



(RESEARCH ARTICLE)



Survey on the "plant salts" production and consumption in the west of Ivory Coast

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Abstract

A field survey was carried out to increase knowledge on salts produced from plants in the west of Ivory Coast. This work intends to serve as a basis for a real promotion of "plant salts" as a food additive in domestic and industrial production. It would also like to provide an alternative to severe low-sodium diets. It is produced in the west of Ivory Coast, salty products made from plants and used as a substitute of sodium chloride. These "edible plant salts" are differentiated from each other by the type of plant (and even organ) used and the manufacturing process. Two manufacturing processes, resulting in physically different salts, were identified. The first, used by the non-native *Malinke*, gives the lumpy "potash" commonly sold at the markets. The second, practiced by the native *Dan, Guere an Wobe* peoples, gives a better developed fine "plant salts". The main "edible plant salts" found in this area are produced from palm or coconut branches. The salts from reeds and many forest trees such as kapok trees are also very appreciated, only they are rare. "Plant salts" are in greater demand for health reasons, hence their qualification as "salts of the sick people". They are consumed as a cooking ingredient or in pharmacopoeia and the elderly are their first consumers. Due to weak demand, productions are very irregular and in low quantities. These products are unknown to populations and industrialists although they could be useful in food and health sectors.

Keywords: Plant salts; Potash; Food additive; Salt substitute; Sodium chloride

1. Introduction

"Plant salts" are commonly call "potash" or "potash salts" or "organic salt" [1]. These are "salty products resulting from the crystallization of mineral salts from plants. Considering their chemical composition, they can be useful for the local African chemical industries, where they could replace the imported potassium or sodium hydroxides and carbonates [2, 3]. In some areas, potashes are used as a fertilizer for agricultural soils but also as an herbicide [4]. Certain types of potashes are still used in human diet and pharmacopoeia in sub-Saharan countries [5]. The raw materials largely determine the chemical composition and the properties of the extracted salts [6]. Thus, the nature of the ashes determines the taste and possibly the prophylactic or curative virtues of the product. Many plants can be used in the same population, depending on individual taste and availability [7, 8]. Potashes could play functional, sensory and technological roles, useful in food industry. However, a very few works have been done on potashes in those domains. Also, common potash is considered unsuitable for performing these roles given its appearance and taste. Thus, it is important to prove that there are potashes, better developed and competitive as salt substitutes. This work aims to prove the existence of edible "plant salts" produced in the west of Ivory Coast. It set itself objectives of identifying them, shedding light on the technologies of their production and establishing the reasons and parameters of their consumption.

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2. Material and methods

2.1. Survey

2.1.1. Place and Duration

The survey was conducted from October to December 2017. 16 villages (Douele, Kpangouin 2, Zele, Diou Ziamba, Sibapleu, Gblonle, Mantongouine, Zon Faedi, Kahin, Binao, Gueyebli, Kouisra, Zeaglo, Kaade, Douandrou and Guinkin) in 3 regions (Tonkpi, Guemon et Cavally) of west Ivory Coast were visited.

2.1.2. Sampling

During the survey, through direct individual interviews, data was collected on the raw materials, the manufacturing and the consumption of the local "plant salts". A structured questionnaire was used and information was collected in a participatory manner from 384 individuals. The size of the sample of individuals to be surveyed was calculated according to the method described by Israel [9] for a non-exhaustive independent sample.

$$N = \frac{z^2 \times p(1-p)}{m^2}$$

With:

N = sample size

z = 1.96 for a confidence level of 95%

p = estimated proportion of the population was set at 0.5

m = permissible margin of error was set at 5%.

The quota method for a non-exhaustive sample, coupled with the snowball method was used for sampling.

2.2. Statistical analyses

The analysis of the collected data was carried out using the software "IBM SPSS" (version 22). The Chi-2 test was used for the qualitative data analysis. Descriptive statistics (frequency, average) were showed in the form of figures and tables.

