Int.J.Curr.Microbiol.App.Sci (2021) *10*(10): 1-10

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 10 Number 10 (2021)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2021.1010.001

Inventory of the Different Methods of Natural Conservation of Food Crops Used in the Markets of Daloa (Ivory Coast)

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Keywords

Food crop, eggplant, tomato, okra, conservation

Article Info

Accepted:
05September 2021
Available Online:
10 October 2021

A B S T R A C T

Food in West Africa is one of the main sources of cash income. It plays an important role in feeding populations (rural and urban). These vegetables are very perishable foods, and generally seasonal, causing several post-harvest losses. Lack of knowledge of the natural techniques used by our peasants to conserve their various crops hampers their application, as well as their popularization. It is with this in mind that this study was initiated. It is based first of all on a survey carried out on large markets and supermarkets in the commune of Daloa (Ivory Coast), with a view to identifying the most widely used natural food conservation methods. It appears from these surveys that the open air preservation method was the most common at 80%. This method is widely used on eggplants (42.29%), tomatoes (33.66%) and okra (24.05%) in the markets. This method could favor certain physico-chemical parameters of the food crop to the detriment of others. The results of surveys carried out in the field have made it possible to show the need to popularize the food sector by training our various producers and sellers in order to know the basic basics of conservation.

Introduction

Food in many West African countries is one of the main sources of cash income. It plays an important role in feeding populations (rural and urban) (Parkouda *et al.*, 2016). In the food sector, vegetables particularly play a preponderant role in the daily diet of the populations. In Côte d'Ivoire, despite the natural assets which provide a gross food production of nearly 8 million tonnes per year, the demand for vegetable products is growing. Imports of vegetables and fruits cause an outflow of currency estimated at around 10 billion (Anonymous 1, 2005). In Côte d'Ivoire, despite the natural assets which provide a

gross food production of nearly 8 million tonnes per year, the demand for vegetable products is growing. According to the National Rural Development Support Agency (ANADER), the quantities of vegetable products in 2009 amounted to 760,000 tonnes (Guede *et al.*, 2016). These vegetables are very perishable foods, and generally seasonal, causing several post-harvest losses. Most of the products only remain consumable for a short time (Alzamora *et al.*, 2004). Some methods for extending shelf life have been developed and several studies have been carried out. These popularized conservation techniques are for the most part expensive and not very accessible to the majority of the population (Lepengue *et al*, 2012). Research has therefore been directed towards simple conservation methods, adapted and accessible to all social strata. In Côte d'Ivoire, the lack of knowledge of the natural techniques used by our farmers to conserve their various crops hinders the application of these methods, as well as their popularization.

It is with this in mind that this study was initiated. The general objective of this study is therefore to make an inventory of the different natural conservation methods used by wholesale food vendors. More specifically, it will be a question of identifying wholesalers of food crops in large markets, of making an inventory of their different conservation methods used and then of evaluating the limits and advantages of these methods.

Materials and Methods

Site and technical study materials

The study was carried out on food crops, through surveys in large sales areas and large food markets, located in the town of Daloa (Ivory Coast). Survey materials were created from two types of questionnaires intended respectively for wholesale and semi-wholesale food sellers and for consumers or customers encountered in the latter.

Survey methods

Sampling

The survey was carried out at the markets of the municipality of Daloa (Côte d'Ivoire). Spaces for large sales of food crops have been identified in markets, around markets and in neighborhoods. In each market, traders and customers were interviewed. A total of fifty-five (55) merchants comprised of wholesale and retail sellers were approached. Seven (7) randomly selected customers from each vendor were interviewed. Thus, three hundred and eighty-five (385) people were therefore interviewed. In the field, the investigations were carried out in the form of an interview. Materials were prepared and then printed to collect the information obtained in the field.

Characterization of food crops

Sampling

The food crops used for this study were the most encountered during the survey. They were carefully selected and transported with care to the laboratory and then stored under the same conditions investigated by the vendors. For each storage time, random samples of 500 grams of typical food crop were made. Three samples were then formed per storage lot. A total of thirty (81) food crop samples underwent physicochemical analyzes during this study for the most widely used preservation method.

