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RESEARCH ARTICLE

Process of *attieke* production in Côte d'Ivoire: new trends, updates and effects on quality and preference of the food

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Abstract

Attieke, the most consumed cassava product in Côte d'Ivoire continues to increase in production due to the increasing urban demand and export market potential. Therefore, many small scale processors are involved in the production of *attieke* with the potential for quality diversification. The present study aims at generating data that can produce useful information on the new trends in *attieke* production processes and their effect on its quality. Studies were carried out on *attieke* samples from selected processing units within seven areas of Côte d'Ivoire from September to December 2012, and data were collected using questionnaire and observation checklist, sensory and chemical analyses. The results showed that *attieke*, just like its traditional inocula were prepared following a single process in all production areas, with the exception of Abidjan production units where process differed from the others by an additional sieving step. However, differences were located in the practice of each unit operation, particularly for raw material (cassava varietes), fermentation and steaming length. Despite the uniqueness of *attieke* and its inoculum production processes as nowadays practiced in different production areas, product quality is highly variable and differently appreciated by consumers. *Attieke* from Dabou, Abidjan and Jacqueville, cities with people at the origin of *attieke* remains the most popular.

Introduction

Attieke is the major fermented plant food in Côte d'Ivoire. It is a steamed granular cassava (*Manihot esculenta* Crantz) meal ready-to-eat, couscous-like product, with slightly sour taste and whitish colour (Djeni et al., 2011). It is consumed two to three times a day with meat, fish or vegetables. The popularity of *attieke* to urban dwellers in recent years has been associated with its cheapness, lower bulk (as compared to other cassava product) and its characteristic of ready to eat food. The largest amounts of *attieke* are prepared by three ethnic groups (Adjoukrou, Alladjan and Ebrie) at the origin of *attieke* production and which supply the big city of Abidjan (Assanvo et al., 2006). But, increasingly, *attieke* preparation is spreading to other countries in West Africa (Aboua, 1995). Also, the large export market potential of *attieke* cannot be underestimated as the size of the West African ethnic population overseas keep increasing. It is also exported to Europe as a dehydrated product without any established specifications, contrarily to gari, a similar product in Ghana and Nigeria. Recent data on *attieke* production and consumption do not exist, but Aboua et al. (1990) estimated its consumption between 28 000 and 34 000 tons per year; in which 100 tons was daily produced only for the Abidjan city by the small-scale channels.

The production of high quality *attieke* is often associated with specific locations and specific ethnic groups in Côte d'Ivoire. However, with increased commercialization, production has now moved to other locations within the country not traditionally noted for major *attieke* processing. Moreover, the traditional preparation process

changed with time within a same location and during the adaption in other locations within the country. Most of these *attieke* are processed by small scale producers, thus making quality control difficult as noted by Sanni (1992) in his study on gary quality and by Sotomey et al. (2001). As a result, the preparation methods, such as fermentation time vary according to the locations or within ethnic groups and these are expected to affect the quality of the product. In addition, differences in the traditional starters used for *attieke* fermentation could be at the basis of different organoleptic qualities of *attieke* sold in the country. Therefore, the present study aims at generating data that can produce useful information on the new trends in *attieke* production process and their effect on its quality.

RESEARCH METHODOLOGY

Data collection and sampling

From September to December 2012, artisanal *attieke* processors, randomly selected in 31 localities of 7 towns (Abidjan, Dabou, Jacqueville, Grand-lahou, Divo, Sikensi and Adzopé) in southern parts of Côte d'Ivoire, were administered a questionnaire constructed and validated by a questionnaire expert group. Some of these cities (Abidjan, Dabou, Jacqueville, Grand-lahou) are known to house people behind *attieke* production, but the others were selected on the basis that even though traditionally they are not considered as initial *attieke* production zones, they produce an appreciable amount of *attieke*, thus becoming the new supply areas of big towns

In collaboration with *attieke* production units, a meeting was organized with selected groups of processors to explain them the objectives of the study. In addition, each participant was given verbal instructions on how to fill in the questionnaire and any other relevant information. The questionnaire was subjected to a preliminary validation on 15 production units to assess its clarity, the suitability of wording, and the average time needed for its completion. Based on this pilot study, necessary modifications were identified and resolved, whereas its results were not included in the final survey. The final questionnaire has been established and has been submitted to the staff on the different production site. All items were multiple-choice questions or statements with 2-6 possible answer choices including true/false and yes/no statements. The data used in this study were also collected by undisguised observations after obtaining the permission of *attieke* production units owners to investigate and observe their practices during production in their premises. A total of 930 *attieke* processors were included in the survey with 30 processors per locality.

