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EFFECT OF DRYING METHODS ON THE MICROBIAL, PROXIMATE AND SENSORY QUALITY OF OKRA (*Abelmoschus esculentus*)

[1]Noah, A. A and [2]Abiaziem, C.V

[1]Department of Food Technology, The Federal Polytechnic Ilaro, Ogun State, Nigeria
[2]Department Science LaboratoryTech., The Federal Polytechnic Ilaro, Ogun State, Nigeria.
Email: adukechoix@gmail.com

ABSTRACT

The effect of sun and oven drying on the microbial, proximate and sensory quality of okra was investigated. The fruit were cut into slices and dried in the sun for one week and in the oven at 60^{o}C for 48hrs. The microbial analysis of fresh and dried okra shows that Total viable counts of the dried samples range from 95x10^{4}cfu/g to 9x10^{4}cfu/g and fresh sample was 72x10^{4}cfu/g. Fungi counts of dried samples range from 8.5x10^{2}cfu/g to 3.5x10^{2}cfu/g while fresh sample was 4.0x10^{2}cfu/g. There was no growth of *Staphylococcus* and *Salmonella spp* in dried samples. The micro-organisms isolated were of the genera *Staphylococcus, Micrcoccus, Bacillus, Mucor, Aspergillus, Penicillium, Rhizopus*. The results of proximate composition in % showed that ash increase from 1.13%in fresh to 7.32% to 7.35% dried okra samples, fat content 0.46%in fresh to 2.27%to 2.34%, crude protein 2.27% in fresh to 16.17%to17.42%, Fibre 1.12%fresh to16.00% to16.05%,carbohydrate11.01% in fresh to47.82% to50.01% while moisture decreases from fresh okra 84.01%to 9.05% to 8.20%,indicated that the dried okra are rich in carbohydrates, fibre, ash and proteins. Sensory evaluation shows significant difference ($p<0.05$) in all attribute rated. This study showed that the effect of the drying methods resulted in an increase in nutrient thereby making dried okra nutritious. The oven dried samples shows low microbial count and makes it safer for human consumption.

Keywords: *Microbial, Proximate Compositions, Okra, Sun Drying, Oven Drying*

INTRODUCTION

Vegetable form a valuable part of human diet in some region of the world, they are good source of vitamins, minerals and dietary fibre; and water to aid digestion. Vegetables are rich in minerals such as potassium, calcium, zinc and phosphorus (Agbo et al.,2008, Ijeomah et al., 2012). They play an important role in maintaining general health due to the pressure of minerals and vitamins in them (Fayemi,1999).Okra (*Abelmoschus esculentus*) is an important vegetable crop grown in tropical, sub-tropical and warm temperature regions around the world. The most important okra producing countries are India, Nigeria, Pakistan, Ghana, and Egypt (De lannoy,2011).

Okra is a prominent fruit and leafy vegetable grown for domestic consumption of highly nutritious immature leaves and fruits in Nigeria (Farinde et al., 2007).

This vegetable is primarily grown for it immature pods generally harvested between 3 - 7 days old after flowering. Consumption of young immature okra pods is important as fresh fruits, and it can be consumed in different forms: boiled, fried or cooked (Akintoye *et al*., 2011). The enormous nutritional and other biological activities in the pods and seeds were reported by Agbo et al. (2008) and Kumar et al. (2010). The okra pods were reported to have viscous fiber and lower cholesterol content (Kumar et al., 2010). Okra seeds were determined to have appreciable protein content according to Akingbala et al. (2003). Okra provides an important medicinal value which has been reported in curing ulcers and relief hemorrhoid and its mucilage is suitable for medical and industrial application as a plasma replacement or blood volume expanders (Siemonsma and Kouame 2004, Adetuyi *et al.,* 2008) Greenish yellow edible okra oil extracted from the seed is rich in unsaturated fats such as oleic acid and linoleic acid with the content of about 40%. Its fibre has been reported to stabilize bloodsugar, curbs rate of absorption of sugar and prevent constipation (Fagbohun and Faleye,2012).

As the other green vegetable, it is affected by diseases such as mosaic, damping off and powdery mildew which are caused by virus, *Pythium sp* (fungus) and *Erysipha* sp respectively. They have been reported to be either soil or air borne pathogens (Fagbohun and Faleye, 2012).Okra is one of the most perishable commodities due to its high moisture content hence the common conservation method used is drying. This process allows people to make okra more durable and preserve them for food insecure periods (Agbo *et. al.,* 2008). Drying technique is probably the oldest method and the most important method of food preservation practice by humans. Drying may be achieved by sun or using hot air oven. Drying preserves food by reducing water activity of the food to a level insufficient for enzymes activity or the growth of microorganism thereby preventing decay and spoilage.(Ofor and Ibeawuchui,2010).Traditional sun drying often yield poor quality since the product is not protected against dust, rain or even against insects, rodents, birds and domestic animals or even handlers while drying. This increases the

risk of soiling contamination with microorganism formation of mycotoxins and infections that could result in disease causing germs (Ofor and Ibeawuchi, 2010). The objectives of the study are to sundry and oven dry okra fruits, investigate the effect of drying methods on mycoflora, proximate composition and overall acceptability of dried okra (*Abelmoschus esculentus*).