Determination of dry matter

This determination method was inspired by BIPEA (1976) where 100 grams of fresh, finely peeled pulp in thin layers were placed in an oven at 70 ° C until a constant weight was

obtained. The weight differences will then be calculated.

$$\% MS = \frac{m2}{m1} \times 100$$

Where

m1: mass of the sample before drying
m2: mass of the sample after drying

Determination of protein content

The protein contents are obtained according to the AOAC method, (2000) using KJELDHAL, based on the determination of the total nitrogen of the sample. It includes several steps including the evaluation of the percentage of dry matter, mineralization, distillation and determination of titrisol NaOH (0.1N). Knowing that 14 mg of nitrogen are captured by 1 ml of 1N HCl and that the protein / nitrogen ratio is 6.25; the following formulas made it possible to determine the protein contents.

$$M\ N\ (mg) = 14\ mg\ N \times 0{,}1 \times V\ HCl$$

Where

VHCl : Volume of hydrochloric acid
M N : Mass of nitrogen
0.1 : Normality of the acid

$$\% NITROGEN = \frac{M\ N}{PNe} \times 100$$

PNe : Net weight of the sample

$$\% PROTEIN = \% NITROGEN \times 6.25$$

Determination of the oil content

The oil content was determined according to the standardized Soxhlet method. This method consists of extracting the oil with an organic solvent (hexane) on a solid matrix (sample ground). The oil content relative to the dry matter after extraction with a giant Soxhlet was obtained from the following formula:

$$m3\ (oil) = m1 - m2$$

Where

m1 : Cartridge pre-tared
m2 : The mass of the filters obtained after extraction and drying
m3: Mass of the oil

$$\% oil / dry\ mass = \frac{m3}{5} \times 100$$

Where

5: Mass of the dried sample

Determination of crude ash content

Five grams (5 g) of dried and deoiled pulp samples were weighed and placed in a crucible. This is introduced into a muffle furnace set at 550 ° C. for 24 h, according to the BIPEA method (1976). The temperature is maintained until a white, light gray or reddish ash is obtained. The crucible is then cooled in a desiccator and weighed.

$$\% Ash = \frac{m\ 2}{m\ 1} \times 100$$

Where

m 1: mass of sample before incineration
m 2: mass of ash obtained

Determination of total sugars content

The total sugar content is determined according to the technique described by (Dubois et al., 1965) using phenol. In the presence of phenol and concentrated sulfuric acid, sugars form complex phenolic compounds called furfural with a yellow coloration, the intensity of which is proportional to the concentration of total sugars present in the medium.

The optical density is read with a spectrophotometer at a wavelength of 540 nm against the control (2 ml of distilled water, 1 ml of phenol and 1 ml of H_2SO_4).

Statistical analysis

For the surveys, the information collected was analyzed manually. By market, data has been aggregated and expressed as a percentage. They are then treated statistically by Pearson's "chi-square" test for the comparison of several distributions observed at the 5% significance level. Each of the tests described in this work was repeated 3 times, and the results subjected to an analysis of variance using Statistica 6.0 software, at a threshold of 5%. Newman-Keuls comparative tests were used, if there was a significant difference.

Results and Discussion

Survey results

Sellers and customers surveyed

The description of the surveys carried out in the town of Daloa is presented in the figures. It appears from the results obtained that 92.13% of food vendors are women against 5.66% men. The remaining 2.21% represent family businesses (Figure.1).

Among those questioned, 64.79% of all salespeople and customers are illiterate, against 20.02% having primary level, 10.69% secondary level and 4.5% represent those who have higher level (Figure.2).

The three most common food crops

The different survey areas were richly made up of three main food crops which are eggplant with a percentage of 42.29%, followed by tomatoes (33.66%) and finally okra (24.05) and those, in different varieties and species (Figure 3).

Update on natural conservation methods encountered

It emerges from the results obtained during the surveys carried out that two (2) natural conservation methods are more used at market level. Storage in the open air of foodstuffs is the most common with a rate of 80%, potash is also used in okra powders as well as certain cereal flours (15%).

The other preservation methods such as storage in bags as well as food crops covered with plastic were used in a minority by sellers during our survey with a percentage of 5% (Figure 4).

Determination of physicochemical parameters on food crops stored in the open air

Dry matter rate

The dry matter contents reveal that during storage in the open air, significant increases from 1 to 10 days of storage in the three food crops respectively from 8.45 to 15.94% in eggplant, 4.12 at 5.33% in tomatoes then in okra from 54.22 to 88.05%.

These rates subsequently drop to 5.92%, 2.01% and 20.43% respectively at 30 days of

storage in the open air. Okra is found to be richer in dry matter (Figure 5).

Protein level

The protein levels in the selected food crops show similar variations in eggplant and tomato. Protein levels increase significantly up to 10 days of storage and then drop beyond that. Indeed, rates vary from 1.65; 2.04 to 1.32% for eggplant then 0.88; 1.72 to 0.10% in tomato.

