 to 48 h.

#### *Detection of Salmonella on agar SS*

This was done by the method of AFNOR (1997) which consists of the following steps: The pre-enrichment, which is to make 10 g of sample in 90 ml of water or 25 g of sample in 225 ml of EPT (stamped peptoned water). This mixture was incubated at 37°C for

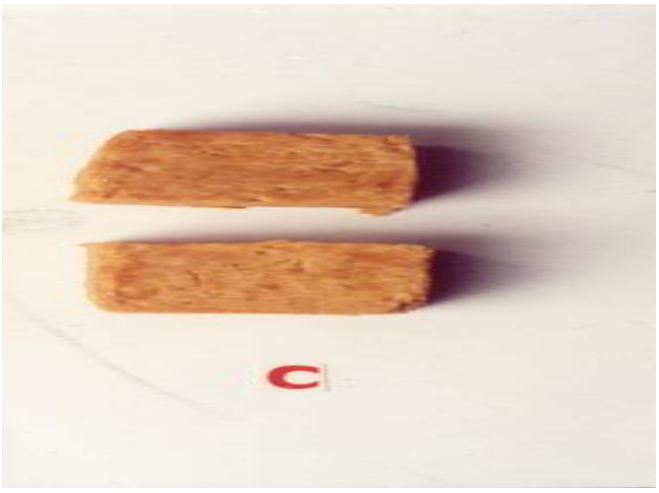

**Figure 2.** Solid seasoning product from *R. heudelotii* kernels.

18 to 24 h. Enrichment is to put 2 ml of subculture in 20 ml of Muller Kauffmann broth (containing sodium tetrathionate and calcium carbonate). The mixture was incubated at 37°C for 18 to 24 h. The seeds were isolated, put on the SS medium and incubated at 37°C for 18 to 24 h.

The review confirmed colonies consisting of a subculture on the TS medium. Full identification of colonies was achieved on an API 20E gallery. The process of Leminor and Veron (1982) allowed us to analyse the biochemical characteristics, in order to finalize the identification of Salmonella.

***Research of coliforms on violet red bile agar lactose agar (VRBL)***

After placing 1 ml of sample or 1 ml of different decimal dilutions into each Petri dish, 15 ml of melted agar VRBL hot bath were added, cooled to 45°C and put in each box, homogenized and left to cool.

A second layer of agar was poured over the first. After solidification, the Petri dishes were incubated at 30°C for 24 h for total coliforms and at 44°C for thermotolerant coliforms. The colonies 0.5 to 1 mm in diameter were counted as colonies of enterobacteria.

***Research on sulphite-reducing anaerobic bacteria (ASR)***

TSN Agar (tryptone sulphite neomycin) was used for detecting these bacteria. Incubation was done at 46°C for 24 to 48 h.

**Study of the microbiological quality**

The microbiological quality of food is governed by standards that are effective methods for identifying microorganisms. There are several standards, including those of the International Organization for Standardization (ISO), *Codex Alimentarius* Commission FAO/WHO, the French Association of Normalization (AFNOR: 1997), the European Committee for Standardization (CEN) and Côte d ' Ivoire Standardization (CODINORM).

The criterion considers the average values used to determine the microbiological quality of foods and their products for consumption. These values are determined in relation to the physico-chemical properties of the food products concerned and the climatic conditions of the country. The level of contamination of food is appreciated using two plans: The plan with two classes; plan with three classes. The one we used here was the plan with three classes.

**The plan with three classes**

It is so called because the results of the tests performed can establish three categories of contamination: A class under the criterion m; a class between the criterion m and the threshold M; a class above the threshold M. m being the criterion set, all results at or below are considered as satisfactory; M is the acceptability limit beyond which the results are not satisfactory or are considered bad. The M values are set at: M = 10 m for a count made in solid medium; M = 30 m for a count made in liquid medium.