After the survey, four (4) *attieke* production units within each city were randomly selected except Abidjan where 7 units were selected and *attieke* samples collected from processors within these units. In all, 31 processors were selected from the seven *attieke* producing towns and 5 samples per processor were collected from each selected production unit for biochemical and sensory analyses. All *attieke* samples were collected from selected processors immediately after steaming in plastic bags as proposed by producers for retail selling. They were then transported in an icebox directly to the laboratory for analyses.

Sample analyses

Thirty grams of *attieke* sample were blended with 70 ml of sterile distilled water and filtered through a Whatman filter paper. The pH was determined on 30 ml of the filtered solution using a pH-meter (pH-meter P107, Consort, Bioblock Scientific, Illkirch, France). Total Titratable Acidity (TTA) was determined using the standard method described by Amoa-Awua and Jakobsen (1996). Ten millilitres of filtered solution were titrated with NaOH 0.1 N, using 1% phenolphthalein as indicator. The volume of aliquot used was recorded to determine the amount of acid in samples. The titrable acidity was calculated as percentage of lactic acid. The percentage of dry matter was determined using the Official Methods of Analysis (AOAC, 1984). The determinations were carried out in triplicates and the mean value recorded.

The sensory analyses of *attieke* samples based on preference test were carried out according to the method described by Lawless and Heymann (1999). Volunteers for sensory evaluation panels were sought among students (with at least master level) of the faculty of Food Sciences and Technology from University Nangui Abrogoua. The panel consisted of 94 assessors, 25 females and 69 males (age range: 23–32). The consumers received no training, however, their cultural attachment to *attieke* was considered as an advantage for judging the food product. The sensory assessments were held in one session in two classrooms of the faculty at ambient temperature (28–30 °C) and in day light. Seven fresh cooked *attieke* samples from each production area (at approximately 28±2 °C) were analyzed in this session. Samples were coded by numbers of 3 uncertain numbers in order to hide their origin from the tasters. The products (approximately 100 g) were presented in white porcelain plates with three random digits code according to a monadic profile and after the tasting, samples were classified according to the procedure described by Issanchou and Hossenlopp (1992). Samples were classified from the most preferred at the less preferred. The most prefered was noted 1 and the less prefered was noted 7. Traditionally, *attieke* is consumed with

sauce or condiments. However, for these tests, samples were tested without sauce to avoid the effect the sauce on the assessment.

Data analysis

Data were analyzed using Epi Info 2004 statistical software (Division of Public Health Surveillance and Informatics Epidemiology Program Office, MS K74, Atlanta, Georgia 30341-3717). Descriptive statistics, such as frequency distribution, mean and percentages were employed for the analysis. One way analyses of variance based on DUNCAN multiple tests with significant level $\alpha=0.05$ were performed in order to compare biochemical and sensory profiles of *attieke* samples and also to determine significant differences between them. The software used for the statistical evaluation was XLSTAT (Addinosoft Inc.). This software was also used for the regrouping of *attieke* according the origin and their quality characteristics. The relationship between *attieke* varieties and biochemical and sensory attributes was illustrated by Principal Component Analysis (PCA).