The contents are rather significant descending during all the conservation in okra. They vary from 4.18; 2.62 to 1.44% respectively on days 1, 10 and 30 with the highest concentrations (Figure 7).

Total sugar content

The variation in total sugars shows different patterns in each of the food crops. In fact, the contents drop significantly from day 1 to day 30 from 3.78 to 1.37% in eggplant, while in tomato and okra, the sugar levels generally increase significantly by 45, 33 at 58.10% and from 1.18 to 2.44% from day 1 to day 30. The highest concentrations of sugars are found in tomatoes (Figure 6).

Ash rate

The ashes during storage in the open show significantly different content variations in the three types of food crops studied. In fact, there is a general decrease in eggplant from 0.25 to 0.12%, when a non-significant increase is observed in tomatoes from 0.58 to 0.62% at 10 days of storage, and then decrease significantly up to 0.41%.

In okra, the ash contents drop significantly from 0.82 to 0.62% on days 1 and 10, not significantly increasing to 0.64% on day 30 (Figure 8).

Sellers and customers surveyed

Most of the food sales businesses are owned by women. This high rate is explained by the fact that monitoring activities for the purchase and maintenance of large quantities of food crops are delicate and require sufficient attention; therefore suitable for women.

Also, in traditional African society, women are in charge of feeding the whole family (Assa, 2007), and therefore handle food products more, to ensure the daily management of the household and at the same time help their husbands to meet the needs of their families. family ; This explains the high percentage of women among salespeople and customers.

It also appeared that the vast majority of traders and food crop customers questioned are illiterate. The recorded percentages reveal an enrollment rate well below the national rate of 53.6% (Anonymous 1, 2009). This could be explained by a low proportion of schooling among the Ivorian population due to poverty and the lack of state monitoring. Also, intellectuals are more preoccupied with other activities and prefer to invest in fields which match their training or devote themselves to activities more profitable and which require less effort than the food trade. This situation thus makes it difficult to have a good knowledge of the characteristics of the equipment, the exact follow-up and the rational management of sales and conversions.