**Statistical analysis of results**

This analysis was focused mainly on the comparison of the mean values for sauces with different tastes made with the seasoning products of *R. heudelotii* kernels. For comparison of means for the solid seasoning at different temperatures and times for the taste and aroma, analysis of variance was used. Where significant differences were observed, Newman-Keuls test (Grais, 1992) was used to classify the various means. When the significance probability (Pr) was less than or equal to α (error risk = 0.05), the $H_0$ hypothesis (equality of means) was rejected. When Pr was superior to α; $H_0$ was accepted.

## RESULTS

The solid seasoning product developed after several trials is shown in Figure 2.

### Sensory evaluation of sauce made with kernels of *R. heudelotii*

The solid seasoning developed was used in cooking especially to enhance the taste of sauces and as a preservative at different temperatures over a period of 48 weeks. The results of sensory evaluation of the prepared sauces are shown on Table 1. Most of the tastes had averages above 7/10 with the exception of one: 6.9/10 in the $6^{th}$ week at room temperature.

The statistical parameters of the taste or the aroma were calculated and are shown in Table 2. The classification of combinations of groups which are not significantly different is shown in Table 3. For the aroma, at TL, Pr < α which leads to a rejection of the $H_0$ hypothesis (equal means), and at TL Pr > α., it leads to an acceptance of the $H_0$ hypothesis.

The statistical parameters for tasting of the sauce with solid seasoning are given in Table 4 and the classification and tidying up groups, not significantly different are shown in Table 5. Concerning the taste, at TR, Pr < α which leads to a rejection of the hypothesis (equal means), and Pr > α at TL leads to an acceptance of the hypothesis, The classification and clustering of different groups, not significantly different at TR give three classes

**Table 1.** Sensory evaluation of the sauce made with the seasoning product.

| Testing panel | Week 1 | | | | 6 months | | | | 12 months | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aroma | | Taste | | Aroma | | Taste | | Aroma | | Taste | |
| | T.R | T.L | T.R | T.L | T.R | T.L | T.R | T.L | T.R | T.L | T.R | T.L |
| 1 | 8 | 7 | 7 | 8 | 8 | 7 | 7 | 8 | 7 | 7 | 7 | 9 |
| 2 | 7 | 8 | 9 | 7 | 7 | 7 | 8 | 7 | 7 | 8 | 9 | 8 |
| 3 | 8 | 7 | 8 | 6 | 7 | 6 | 7 | 8 | 8 | 7 | 8 | 7 |
| 4 | 7 | 8 | 8 | 8 | 6 | 7 | 8 | 8 | 8 | 8 | 7 | 7 |
| 5 | 7 | 9 | 9 | 7 | 7 | 8 | 6 | 7 | 7 | 8 | 7 | 8 |
| 6 | 8 | 8 | 7 | 7 | 8 | 7 | 7 | 7 | 7 | 7 | 8 | 9 |
| 7 | 8 | 7 | 6 | 8 | 7 | 7 | 8 | 8 | 8 | 7 | 7 | 7 |
| 8 | 7 | 7 | 7 | 7 | 6 | 8 | 7 | 9 | 7 | 6 | 7 | 7 |
| 9 | 7 | 8 | 8 | 8 | 7 | 6 | 6 | 7 | 6 | 7 | 7 | 8 |
| 10 | 8 | 7 | 9 | 7 | 8 | 7 | 6 | 7 | 7 | 8 | 8 | 8 |
| 11 | 7 | 7 | 7 | 8 | 7 | 6 | 7 | 8 | 8 | 7 | 7 | 7 |
| 12 | 8 | 8 | 8 | 7 | 6 | 7 | 8 | 8 | 7 | 8 | 8 | 9 |
| 13 | 7 | 8 | 8 | 7 | 7 | 8 | 7 | 9 | 7 | 7 | 7 | 7 |
| 14 | 7 | 7 | 7 | 8 | 8 | 7 | 8 | 7 | 6 | 7 | 7 | 8 |
| 15 | 8 | 8 | 9 | 7 | 7 | 6 | 7 | 8 | 8 | 8 | 7 | 7 |
| 16 | 7 | 7 | 9 | 8 | 7 | 6 | 6 | 8 | 7 | 7 | 8 | 8 |
| 17 | 8 | 7 | 8 | 6 | 8 | 7 | 6 | 7 | 6 | 8 | 7 | 7 |
| 18 | 8 | 8 | 9 | 7 | 7 | 7 | 7 | 8 | 8 | 7 | 7 | 8 |
| 19 | 7 | 8 | 6 | 7 | 7 | 7 | 8 | 7 | 7 | 7 | 8 | 8 |
| 20 | 8 | 7 | 9 | 8 | 8 | 7 | 7 | 8 | 8 | 7 | 7 | 8 |
| Average/10 | 7.5 | 7.6 | 7.8 | 7.3 | 7.15 | 6.9 | 7.05 | 7.7 | 7.2 | 7.34 | 7.4 | 7.7 |