RESULTS

Processes of *attieke* production in the South of Côte d'Ivoire

Attieke production, as currently practiced in administrative regions of southern parts of Côte d'Ivoire, and characterized in this study is achieved according two separate processes (Fig. 1). The first process is practiced in *attieke* production units of Abidjan city by Ebrie ethnic group. To produce *attieke* in this area, roots are peeled, cut into pieces, washed three times with fresh water and then ground. The grinding generally takes place in a cooperative crusher located in the village or the neighborhood. Before grinding, an estimated amount of 5 to 10% (w/w) of traditional inoculum, 10% (v/w) water and about 0.1% (v/w) of palm oil are added and cassava pieces are ground to a fine paste, which is placed in large bowls. The dough is left to ferment for about 12 hours at ambient temperature (30–32°C). After fermentation, the dough is placed in a jute sack and pressed continuously with a mechanical press for about an hour. The press cake is then passed through two sieves to obtain a fine powder. The grains are formed by shaking and rotating the powder in a large bowl. The grains are sun-dried on black plastic canvas or flat bowls for about 10–15 minutes. After drying, fibres and dirt are removed by sprinkling grains which are poured onto the sieve up to a height of 15–20 cm for steaming for about 25–35 minutes (according production units). The *attieke* obtained is filled into plastic bags, sealed airtight and sold on local markets. The second process is practiced in production units of Grand-Lahou, Dabou, Jacqueville, Divo, Sikensi and Adzopé cities. This process is entirely similar to the first one at the difference of a second sifting after drying step which is not praticed in these production areas. However, whatever the production process, cassava variety used, length of fermentation, drying and cooking time vary from a production area to another. A Principal Component Analysis (PCA), taking into account the way each unit operation was achieved, particularly, raw material, fermentation and steaming allowed classifying the production areas into four groups according to the two first dimensions D1 and D2. In the first group containing production units of Abidjan and Dabou, cassava of IAC variety was the most used for *attieke* production. Fermentation, drying and steaming steps last respectively in average twelve hours, twenty minutes and thirty five minutes. In the second group with production units of Grand-Lahou and Divo, cassava IAC variety was also used for *attieke* production and fermentation, drying and steaming steps were achieved respectively during eighteen hours, ten minutes and thirty minutes. Production units from Sikensi and Adzope and those of Jacqueville constitute the thrid and fourth groups. In both groups, fermentation times were respectively sixteen hours with variable times for the other unit operations (Fig. 2).

A part of cassava processing into *attieke* includes the use of inocula. Those incocula are generally obtained after 2 or 3 days of fermentation of ''blanched'' peeled whole or cut cassava roots (Fig. 3). Irrespective of the basic processing steps, there are slight but significant variations from one production area to another. Principal Component Analysis plotting production areas and parameters of inocula preparation, allows to distinguish two main practices according to the dimensions D1 and D2. Production areas of Abidjan, Dabou and Jacqueville boiled peeled cassava roots of IAC variety for 20 min and let them to ferment during 2 days. In the second practices, met in Divo sikensi and Adzope production areas, there were no specifications of cassava varieties and roots were boiled for 20 min and fermentation of boiled cassava last 3 days (Fig. 4).

Biochemical characteristics of *attieke* from processing areas and their preference by consumers

The biochemical properties of *attieke* samples from different processors within each processing areas did not show significant variations ($p > 0.05$) (data not shown). But, by comparing samples between processing areas, significant variations were observed. Indeed, the mean of total titratable acidity levels of *attieke* samples, expressed as percent of lactic acid ranged between 1.85 ± 0.16 (samples from Dabou) and 2.15 ± 0.92 (samples from Adzope). Mean pH values also ranged between 4.12 ± 0.6 (Adzope samples) and 4.29 ± 0.04 (Dabou'samples). The range of dry matter

contents was between 51.3 ± 2.9 % (samples from Grand-Lahou) and 53.25 ± 1.3 % (samples from Divo). These values significantly varied from one area to another (Table 1).

Preferences of consumers for the different samples are shown in Table 2. Consumers most liked *attieke* from Dabou, Jacqueville and to lesser extent this of Abidjan, while *attieke* from Sikensi and Adzope were the least preferred (Table 2).

In an attempt to simplify interpretation of the data, principal component analysis was applied to the combined data set for *attieke* preference and biochemical parameters. The first two principal component explained 82.20% of the variation in the data, with the first dimension (D1) accounting for more than 49% of the variation and the second dimension (D2) accounting for 32% of the variation. The contribution of the combined data to the principal component is illustrated in Fig. 5. According to their processing origins and their properties, 3 *attieke* qualities could be distinguished: this from Dabou production units which *attieke* was entierely different from the others, these of Abidjan and Jacqueville prodcution units which showed important similarities and the others from the other production units of this study.

