Effect of Temperature and Time on the Moisture content, colour and Texture of okra

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ABSTRACT

Effect of drying temperature and time on okra (*Hibiscus esculentus*) was investigated. The moisture content, colour and texture of the okra were evaluated. A model was developed to meet the required safe storage moisture content, using data drawn from a 2^2 factorial conducted in triplicates. The colour and texture parameters were statistically evaluated using chi-square. The results showed that a temperature of 65°C and a drying time of 5 hours are most appropriate for drying okra to safe storage moisture content of 3.2% dry basis (0.032 db). At $P \leq 0.05$ results showed that there was significant difference in colour and no significant differences in the texture of fresh and dried samples.

Keywords: *Okra drying temperature-drying time, moisture content, colour and texture.*

INTRODUCTION

Fruits and vegetables are seasonal and perishable. They undergo spoilage shortly after harvest, leading to gross post harvest losses, which possess a grave danger on Nigeria food security (Sam, 1999). Studies have shown that the use of low temperature are inappropriate for many crops of tropical and subtropical origin such as Okra due to their susceptibility to chilling damage resulting in pitting discoloration and rottening (Okaka, 1997).

Sun drying of Okra is common in developing countries such as Nigeria, since it offers a means of limiting wastage during peak production season. Traditionally vegetables are usually washed cut into slices and spread on paved roadsides, on mats or raised platform for sun drying. Drying continues for days until the product is fully dried. Vegetables dried in this manner have been reported to be highly contaminated by dirt and microbial spores hence they are inferior in colour and wholesomeness and that some food pigments are adversely affected by ultra violet rays from sun light when in direct contact with the foods (Okaka, 1997, Jean-Francois, 1997).

Makama *et al*. (2005) noted that the prevention of post harvest losses require a holisltic and integrated approach, whereby each stage of the post harvest are carried out with the aim of ensuring that quantity and quality of the food crops are not affected negatively.

Omojiba (2000) noted that monitoring the drying temperature and drying time would bring about satisfactory control of the degradation in the quality of okra during drying. In this study the effects of drying temperature and time on the moisture content, colour and texture of okra were investigated with a view to establishing appropriate drying temperature-time that will result in minimum loss of the desired quality of the dried okra.

MATERIALS AND METHODS

Freshly harvested okra (*Hibiscus esculentus*) was obtained from a major vegetable farm in Kaduna. The fresh samples were washed, weighed and sliced uniformly into 1cm thickness using stainless steel. They were then spread uniformly on the drying tray of the tray dryer in a single layer to dry at 35 to 65°C at 35 hours for lower and upper levels of temperature and time respectively. The moisture content of the samples was determined using oven method as described by Association of Official Analytical Chemists (AOAC, 1995).

The moisture content values observed were used to analyze the 2^2 factorial stepwise regression, using Microsoft Excel 2003.

The colour and texture of the coded okra sample were determined during the drying process using visual/organoleptic method by a semi-trained ten-man sensory panel constituted by lecturers, laboratory technologist, caterers and market women using eight-point Hedonic scoring scale (Ihekoronye and Ngoddy, 1985). The data collection was statistically analyzed using chi-square (Kawanchai *et al.*, 1984; Montgomery, 1991).

Regression of data was based on the model

$$\acute{y} = b_o + b_1X_1 + b_2X_2 \quad (1)$$

where the bs are the regression coefficients of the model, the Xs are the coded variables which measure the discrepancy in the functional relationship.

Similarly, the model for the colour of the okra samples was based on a statistical hypothesis

$$H_o: = 8 \text{ versus } H_1: : < 8 \quad (2)$$

where: H_o = Null hypothesis H_1 = Alternative hypothesis = means.

To determine whether the observed frequencies (0) differ significantly from the expected frequencies (E), a measure of the discrepancy existing between the observed and the expected frequencies was determined from chi-squire X^2 given by:

$$X^2 = (O_j = E_j)^2/E_j \quad (3)$$

where O_j = observed frequencies,
E_j = Expected frequencies = 8

RESULTS AND DISCUSSION

Moisture Content

Results of the regression of moisture contents of the dried okra samples obtained in this work are as shown in Tables 1 and 2

X_1 on the Table 1 represents drying temperature, X_2 on Table 2 represents drying time, Y_{uj} represents observed values of moisture content (on dry basis) which was developed from varied drying temperatures and time, with base level of 50°C for 4 hours as drying temperature time respectively, with 65°C at 5 hours and 35 °C at 3 hours for upper and lower levels respectively indicated values that samples dried under 65 °C at 5 hours had the lowest moisture content of a mean value of 0.0323 db (3.2% db) followed by 0.0583 db, 0.0598 db, and 0.0838 db respectively for drying conditions at 65 °C at 3 hours, 35 °C at 5 hours and 35 °C at 3 hours respectively, the result indicating that drying temperature has greater effect on moisture loss than drying time, with 65 °C at 5 hours the most effective drying temperature time combinations in terms of faster moisture loss for okra drying using tray dryer. The regression as analysed (Tables 1 and 2) showed a model of the okra drying as

$$\acute{y} = 10.2916 \; 0.0886X_1 \; 1.2516X_2$$

This indicates that for every unit increase in temperature from the base level, which was 50 °C at 4 hours, results in a reduction in moisture content of the okra from the original level by 1.2516.

