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# Comparison of Traditional Storage Methods of Sheanut Kernels (*Vitellaria paradoxa* Gaertn.) Using Drying Curves

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**Abstract:** Water content of a product depends on many parameters amongst which are temperature and relative humidity of its environment. A study was carried out on the dehydration of sheanut kernels (*Vitellaria paradoxa* Gaertn.) in order to compare three traditional storage methods and identify the better one for their preservation as a function of time. Sheanuts stored under different conditions (atmospheric, under ground in a polyvinyl bag and under the sand) underwent drying in a forced convection dryer. The results obtained showed that before 7 h of drying, samples stored under the sand had a better coherence while after this time better results were obtained with samples stored under the ground in a bag. These results indicate that the traditional under ground storage of sheanuts by female farmers at the village level should be enhanced.

**Key words:** *Vitellaria paradoxa* Gaertn, preservation, drying, dehydration, sheanut kernels, France

## INTRODUCTION

Shea (*Vitellaria paradoxa* Gaertn.) is a species of tropical Africa (Booth and Wickens, 1988) which belongs to the family Sapotaceae. Its fruits are unconventional oilseeds and constitute an important source of lipids (UNIFEM, 1997). It is thus necessary to carry out research on new sources of vegetable oils to meet the growing needs of the world population (Haq, 2000). Various methods are used by farmers to produce oil. However, the quantities collected are much and cannot all be used immediately. The traditional and priority occupations do not leave enough time for producers to focus on the processing of sheanut kernels which is considered a secondary activity.

Different local methods to store the excess harvest of sheanut kernels or the quantities remaining for further exploitation exist. However, these conservation methods are still not without drawbacks on stocks. The initial characteristics of products are sometimes changed especially since the water content of the shea fruit is about 60%. Meanwhile the drying operation is meant to facilitate the extraction of shea butter. Numerous studies (Tchiegang *et al*., 2003) indicate that the extraction yield increases with the reduction of product moisture. If aspects of the extraction of shea butter (Tano-Debrah and Ohta, 1994) physical chemistry of shea butter (Kapseu *et al*., 2001) have been the subject of research, the study of traditional methods of shea fruit storage seems to have been given little attention.

The question that arises is what is the effectiveness of these traditional methods of preservation or which of them is most satisfactory? The objective of this research is to compare different traditional storage methods of sheanut kernels using drying curves.

## MATERIALS AND METHODS

**Biological samples:** *Vitellaria paradoxa* Gaertn. nuts were bought from Bambi village, a suburb of Ngaoundere in the Adamawa Province of Cameroon. Bambi village is located at latitude 7°32'N and longitude 1333°78'E on an altitude of 1381.66 m.

**Description of the drying apparatus:** The samples were dried in a forced convection electric dryer (Fig. 1) developed at the Advanced School of Agro-Industrial Sciences of the University of Ngaoundere (Cameroon). This dryer has a height of 170 cm, a length of 52 cm and a

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Fig. 1: Forced convection dryer (Haq, 2000) used in the study

width of 40 cm with a weight of 50 kg. It consists of two compartments each with 4 removable drying trays. The airspeed of the drying air is 2 m $sec^{-1}$. The temperature ranges from 20-60°C.

**Methods:** The nuts were stored under different conditions:

- Traditional storage in a kitchen on the ground
- Wrapping in high density polyethylene bag and buried 1 m deep underground
- Burial 1 m deep under sand

For samples buried underground and sand, storage lasted 8 months while for the storage in the kitchen, the time was 5 months. Samples were treated and characterized as shown in Fig. 2. The sheanuts were selected and the good ones retained. The diameter and length of the kernels were then determined with a vernier callipers (Junior Roche).

Their corresponding masses were determined with the use of a precision (0.001) balance (Sartorius Basic). Their average characteristics were: length 4.20±4.85 cm, diameter 2.73±4.17 cm and weight 20.89±6.09 g. The kernels were cut into slices of thickness between 3 and 4 mm before drying at 60°C. The mass of the sample was

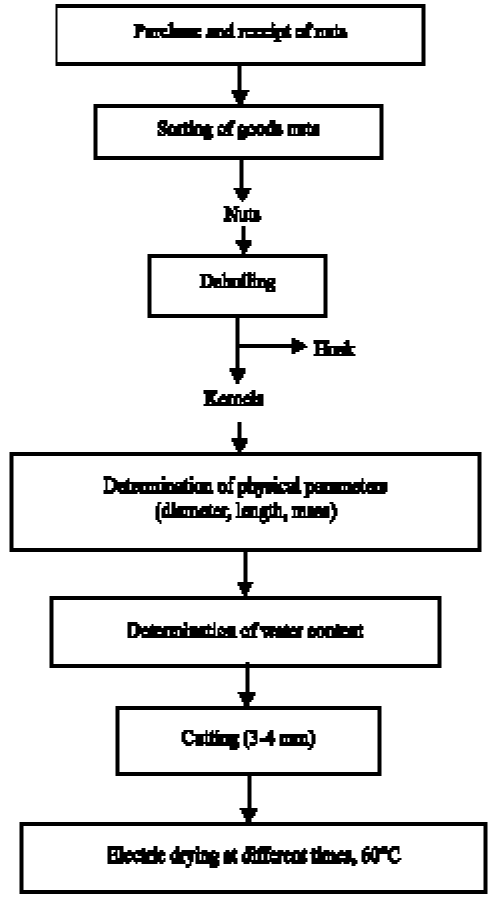


Fig. 2: General scheme of the study on shea nuts

measured as a function of time until constant weight. Modelling by the method of Henderson and Pabis allows connecting the normalised water content, Xr to the drying time using the following equation:

$$\frac{X - X_{eq}}{X_{cr} - X_{eq}} = A\exp(-kt)$$

$$Xr = \frac{X - X_{eq}}{X_{cr} - X_{eq}}$$

Where:

$X_r$ = The normalised water content
$X_{eq}$ = The equilibrium moisture content
$X_{cr}$ = The critical moisture content
$X$ = The water content at t time
$k$ = The characteristic drying constant
$A$ = The other constant of the model

By plotting the logarithm of Xr as a function of time, the researchers deduce the value of k. k talks of how fast or slow a reaction is.