3. Results and discussion

3.1. Knowledge of the plant salts

All the interviewed people are familiar with "plant salts". However, the youngest (under 30) have only a basic knowledge about it. They often, unconsciously, consumed these products in traditional remedy. This type of salt, extracted from ashes, is still present in the diet and pharmacopoeia of many populations in sub-Saharan Africa today. It is called *cukkuri* in the region of Maroua (Cameroon) and known as *dalang* in the region of Garoua (Cameroon) and in Nigeria [5, 6]. Like those studied by Ameyran et al. [1] in Togo, they are said to have a preventive and curative effects for many diseases such as high blood pressure, cough, etc.

"Plant salts" production is mainly practiced by women (75.9%). Men (24.1%) hardly produce salts for profit. They do this only for their personal consumption, very often when they are widowed. The production of "plant salts" therefore takes into account social norms and conformity to the roles devolved to each sex in traditional African societies [10]. 65.6% of producers are between 50 and 70 years old and 17.2% of them are over 70. 32.8% are not educated while 34.4% and 32.8% have respectively primary and secondary levels (Table 1). This could denote the simplicity of the manufacturing process as noted by Koffi [11] among *koutoukou* producers in Ivory Coast. However, the concentration of this activity in rural areas and the fact that it isn't really profitable could explain this state of fact.

3.2. Producers of plant salts

Table 1 Factual data (sex, age and educational level) of "plant salts" producers in the west of Ivory Coast.

Factual data	Tonkpi (n = 14)	Guemon (n = 23)	Cavally (n = 21)	Total producers (N = 58)	Chi-2	p
Gender					22.205	0.000
Men	28.6%	42.8%	28.6%	24.1%		
Women	22.8%	38.6%	38.6%	75.9%		
Age					22.541	0.000
35 - 50	30%	30%	40%	17.2%		
50 - 70	21.1%	36.8%	42.1%	65.6%		
>70	30%	60%	10%	17.2%		
Educational level					21.301	0.000
Illiterate	31.6%	36.8%	31.6%	32.8%		
Primary	20%	40%	40%	34.4%		
Secondary	21.1%	42.1%	36.8%	32.8%		
Total producers(N = 58)	24.1%	39.7%	36.2%			

p: the p value of the Chi-2 test; n: sample size by region; N: total sample size

3.3. Plant salts manufacturing

3.3.1. Vegetable matters

The main salts found are produced from arecaceae branches: palm (*Elaeis guineensis*) or coconut (*Cocos nucifera*). Salts produced from plantains (*Musa paradisiaca*) peels, cocoa (*Theobroma cacao*) pods, coffee (*Coffea L.*) husks, reeds (*Phragmites australis*) and forest trees are also present (Figure 1). As also found by Langlois *et al.* [12] among the *Dabas*, the raw materials are collected around the villages, in fields and in the forest (Figure 2). A high quality of raw material ensures the quality of the product. So, it is even more imperative that it is available. The above-mentioned materials are all available in Ivory Coast where more than 4,000,000 ha and 440,152 ha are respectively devoted to the cultivation of cocoa-coffee and palm-coconut pairs [13]. However, given the mapping of crops grown in Ivory Coast, only the quality of "plant salts" from arecaceae could explain their high use (Figure 1). Indeed, they are much more cultivated in the coastal south of the country [13].

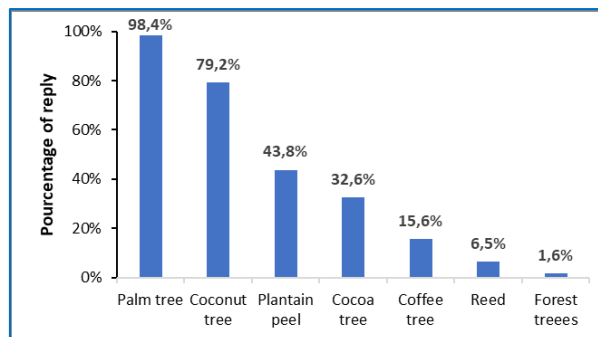


Figure 1 Main raw materials for "plant salts" production in the west of Ivory Coast