Fig.1 Distribution by sex of sales people

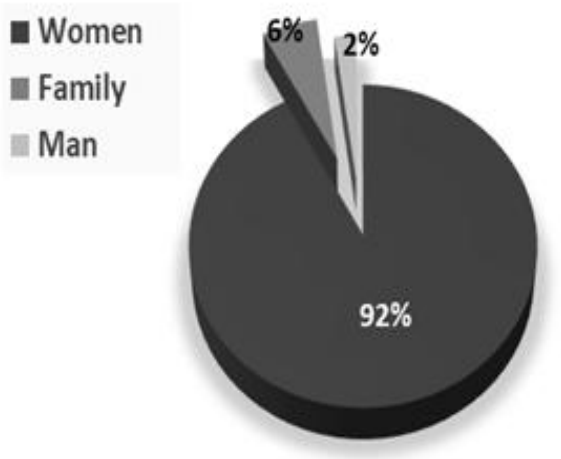

Fig.2 Intellectual level of customers and sales people surveyed

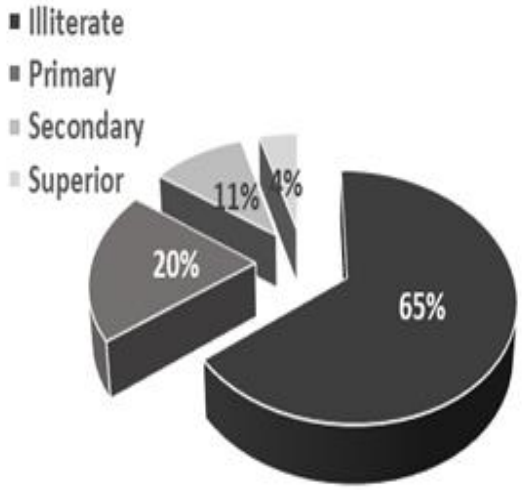

Fig.3 Proportions of the three food crops most encountered during the surveys

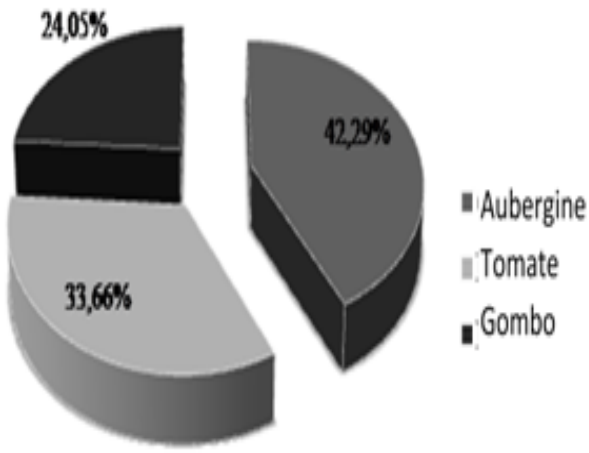

Fig.4 Proportion of conservation techniques most used during surveys

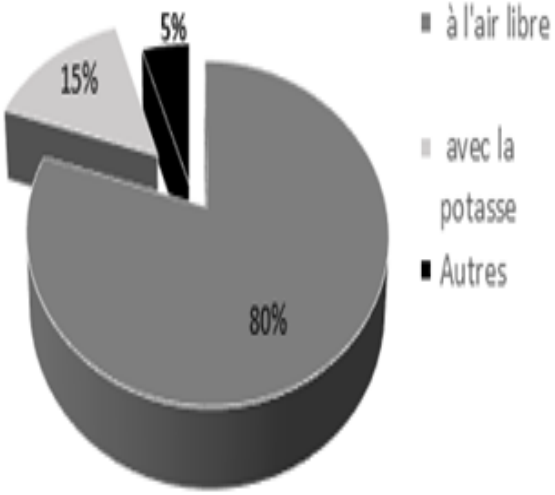

Fig.5

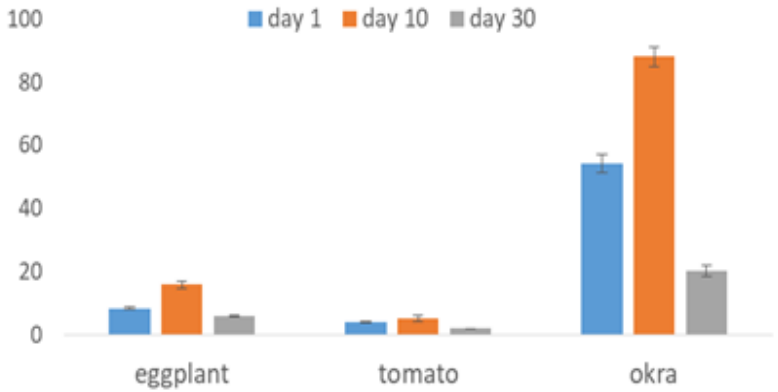

Figure 5: Dry matter rate (% MS)

Fig.6

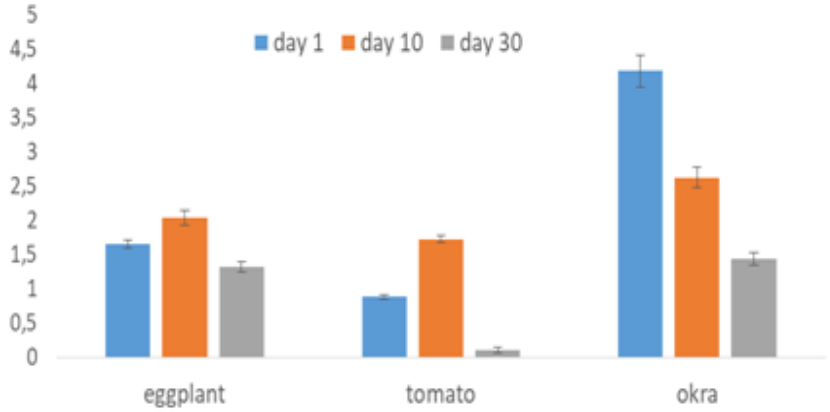

Figure 6: Protein level (% / 100 g MS)

Fig.7

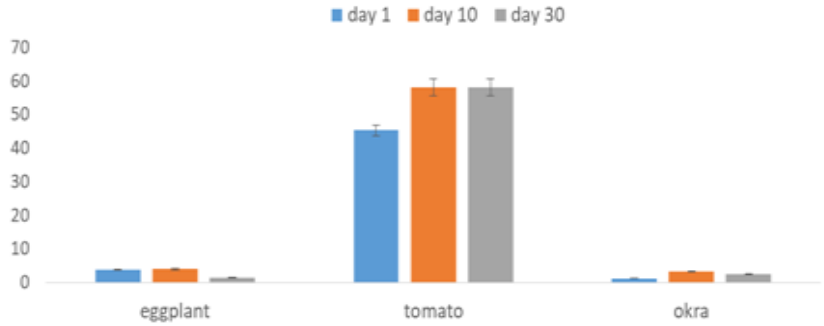

Figure 7: Total sugar content (% / 100 g MS)