Table 1: Biochemical characteristics of freshly collected *attieke* from seven production areas in southern parts of Cote d'Ivoire

Production areas	pH	Total titrable acidity (%)	Dry matter (%)
Abidjan	4.21 ± 0.2^{a}	1.88 ± 0.73^{a}	51.4 ± 2.5^{b}
Adzope	4.12 ± 0.6^{c}	2.15 ± 0.92^{c}	52.4 ± 3.4^{c}
Divo	4.17 ± 0.14^{b}	2.0 ± 0.16^{b}	53.3 ± 1.3^{d}
Sikensi	4.13 ± 0.03^{c}	2.12 ± 0.08^{c}	52.1 ± 2.8^{c}
Jacqueville	4.25 ± 0.22^{a}	1.87 ± 0.27^{a}	51.3 ± 4.2^{b}
Grand Lahou	4.18 ± 0.1^{b}	1.98 ± 0.34^{b}	51.3 ± 2.9^{b}
Dabou	4.29 ± 0.04^{a}	1.85 ± 0.16^{a}	51.6 ± 3.7^{a}

Values are means of three determinations. In a column, means values followed by different superscript are statistically different (Duncan multiple test range at $P \leq 0.05$).

Table 2: Preference tests of freshly collected *attieke* from seven production areas in southern parts of Cote d'Ivoire

Production areas	Sum of ranks	Order of preference
Dabou	25^{a}	+
Jacqueville	23^{ab}	
Abidjan	18^{b}	
Grand-Lahou	12^{c}	
Divo	10^{c}	
Sikensi	4^{d}	
Adzope	2^{d}	-

Values are means of three determinations. In a column, means values followed by different superscript are statistically different ((Duncan multiple test range at $P \leq 0.05$). +: more preferred, -: less preferred,