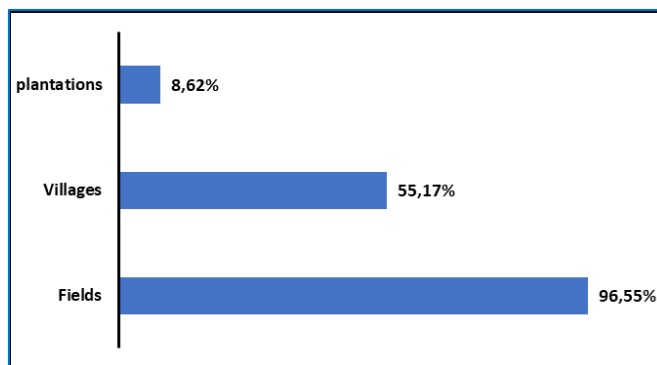


Figure 2 Sources of raw materials for "plant salts" production in the west of Ivory Coast

3.3.2. Manufacturing process

"Plant salts" are obtained by crystallization of mineral salts from plants. In the surveyed area, two (2) main manufacturing processes could be observed. These processes share similarities to which are added particular materials and know-how. Indeed, "plant salts" manufacturing is based on the same principle: plant material incineration - ashes collection and hydration – obtained salt crystallization and drying. According to Langlois et al. [12], the principle is the same in all places where these kind of salts are produced, except that the last step (crystallization) is not compulsory for some. The ashes, were either gradually hydrated on a filter by sprinkling water (native *Dan, Guere* and *Wobe* peoples) or directly diluted in water (non-native *Malinke* people). Filtration is done through a sieve made of vegetable or synthetic fibers or on a jute bag. Water in the filtrate is evaporated either by cooking or sun-drying. The obtained dough has a higher humidity (≈ 7 to 10%) among native producers than the others (around 5%). For drying, the *Malinke* spread the wet dough, in small portions (irregular balls), on a bag in the open air (Figure 3). However, in a particular way, *Dan, Guere* and *Wobe* peoples use a drying system (a crystallizer). This system consists of a basin inside which are placed a layer of fine sand (lower layer) and a layer of sieved ashes (upper layer) (Figure 4). Drying on a crystallizer takes place in the open air between 3 and 6 hours, often longer. In addition, to reduce the humidity of the crystallized salt, it can be roasted in a pot over low heat. This operation can cause, if not controlled, the agglomeration of several crystals of salt. Other structures, notably incineration ovens - earthen filters and pots, involved in the massive production of "plant salts" were discovered in the 19th century in Cameroon, Chad and Niger [12, 14, 15]. *Malinke* process gives a lumpy "potash" when that of *Dan, Guere* and *Wobe* gives a better developed "plant salts" (Figure 5).