Fig.8

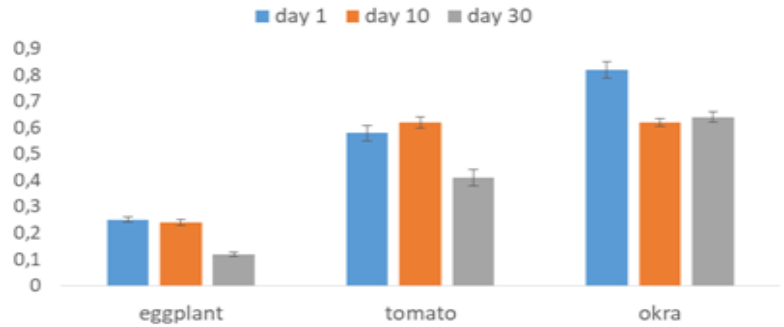

Figure 8: Ash rate (% / 100 g MS)

Characterization of food crops

Among the food crops surveyed, eggplants, tomatoes and okra are mostly found in the markets. Certain social, customary or prestige motivations also justified the choice of these traditional cultures. In fact, the products would be easier to cultivate and would show fewer seasonal requirements, fitting well with conventional farming systems (Camara, 1984). Also many culinary dishes are based on these three food crops.

The surveys carried out reveal that two (2) methods of natural conservation are more used at the market level. The high percentage of use of the open air storage mode is said to be due to its simplicity. However, this method is found to be defective according to CIRAD (2002) because it would facilitate the development of molds as well as insect and rodent attacks. Then comes the use of potash in okra powders as well as some cereal flours. This method would be used with the first aim of improving the organoleptic character of the products and then taking advantage of its ability to preserve these food products. The other preservation methods such as storage in bags as well as food crops covered with plastic would be used in a minority by sellers because of their short shelf life.

Storage in the open air

The percentage of dry matter is the ratio between the mass of the dry matter and the mass of the non-dry matter (hydrated). The levels reveal that during storage in the open air, significant increases from 1 to 10 days of storage in the three food crops, which would be linked to the phenomenon of evaporation (Hincker, 2005). The subsequent drops would be the result of internal transformations of the product's cells which would begin the deterioration phase after 10 days of storage in the open air (Lepengué *et al*., 2012). Okra is richer in dry matter.

The variation in total sugars shows different patterns in each of the food crops during storage in the open air. This reveals the differences in the behavior of food crops during their conservation. In fact, the levels decrease in eggplant, while in tomato and okra, the total sugar levels generally increase significantly. Mainly made up of reducing sugars, the carbohydrate source of eggplants would be rapidly catabolized as soon as the fruits are harvested, thus leading to a high concentration of reducing sugars which constitute the crossroads of most biochemical activities (Lepengué *et al.*, 2012). The differences in proportions observed, however, in the other food crops, would be linked to the different post-harvest metabolic reactions that take place there (Pech *et al.*, 2002). The highest concentrations of sugars are found in tomatoes.

The levels of proteins contained in practically similar eggplants and tomatoes show identical evolutions unlike those of okra; hence the adaptation of the conservation method to plant material (Bahn *et al*., 2007). Synthesis and degradation activities would be the basis of the different variations during our conservation (Hincker, 2005).

Storage in the open air also shows different from one food crop to another in terms of ash. The ash content provides information on the mineral composition of the product. This method of preservation would put eggplants and okra at a greater disadvantage in terms of preserving their mineral quantities. However, the different variations used would be due to the use of the different constituents of the ash in the biochemical activities occurring during conservation (Pettigrew, 2008).

The survey carried out in the town of Daloa, in order to identify the natural methods of food

crop conservation, as well as the most encountered, revealed some characteristics of the food crop market in Daloa., It emerges from the diagnosis. the different conservation methods most used in Daloa's markets are: Two conservation methods, storage in the open air and the addition of potash, are mainly used by sellers. These methods are more used on eggplants, tomatoes and okra in the markets. These natural conservation methods would benefit certain physicochemical parameters of the food product to the detriment of others. The results of surveys carried out in the field have highlighted the need to popularize the food sector.

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How to cite this article:

DEFFAN Zranseu Ange Bénédicte, MASSE Diomandé, YAPI Jocelyn Constant and BEUGRE Grah Avit Maxwell. 2021. Inventory of the Different Methods of Natural Conservation of Food Crops Used in the Markets of Daloa (Ivory Coast). *Int.J.Curr.Microbiol.App.Sci.* 10(10): 1-10. doi: https://doi.org/10.20546/ijcmas.2021.1010.001