TL: = Temperature of laboratory (25-28°C) TR: temperature of refrigerator = (8-12°C).

**Table 2.** Statistical parameters for the sensory evaluation of the aroma for the seasoning product.

| | Aroma with T R | | | | | Aroma with T L | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Soure** | **ddl** | **SCF** | **CM** | **F.Fischer** | **Pr>∝** | **SCF** | **CM** | **F. Fischer** | **Pr<∝** |
| Modes | 2 | 1.433 | 0.717 | 1.796 | 0.175 | 4.3 | 2.15 | 5.850 | 0.005 |
| Error | 57 | 22.750 | 0.399 | | | 20.950 | 0.368 | | |
| Total | 59 | 24.183 | | | | 25.250 | | | |

Pr = Probability of significance; α = 5% (0.05) error risk; ddl = degree of freedom; CFS = sum of squares factorial/CM = means squares.

**Table 3.** Classification and tidying up groups not significantly different.

| Aroma with T R | | | Aroma with T L | | |
|---|---|---|---|---|---|
| **Modalities** | **Averages** | **Rankings** | **Modalities** | **Averages** | **Rankings** |
| Week 1 ($S_1$) | 7.5 | A | $S_1$ | 7.55 | A |
| 12 Months(M) | 7.2 | A | $M_{12}$ | 7.3 | A |
| 6 Months ($M_6$) | 7.15 | A | $M_6$ | 6.9 | B |

A, B and AB. At TL, we had a single class A.

## Microbiological evaluation of the seasoning product made from *R. heudelotii* kernels

The seasoning product obtained was subjected to microbiological analysis after storage. The results of these tests are shown in Table 6. In the seasoning product, only mesophilic aerobic bacteria were counted from the first week to the 32$^{nd}$ at TL and the 24$^{th}$ week at TR. We also noticed a total absence of mold and Salmonella.

**Table 4.** Statistical parameters for the sensory evaluation of taste for the seasoning product.

| Source | Taste with TR | | | | | Taste with TL | | | |
|---|---|---|---|---|---|---|---|---|---|
| | ddl | SCF | CM | F.Fischer | Pr<∝ | SCF | CM | F.Fischer | Pr>∝ |
| Models | 2 | 7.3 | 3.65 | 5.551 | **0.006** | 2.433 | 1.217 | 2.652 | **0.079** |
| Errors | 57 | 37.55 | 0.659 | | | 26.150 | 0.459 | | |
| Total | 59 | 44.85 | | | | 28.583 | | | |

**Table 5.** Classification and tidying up groups not significantly different.

| Taste with TR | | | Taste with TL | | |
|---|---|---|---|---|---|
| **Modalities** | **Averages** | **Rankings** | **Modalities** | **Averages** | **Rankings** |
| Week 1 ($S_1$) | 7.9 | A | $M_{12}$ | 7.75 | A |
| 12 Months($M_{12}$) | 7.4 | A B | $M_6$ | 7.7 | A |
| 6 Months ($M_6$) | 7.05 | B | $S_1$ | 7.3 | A |