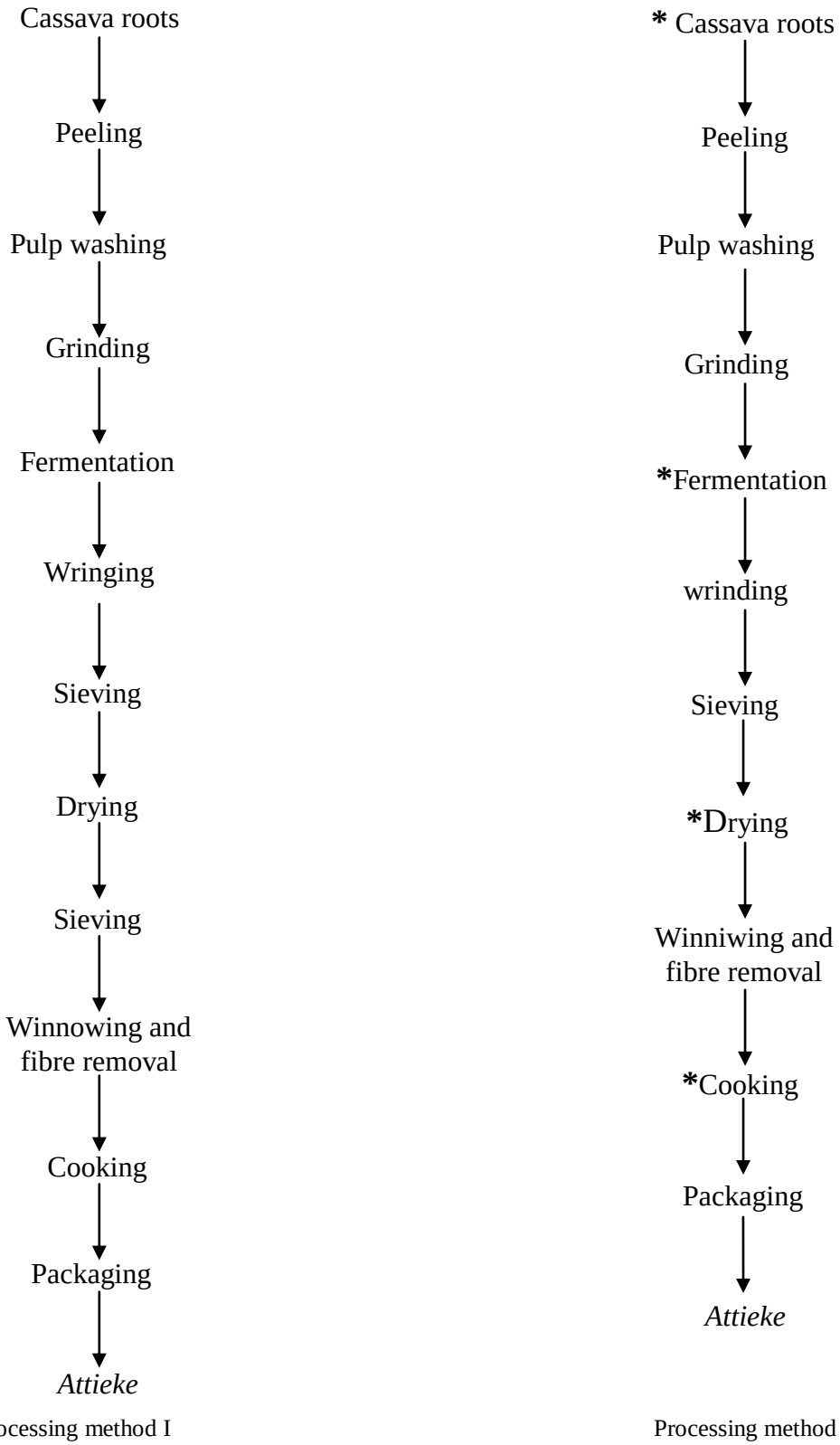

Figure 1: Process of cassava traditional inocula production used for cassava dough fermentation during *attieke* production in different area of processing in southern parts of Côte d'Ivoire. * stage where some differences exist

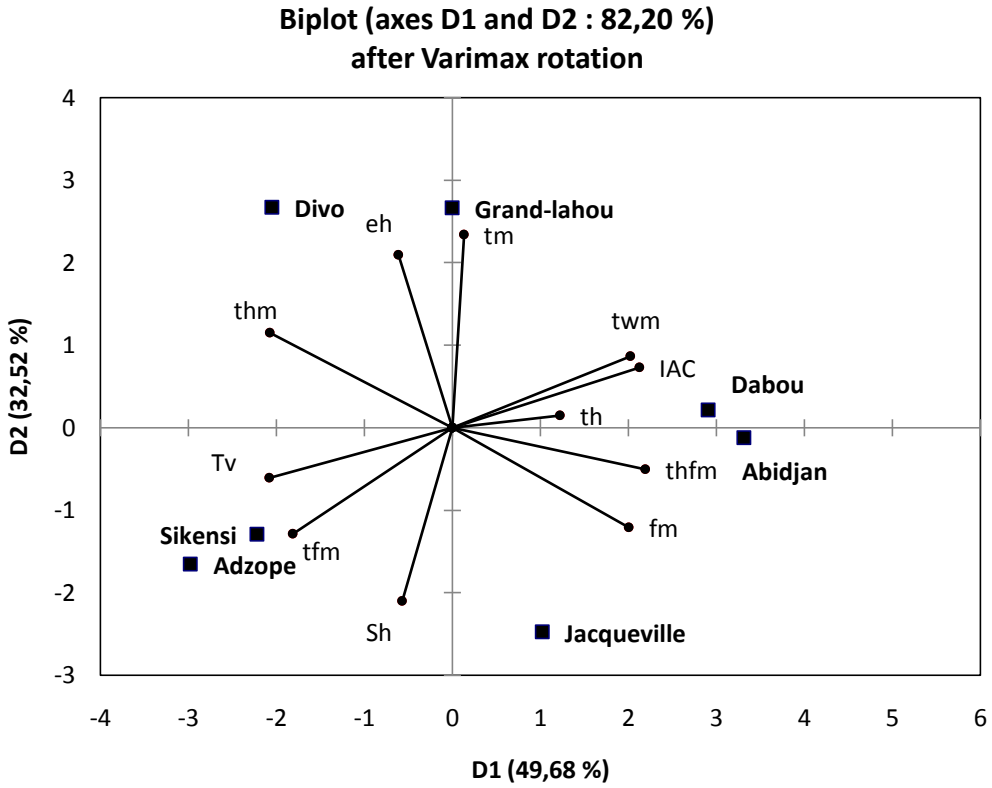

Figure 2: Principal component analysis (PCA) loadings for *attieke* production in different area of processing in southern parts of Côte d'Ivoire. Tv: two varieties, th: twelve hours , sh: sixteen hours, eh: eighteen hours, tm: ten minutes ; fm: fifteen minutes, twm: twenty minutes, tfm: twenty five minutes, thm: thirty minutes, thfm: thirty five minutes

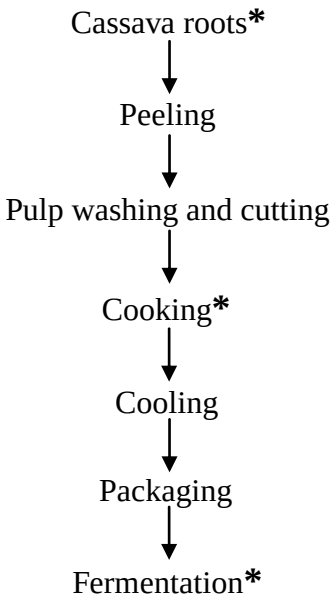

Figure 3: Process of cassava traditional inocula production used for cassava dough fermentation during *attieke* production in different area of processing in southern parts of Côte d'Ivoire. * stage where differences exist