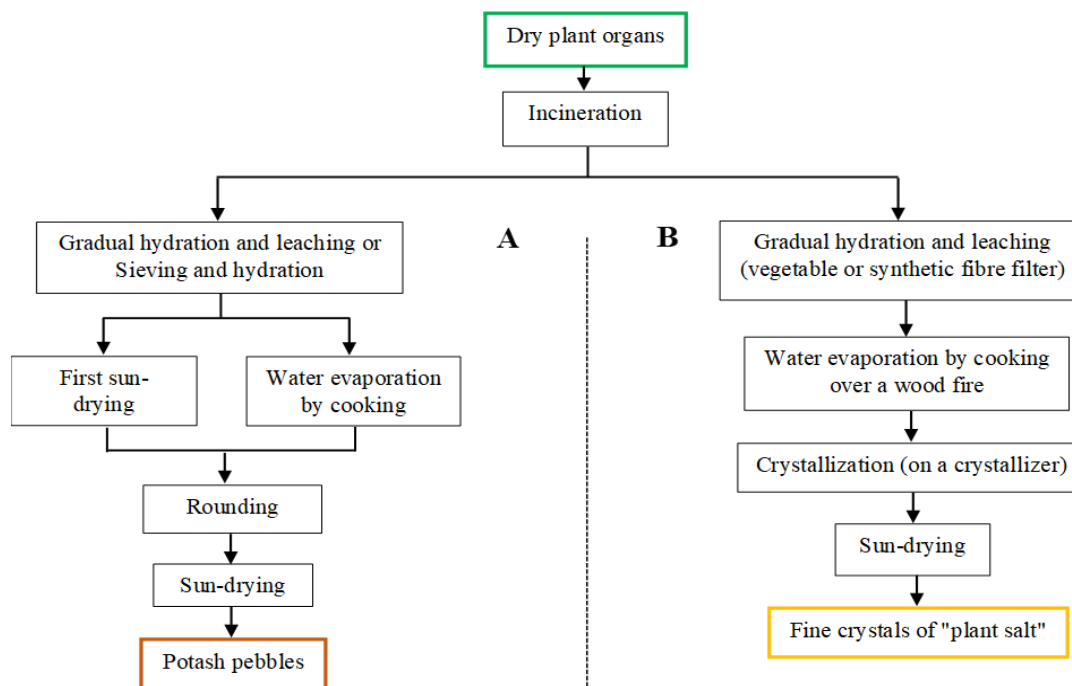


Figure 3 Diagram of production of: A- non-native common potash and B- natives "Plant salts" produced in the west of Ivory Coast



Figure 4 Traditional crystallizer for "plant salts" (Kpangouin 2, Tonkpi)



Figure 5 Physical differences between *Malinke's* Common potash (at left) and "Plant salt" from *Dan, Guere* and *Wobe* peoples (at right)

3.4. Different types of plant salts

In the west of Ivory Coast, for reasons of taste and technology, each salt is specific to a plant, or even an organ. As reported by Mianpeurem et al. [5], the raw materials largely determine the chemical composition and the properties of salts extracted from them. Thus, we have two types of "plant salts" produced in the west of Ivory Coast.

3.4.1. Inedible plant salts

"Inedible plant salts" are salts deemed to be too aggressive ("too strong" in the usual language). These are produced exclusively for cosmetic purposes, in soap factory in particular. *Malinke people* produce this kind of salts mainly from coffee hulls and cocoa pods. Similar potash salts are widely produced in Nigeria from many trees ashes, sawdust, banana peels etc. [16, 17].

3.4.2. Edible plant salts

The "edible plant salts" are those that are considered less aggressive, soft. In the surveyed area, the vernacular names of this kind of salt are: *tonh nehin* among the *Guere* people (Cavally) and *kah weh* among the *Dans* (Tonkpi). *Tonh* and *weh* are their names of origin literally meaning "salt". *Nehin* and *kah* mean sharp or aggressive. Among the *wobe* people (Guemon), they are called *sehe* or *sebe*. For the *Dan, Guere* and *Wobe* peoples, palm and coconut salts are the most produced. However, salts from forest trees such as kapok tree, although rare, are also very popular (Figure 6).

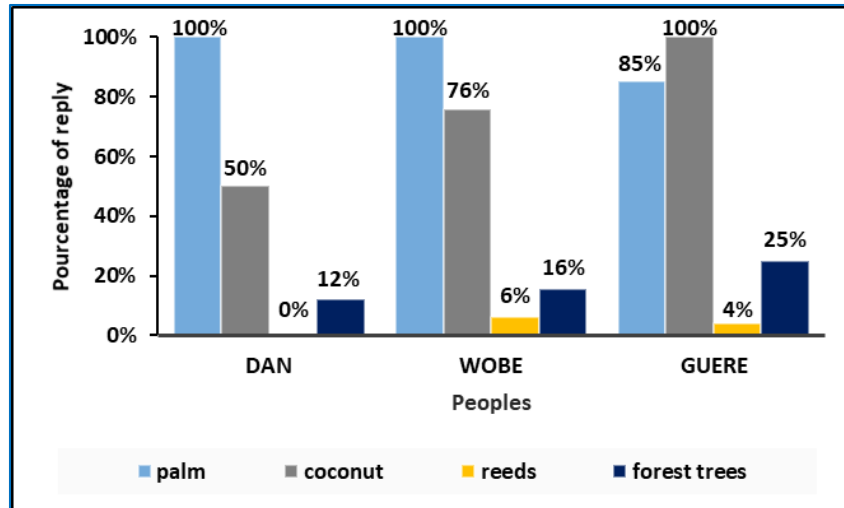


Figure 6 Most “edible plant salts” produced by the natives of the surveyed regions