**Table 6.** Evolution of microbial flora in the seasoning product.

| Germs/g / Time (Weeks) | GAM | | CT | | CTh | | M | | ASR | | S | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | TL | T R | TL | T R | TL | T R | TL | T R | TL | T R | TL | T R |
| 1 | $30.10^4$ | $3.10^4$ | $3.10^3$ | $2.10^3$ | $2.10^2$ | $10^2$ | 0 | 0 | 10 | 10 | 0 | 0 |
| 8 | $20.10^4$ | $2.10^3$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 16 | $3.10^3$ | $10^2$ | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 24 | $6.10^2$ | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 32 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 40 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 48 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

TL: = Temperature of laboratory (25 to 28°C) TR: temperature of refrigerator = (8-12°C). mesophilic aerobic germs (G.A.M); total coliforms (C.T); thermotolerant coliforms (C. Th); Salmonella (S); sulfite-reducing anaerobic bacteria (ASR); mold (M).

## DISCUSSION

Looking at the solid seasoning product, the probability of significance (0.175) of the aroma at TR is higher than the risk α (0.05). The averages are identical from the first week to 12 months. The aroma remains intact when the product is stored in the refrigerator (TR) for 12 months. It is not the case when this seasoning product is stored at room temperature (TL) (Pr (0.005) $< \propto$ (0.05).

With regards to the taste, at TL, Pr (0.079) > α (0.05), which means that the averages are equal. The taste at TL is retained in the seasoning product from the first week to the 12th month. This is confirmed by the fact that non significantdifferent groups make up, one group (Table 5). It somehow decreases at TR (Pr (0.006) $< \propto$ (0.05). At TR, there is a slight decrease in the taste probably due to storage conditions and the lack of interest for the “akpi” by some testers. The solid seasoning developed was appreciated by the testers, because the overall averages were ≥7.2/10. This means that the product is of good quality.

Microbiological control of the seasoning product shows the presence of aerobic mesophilic bacteria, total coliforms ($3.10^3$ to $2.10^3$ at TL and TR), thermotolerant coliform ($2.10^2$ to $10^2$ at TL and TR) (Table 6) from the first day of storage at room temperature (TL = 25 to28°C) and refrigerator temperature (TR = 8 to 12°C), except mold and Salmonella.

From 8 to 32 weeks, GAM remains high in the seasoning product and starts decreasing and disappears completely by the $40^{th}$ week, but storage lasted for 48 weeks. This decrease in GAM had also been proven by Kacou (2000) for cassava paste. But these results are different from those of Whitney (1988) and Toka (1998) for cassava dough. The reduction was due to low water activity and the presence of salt in the seasoning. These two parameters prevent the proliferation of micro-organisms. However, the GAM rate is lower than the maximum criterion (900 000 seeds/g) which shows that this seasoning product could be safe for consumption or

is without danger.

## Conclusion

From the results of this work, we can say that *R. heudelotii* kernels can be used as a flavor and aroma agent in the preparation of sauces because the sensory evaluation performed on the broth made with the kernels of *R. heudelotii* gave satisfactory values.

The taste evaluation of the seasoning product of *R. heudelotii* kernels was appreciated by randomly selected testers. The statistical parameters of the sensory evaluation of sauces made with *R. heudelotii* kernels show that the aroma remains in the seasoning product for 12 weeks and for 6 weeks in the paste. The microbiological analysis of the product showed that it was not contaminated by bacteria during storage. The product is of good microbiological quality after 48 weeks of storage. GAM also disappeared completely by the 40$^{th}$ week.

The results of these analyses and the development of this seasoning product from *R. heudelotii* kernels raises the need to call for the attention of agroforesters and farmers on the importance of the cultivation of *R. heudelotii*. These results interestingly, will invite the authorities of our countries to sustain the efforts of harnessing of wild plants namely *R. heudelotii* in Cameroun, Côte d'Ivoire, etc, started by researchers.

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