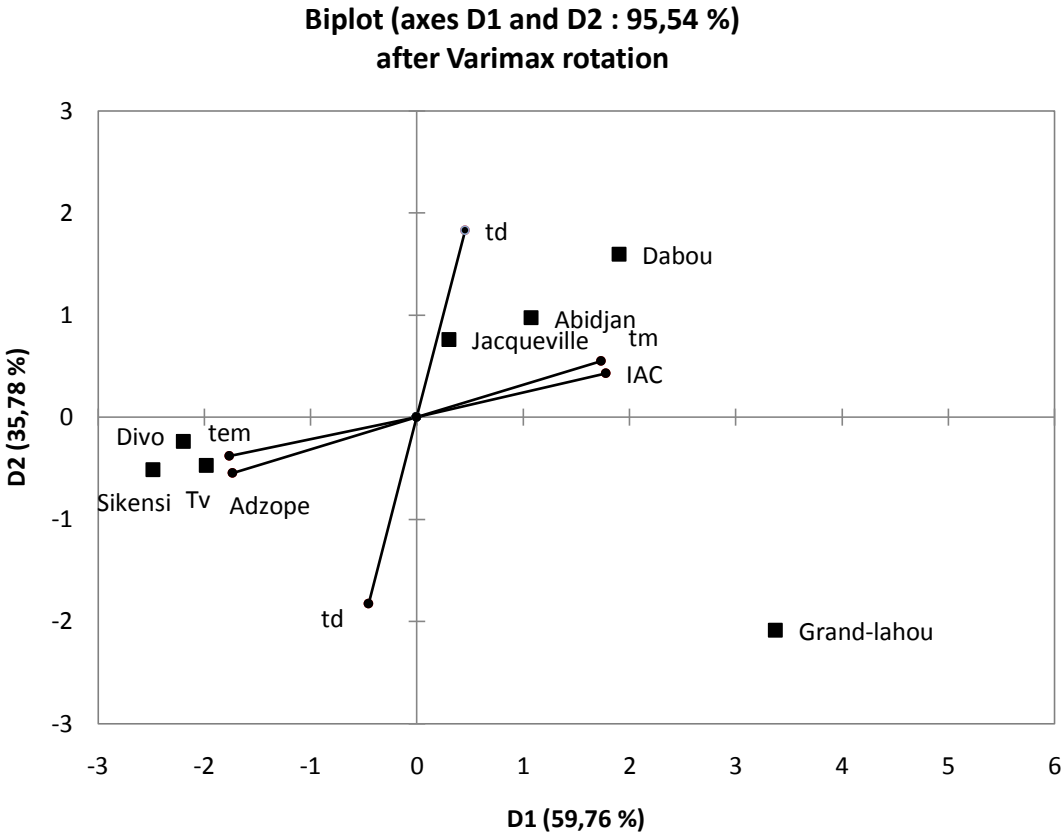

Figure 4: Principal component analysis (PCA) loadings for cassava traditional inocula used for cassava dough fermentation during *attieke* production in different area of processing in southern parts of Côte d'Ivoire. td: two days, tm: twenty minutes, tem: ten minutes, td: three days, Tv: two varieties