This situation expressed the fitted model for a suitable drying temperature-time relationship for drying okra. The results showed that using a drying temperature of 65°C and drying time of 5 hours, the moisture content (dry basis) will reduce from the original 88%wb (7.3% db) to 0.032db. The moisture content at this relationship is appropriate for good storage since it has been observed that level of moisture contents that will prevent microbial growth is less than 10% and that for the prevention of biochemical deterioration, should be less than

5% db (Kordylas, 1990). Hence the optimum temperature for drying okra as far as this study is concerned seems to be about 65°C while the corresponding drying time is about 5 hours using tray dryer.

Usually high moisture content facilitates food deterioration and spoilage by both chemical and biochemical means (Desrosier and Desrosier, 1977).

The lowest moisture content obtained by drying of okra sample at 65°C for 5 hours in a tray dryer (0.032db) falls within recommended 3-7% wb final moisture content for dried fruits and vegetables (Fields, 1977), which seems to be an improvement compared to that of 7.5% wb reported by Bello (1999). The 0.032 db final moisture content obtained also compared favourably with that obtained by solar drying (4.6%) reported by Onwuka *et al*. (2002) and 4% wb reported by Omojiba (2005), which also seemed to be of slight improved value as compared with oven drying (3.4%), reported by Onwuka *et al*. (2002).

COLOUR

Results of the panelist's scores for the colour of the dried samples of okra are
shown in Table 3. The X^2 value was determined to be 4.86 which is greater than 3.84 but less than 6.6 (P< 0.05 and 0.01) respectively.

The validity of the result checked using Yates correction factor and X^2 (corrected) was found to be 7.74, showed that there is a slight difference of the dried okra from the original colour of okra sample. The colour of the sample seemed to reduce with higher temperature and longer time. This indicates that the samples dried under lower temperature, 35°C for 5 hours retained their green colour much more than those dried under higher (65°C) temperature. Hence higher temperature results in faster rate of moisture loss, but could equally result in higher loss of good acceptable colour quality.

Okra is mostly cherished for its green colour (Orishabgemi *et al*., 2002). Chlorophyl pigments (a and b) consisting of poprphyrin structure with magnesium atom at the center constitute the green pigment in vegetables and it has been shown that chlorophyll becomes unstable molecules in dead cells (as in harvested vegetables) (Orishagbemi, *et al*., 2000). Bello (1999) reported thatfor good desirable colour quality, the over ripened and underripened fruits resulted in off-clour and off-flavoured dried fruits, showing that the degree of ripeness of the fruit prior to drying affects the final colour of dried okra.

Okaka (1999) noted that ascorbic acid (vitamin C), which is contained in most fruits and vegetables, is about 47mg/100g in okra. Omojiba (2005) stated that vitamin C is a food component that can undergo non-enzymatic oxidation resulting in the formation of brown pigments. But Fields (1997) noted that products high in thiamin, about 0.04mg/100g as reported by Omojiba (2005) should be not be sulphited since sulphite sedtroys the vitamins. Lowering the acidity of okra through chemical dipping has been reported to enhance good colour retention (Orishagbemi, *et al*., 2000)

The okra dried under 35 °C from 3 hours tend to grow mouldy after two days with slight brownish colour change. This might be because the moisture content is not low enough but still able to permit activities of moulds which hastens the spoilage of the okra sample.

TEXTURE

Results of panelists' scores (Table 4) showed a value of 3.81 and Yates validity correction factor of 6.4 indicating that the observed texture frequencies for the dried okra do not differ significantly in texture from the original (fresh okra sample) texture frequencies, thus the resultant texture of the okra samples at the end of drying under the 65°C and 5 hours could be said to be of no significant difference from the texture of the fresh okra sample samples.

This trend can obviously be explained by the fact that drying under high temperature results in greater shrinkage (Omojiba, 2005). The higher the temperature with consequent lower moisture content results in smoother texture compared with lower temperatures as the okra dried at 65°C for 5 hours with moisture content of 0.032. This gave the smoothest texture followed by that which was dried at 65oc for 3 hours. Rated lowest was the sample that was deired at 35°C for 3 hours.

CONCLUSION

The results obtained from the 2^2 factorial design technique employed in the study of the effects of temperature and drying time on some quality parameters of dried okra showed that a drying temperature of 65°C and drying time of 5 hours are suitable to reduce moisture content of the product from 88% wb (7.3% db) to 0.032 db (3.2% db) which is safe enough for the storage of the dried product. The result of the sensory evaluation showed a slight difference in colour but no significant difference in the texture of the dried okra samples when compared to the values of the fresh samples.