The scarcity of the forest trees salts is explained by the destruction of more than 80% of the forest cover for the benefit of habitat and the expansion of industrial crops [18]. Next to these, there is one that it is very common to find in all Ivorian markets. It is simply called “potash” or *Anango blô*. The technology of its manufacture could come from Nigeria. According to some respondents, it would come from a mixture of plants, for others from plantains peels. However, Martin et al. [4] and Ameyran et al. [1], notice the same kind of potashes in Mali and Togo without detailing their manufacturing process. This potash is in the form of light grey pebbles and tastes salty. It is generally produced by the *Malinke* and call *segue* (Figure 5A, section 3.3.2). This common potash is not use in meals salting. Rather, it is used to soften meats, make okra-based sauces stickier, prepare millet cakes and corn jelly. Zaki [7] and Doh [8] made the same observation for “plant salts” produced in the West African sub-region countries like Benin, Nigeria and Togo.

3.5. Plant salts productivity

Producers are all consumers of their products. The category of “small producers”, productions less than 1 kg, represents 29% of the workforce. Their products are strictly dedicated to their personal use. The productions between 1 and 5 kg and of more than 5 kg are respectively attributed to 50% and 21% of the interviewed producers. They are classified as “large producers” (Figure 7). Due to the expansion of sea salt, the production of “plant salts” has declined dramatically. This observation had already been made by Passarge [14] concerning the “plant salts” produced in the south of the Chadian basin. These salts were very important in hinge of the 19th and 20th centuries. Unfortunately, they lost any market value with the advent of mineral salt (NaCl).

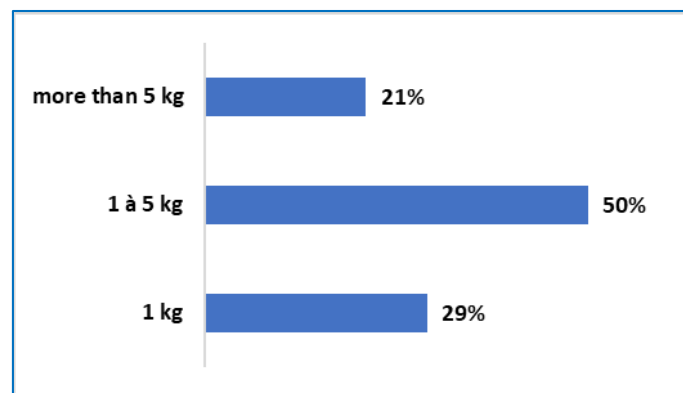


Figure 7 “Plant salts” productivity in the west of Ivory Coast

3.6. Plant salts consumption

“Plant salts” are used as cooking or traditional medicine additive. Precisely, 34.6%, 32.4% and only 9.8% of interviewed, respectively aged over 70 years old, from 50 to 70 and 35 to 50 years old, consume them for their taste (Table 2). Most of those, who consumed them in meals, did so because they were used to soften meat, improve the stickiness of okra

sausages, etc. These “plant salts” are consumed more for health reasons than for their taste and usefulness. The various health reasons mentioned are high blood pressure, reproductive health, influenza, etc. (Figure 8). It is also for these same reasons that Ameyran et al. [1] wanted to contribute to the promotion of “plant salts” from Togo. The elderly are their first consumers. In fact, 22% and 13% of interviewed people, respectively aged over 70 and from 50 to 70, consume them daily. Most (87%) of the respondents aged between 35 and 50 are occasional consumers (Figure 9).

Table 2 Reasons and way of "plant salts" consumption according to age

Consumption	35 - 50 (n = 132)	50 - 70 (n = 145)	>70 (n = 107)	Chi-2	P
Reasons					
Health	93,2%	61,4%	84,1%	44,252	0,000
Taste	9,8%	32,4%	34,6%	25,459	0,000
Technology	51,5%	47,6%	67,3%	10,324	0,006
Availability	20,5%	38,6%	63,6%	46,051	0,000
Way of consumption					
Medicines	89,4%	89%	98,1%	8,131	0,017
Meals	56,8%	95,2%	97,3%	56,055	0,000