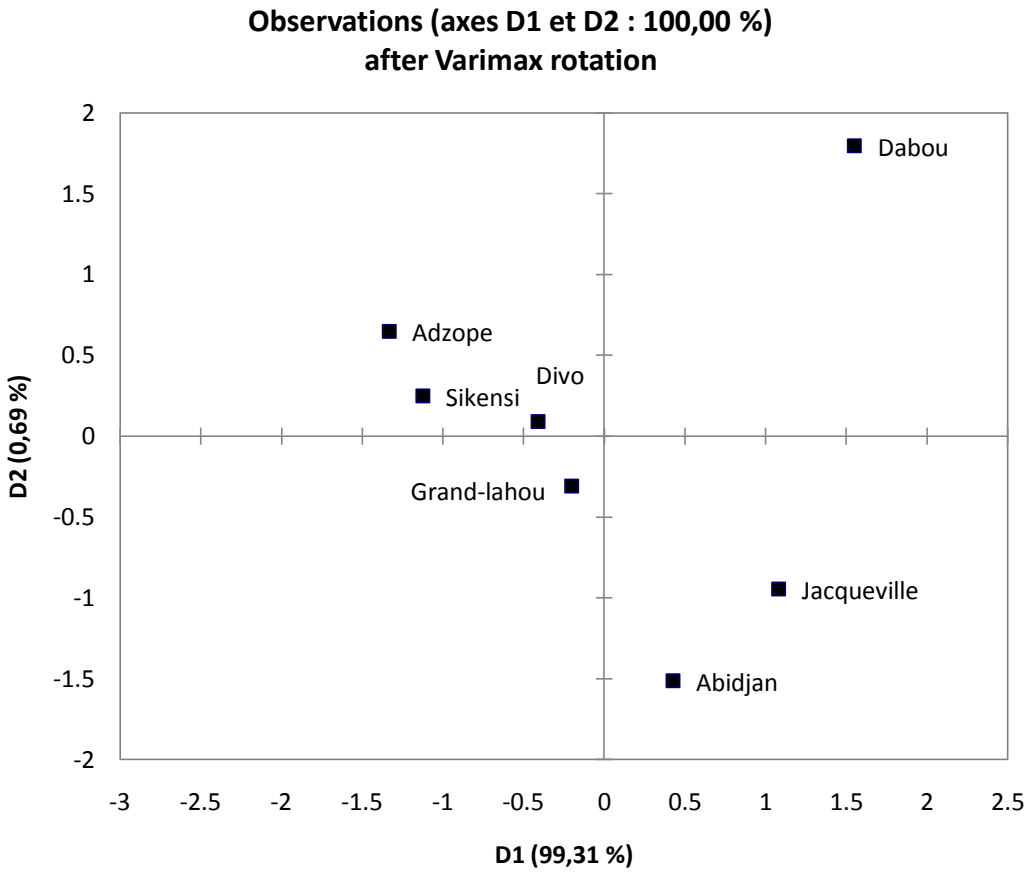

Figure 5: Principal component analysis (PCA) loadings for physico-chemical properties and preference by consumers of *attieke* from seven production areas in the southern parts of Côte d'Ivoire.

DISCUSSION

The processing of cassava into *attieke* was reviewed in production areas of southern parts of Côte d'Ivoire with the aim to generate data that can produce useful information on the new trends in *attieke* production process and the way *attieke* quality and diversity were affected and/or generated throughout the main processing areas. *Attieke* was originally prepared and consumed exclusively in a restricted ethnocultural setting among the ethnic groups (Adjoukrou, Ebrie, Alladjan, Avikam, Aizi) living in the Laguna area in the south of Côte d'Ivoire (Kouadio et al., 1991; Assanvo et al. 2006). In recent years, the product has become popular beyond the boundaries of this area. It is now produced in many other regions of Côte not originally known to produce *attieke*. One reason for this extension is that cassava is available in almost regions in the country and that *attieke* is a convenient fast food very consumed by people. Thus, there have changes from original production process of *attieke* and its traditional inocula during adaptation in new producing regions. This study achieved in seven regions of *attieke* production has evidenced two processes of *attieke* production almost similar excepted one unit operation, notably a supplementary step of sieving in the processing method I which is characteristic of Abidjan production units. This sieving is practiced in order to separate smallest granules of *attieke* from the biggest, the consequence of which lead to two king of *attieke* in this production area: ordinary *attieke* with small granules and *attieke* with mean or big granules so called *agbodjama*. Similar observations were reported by Aboua (1989), Kouadio et al. (1991) and Djeni (2009) on their respective works on *attieke* in Côte d'Ivoire. However, the right differences between cassava processing into *attieke* were not based on operation units, but on the way each operation unit is achieved. Obervations on practices have revealed main differences on raw material, fermentation, drying and steaming steps. Oduro et al. (2000) reported similar differences in the process of *gari* production in the South of Ghana. These different practices allow classifying the production areas visited in four groups of practice: Abidjan and Dabou, Divo and Grand Lahou, Sikensi and Adzope and finally Jacqueville. The clustering of Dabou and Abidjan production zones; as well as those from Divo and Grand-Lahou could be explained by the proximity of people living in these localities. Therefore, these peoples could

have transmitted their know-how as a result of contact between them. Furthermore, the specificity of practices in Jacqueville production units could be due to the fact that this area is enclosed and therefore his process has not undergone significant changes. As for the new zones of production (Sikensi and Adzope), the technology has been imported from the other production areas.