## RESULTS AND DISCUSSION

**Evolution of the air characteristics in the dryer:** The average temperature of the air surrounding the dryer, during the drying period was 25.71±1.19°C (relative humidity 72.27±3.17%). The temperature of the air leaving the dryer was 42.73±3.67°C (relative humidity 65.09± 7.91%). Figure 3 shows the variation of temperature and humidity of air in the dryer during drying.

After 1 h of drying, temperature stabilized at 61.2°C till the end of drying. The decrease in temperature at the beginning of drying should be due to the heat exchange between water evaporating from the sample (surface) and hot air of the dryer. The humidity of the air in the dryer varied from 65-73%.

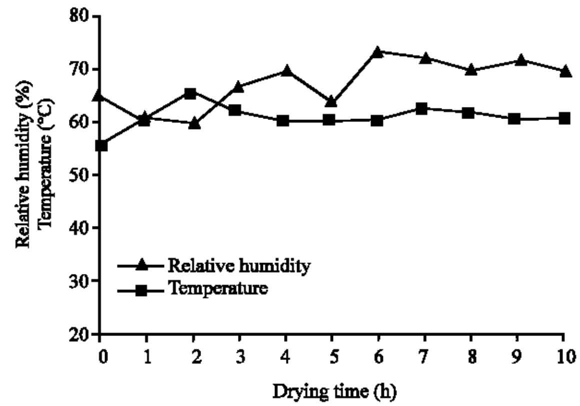


Fig. 3: Changes in air characteristics in the dryer during kernel drying cut at 60°C

**Drying kinetics:** Figure 4 shows the influence of storage methods on the drying kinetics of sheanut kernels. After 2 h of drying, the moisture content of kernels kept traditionally in the kitchen quickly decreased to 19.36% and then decreased slowly this time, up to 8.34% at the end of drying. Between 0-7 h of drying, the moisture content of kernels stored in the sand decreased to a final value of 16%.

As far as samples stored under ground were concerned, there was a steady decrease of water content to 3.1% during the first 6 h of drying. This was maintained up to 8 h and there was a slight decrease to 1.5% moisture content at the end of drying; this curve is thus the most regular. This could be explained by the fact that storage underground had preserved the natural and fresh (water content 55% wet basis) character of the sheanut kernels. On the contrary, regarding the traditional in the kitchen, the dry matter increased at the expense of the moisture. These samples were further more subjected to variable and often negative climatic conditions.

The high water content of samples stored in the sand can be explained by the gain of moisture from the seed during storage. The drying curve here corresponds to a beginning of period 2 of the theoretical drying curve (Bimbenet *et al*., 2002) because they do not observe a constant limit value of water content. A further drying beyond 10 h would give more information about it. On the contrary, the other samples shown a complete and consistent period 2 type curve.

The higher water content of the samples stored under the sand would be a concern for long term preservation. However, compared to literature observation, the drying curves (storage in the kitchen and underground in a bag) have the same appearance as those obtained by (Tchiegang *et al*., 2003; Womeni *et al*., 2002) on the sheanut kernels. Table 1 gives the different model

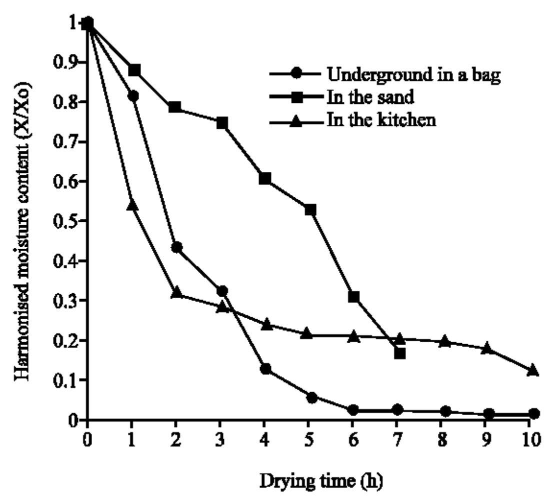


Fig. 4: Drying kinetics of sheanut kernels at 60°C as a function of storage methods

Table 1: Constants and $R^2$ values for the Henderson and Pabis model

| Values | Underground in a bag | In a sand | In the kitchen |
|---|---|---|---|
| k | 0.757 | 0.251 | 0.275 |
| A | 4.007 | 1.527 | 0.696 |
| $R^2$ | 0.911 | 0.818 | 0.859 |

constants obtained from Henderson and Pabis. The associated $R^2$ is the highest and reflects the fact that the model is adequate to describe the drying behaviour of these kernels. These results confirmed the observations made earlier. Indeed, the k value is higher for samples stored underground. Thus, the drying curve of sheanuts kernels stored underground in a bag is consistent and regular.

## CONCLUSION

After this study which had an objective the selection of a better storage method using drying curves, it is clear that the drying process of kernels in the atmosphere in the kitchen has lowest rate with respect to low k value. Storage underground preserves the natural state of the product state.

For these products, the drying rate is highest. Thus, the drying process of kernels stored underground in a bag was fastest. The traditional preservation of sheanuts underground in this sense is recommended at the village level. It presents a comprehensive and coherent curve.

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