n: sample size by age group

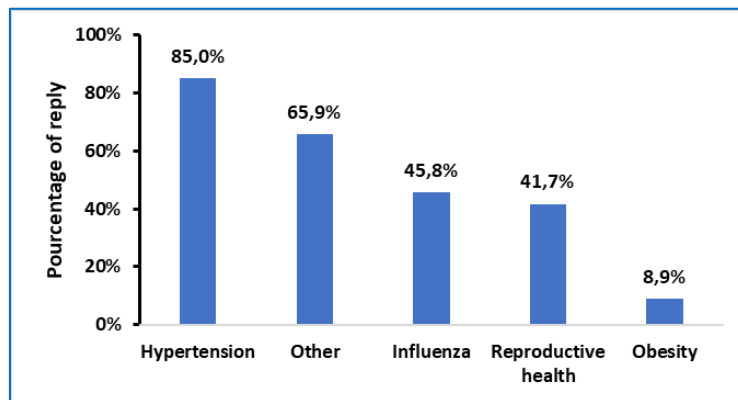


Figure 8 Health reasons for "plant salts" consumption in the west of Ivory Coast

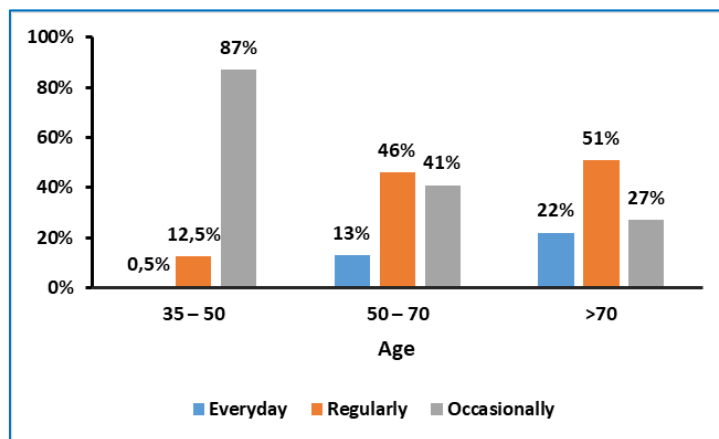


Figure 9 Frequency of "plant salts" consumption according to age

3.7. Plant salts storage and marketing

"Plant salts" storage conditions are not trivial. They involve traditional and modern packaging. Indeed, katemfe leaves (*Thaumatococcus daniellii*) are specially used in the camps to keep small quantities. Large amounts of salts can usually be stored in plastic buckets. However, plastic and glass boxes are used for household storage (between 100 g and 1000 g). Retailers use polyethylene bags (87.93% of responses) (Table 3). Like common salt (NaCl), "plant salts" can be kept for a very long time, beyond three (3) months. It is only imperative to set up the right conditions for their conservation, in particular the moisture barrier. In fact, just like any water-soluble products with a fine particle size, they can easily hydrate and liquefy [19].

Table 3 "Plant salts" storage conditions and marketing in the west of Ivory Coast

Storage	Percentage of reply
Plastic bucket	27,59%
Box (glass and plastic)	84,48%
Plastic bag	87,93%
leaf of plant	24,14%
Marketing	Percentage of reply
Household	67,2%
traditional practitioner	19%
retail	63,8%

Very often, "plant salts" are made, on demand, for households and traditional medicine practitioners. However, 63.8% of producers also engage in retail trade (Table II). Purchases in several localities allowed us to estimate the cost of 100g of "plant salt", produced in the west of Ivory Coast, to 500 FCFA.

4. Conclusion

The survey revealed two main groups of "plant salts": "edible plant salts" and "inedible plant salts". The "edible plant salts" are mainly produced, by the natives *Dan*, *Guere* and *Wobe* peoples, from palm or coconut branches. They use them as cooking and traditional medicine additive. These "plant salts" are mainly consumed for health reasons and then, the elderly are their first consumers. It would be interesting, later, to carry out a study on their biochemical characteristics in a view to get a glimpse of their potentialities in human diet and food industry.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors, Hermann Dekpaho Gnahe, Jean Didier Kouassi-Koffi, Hermann Antonin Kouassi and Emma Fernande Assemmand, declare that they have no competing financial interests, no known conflicts of interest associated with the publication of this manuscript. The authors also disclose conflict of interest with products that compete with the one mentioned in this manuscript.

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