Moreover, this study showed that the diversity of practices during *attieke* production has a very obvious influence on their biochemical characteristics including acidity (which is a criterion of choice) and their quality attributes notably their preference. Indeed, *attieke* produced in Dabou areas was the most preferred by consumers, followed by those of Jacqueville and Abidjan. These results are in agreement to those of Assanvo et. al. (2000) who demonstrated through a consumption survey restricted at three communes of Abidjan city that Adjoukrou *attieke* was the most preferred by consumers. The previously observed differences in organoleptic characteristics of *attieke* samples from the different locations are likely to be due to the inherent differences of cassava varieties used, specific techniques during production, extent of fermentation and traditional starter used to ferment cassava dough. In general, the bitter varieties of cassava are used for *attieke* processing. The variety most appreciated by producers is ‘‘Improved African Cassava’’ (IAC) because of its easy availability and its low moisture content. In connection with that, Adjoukrou people pay a particular attention in the choice of cassava roots (roots cultivated without fertilizer) and the preparation and proportioning of traditional inoculum, the essential element for a good organoleptic *attieke* quality. Almazan (1988) found that some quality attributes of *gari*, another fermented cassava product, vary depending on cassava variety used for processing. Indeed in Côte d’Ivoire, there were several types of *attieke* produced by different ethnic groups following the same process and each type of *attieke* has specific characteristics and is differently appreciated by consumers. Three of these ethnic groups (Adjoukrou, Ebrie and Alladjan) are recognized as the best producers, and their products are consumed in large scale in urban areas, particularly in Abidjan, thus, increasing the interest of these *attieke* types for consumers and also for researchers. In this way, several studies have been devoted to these types of *attieke* (Assanvo et al., 2000, Djeni et al., 2011). These authors stated that differences of quality between these *attieke* could probably be due to differences in their traditional starters used to conduct fermentation. Empirical knowledge of ethnic groups living in southern regions of Côte d’Ivoire in production of traditional cassava inocula and their characteristics are very poorly documented. But, the positive effects of such inocula are thought to include product preservation, flavor development, cyanide reduction and changes in functional properties (Akindahunsi et al., 1999).

These traditional inocula are obtained following a single process in the various areas visited: the “Blanching” method. And this challenge various *attieke* traditional inocula designations previously established, especially those established on ethnicity basis. Indeed, Kouadio et al. (1991) described three different preparation methods respectively among Ebrie, Adjoukrou and Alladjan peoples and named them by the name of people who produced them. These designations have been used for a long time without taking into account the inadequacy between such designation and the specific preparation method. Nowadays, the situation is that production process is no longer linked to ethnic groups who practice it and that all people use technique known as ‘‘blanched’’ inoculum to prepare theirs during *attieke* production. However, taking into account unit operations length and raw material, two trends emerge. Unit operation lengths are not determined scientifically, but empirically by experience. Indeed, producers are from the production area or have acquired habits from the host region. This could explain the regrouping of usual attieke production areas (Abidjan, Jacqueville Dabou) and recent production areas which are Divo Sikensi and Adzope. In areas where *attieke* is the staple food, cassava is grown primarily for *attieke* production; therefore suitable varieties are selected and available. In the other areas, cassava was used primarily for consumption in other ways, especially in combination with banana and eaten as *foutou*. Because of its high hydrogen cyanide content, IAC variety is not suitable for foutou or consumption in fresh state (Coulin, 2004). It would be of recent introduction and not available for *attieke* production. This could explain the use of sweet varieties not suitable for *attieke* production in new production areas.

CONCLUSION

It may be conclude from this study that *attieke* production is very common in southern parts of Côte d’Ivoire, even in non-renowned regions of production. Nowadays, *attieke* is prepared following two processes which differ by only one additional sieving step. However, in the practice of unit operations, each producing region or people has specific know-how which give particular characteristics to product quality. This expertise is a characteristic of people or regions behind *attieke*, particularly Adjoukrou ethnic group from Dabou, Ebrie from Abidjan and Alladjan from Jacqueville, which *attieke* are the most appreciated by consumers.

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