MATERIALS AND METHOD

Sample Collection and Preparation

Fresh okra fruits was purchase from Sayedero market in Ilaro, Ogun state. The okra pods were separately sorted to get fine grades which were cleaned, washed, drained and dried using hot air dryer (oven) and sun drying methods.

Drying Methods

The okra fruits were dried in the sun and in electric oven. The temperature of 60°C was chosen for the electric drying for 48 hrs. For sun drying, the slices of okra were placed on boards and are exposed to direct sunlight for one week. After drying, the fruits then pulverized using a mortar and thoroughly homogenized. They were packed in polythene bags and stored in air-tight containers for laboratory analysis.

Microbial Analysis

Isolation of Fungi (Yeast and Mold)

Dilution plate method: This method was used to determine the type of fungi present in the dried and fresh okra samples. About one gram of the sample was sterilized with ethanol and grinded with 10 ml of sterile distilled water. This was shaken thoroughly and 1 ml of suspension was pipetted into a sterile test tube containing 9 ml of distilled water. This was thoroughly mixed together. The sample was serially diluted and 1 ml each of aliquots of 10^4 were added to molten PDA plates. The plates were swirled gently to obtain thorough mixing and were allowed to solidify and incubated at room temperature for 5 to 7 days. The fungal colonies were counted every 24 hrs. Successive hyphae tip were transferred until pure cultures of each of fungus was obtained.

Total Viable Count: From the tenfold dilution of each sample,1ml of each dilution four (10^4) were pour plated aseptically in triplicates using Nutrient Agar for Total viable count, plate incubated at 37^{o}c for 24-48hrs.

Staphylococcus Count and Salmonella Count: Baird Parkers Agar was use for isolation of Staphylococcus count and Bismuth sulfite Agar for Salmonella count. All the plates were incubated at 35^{o}C for 24-48hrs while Colonies were counted on colony counter. Pure cultures of each isolates were obtained by streaking the specific colonies on suitable media and incubated appropriately (Lynne, 2003)

Proximate Composition Determination: The crude protein, ash, fat, and the moisture content for all the prepared samples were determined using standard analytical methods as described in AOAC (2000).

Sensory Evaluation

Oven dry and sundry okra fruits were evaluated for aroma, taste, sliminess, colour, and overall acceptability of their cooked products (soup) .The quality attribute of the samples were evaluated using seven(7) panelists invited using simple comparison test and the samples are presented to panelist at random with each samples having it own code.

Statistical Analysis

Results were expressed as mean ± standard deviation of the triplicate assays. Data were analyzed using (Anova).

RESULT AND DISCUSSION

Microbial Analysis

The microbial analysis of the okra fruits are presented in Table 1.The total viable count of fresh, sun and oven dried okra were72 x10^4cfu/g, 95 x 10^4cfu/g, 9x10^4cfu/g. The staphylococcus count of fresh okra1.0 x10^2cfu/g. Fungi count range from fresh 4.0 x10^2 cfu/g, 8.5 x10^2cfu/g, and 3.5x10^2cfu/g of dried okra with no growth of *Staphylococcus* and *Salmonella* in both samples.
Water activity is an important intrinsic factor that determines the spoilage of foods. The microbial counts in all samples could be due to the temperature

and length of sun drying. Foods with high moisture content are prone to easy microbial spoilage and subsequent short life (Ijeoma *et al.*,2012).

Table 1: Microbial Analysis of Fresh and Dried Okra

Sample Code	Total viable count (cfu//g)	Fungal count (cfu/g)	Staphylococcus count (cfu/g)	Salmonella count (cfu/g)
Fresh Okra	72×10^4	4.0×10^2	1.0×10^2	nil
Sundried	95×10^4	8.5×10^2	nil	nil
Oven dried	9×10^4	3.5×10^2	nil	nil

Microbial species isolated from the dried okra sample can be due to contamination during drying process or through the handlers. Commodities which are exposed to sun drying might become highly contaminated because of the longer drying time required. The foods sun dried over a long period of time are highly contaminated and yield poor quality that required the total viable count of $95x10^4$ cfu/g while the viable plate count of oven dry sample recorded lower count of $9x10^4$cfu/g.

Microorganisms isolated were of the general; *Stapyhlococcus, Micrococcus, Bacillus, Rhizopus, Penicillium, Aspergillus, Mucor. Staphylococcus and Micrococcus* had been reported to be normal flora of human beings while Bacillus had been identified as normal flora of many vegetables. The presence and abundance of Bacillus in some of the samples may not be surprising, as these organisms are indigenous to soil environment. *Staphylococcus aureus and Salmonella sp* were not found in dried okra .The absence of these two pathogens reduce the sanitary risk due to dried okra consumption. Indeed, *Salmonella and Staphylococcus aureus* are pathogenic microorganisms which could induce food infection (Agbo et al.,2008). The mycoflora of fresh okra and dried okra corroborate with the earlier work reported by (Adebanjo and Shopeju, 2002). The oven dry samples recorded the least microbial counts due to drying method are safer for human consumption

Most of the fungi isolated from the dried okra samples has been reported to be associated with pre harvest and post-harvest contamination of dried and fresh vegetables (Fagbohun et al.,2011). In general, microbial load in fresh okra decreased after the drying process. This could be due to the water

activity declining which result from the loss of humidity in samples, causing the inhibition of microbial growth

Proximate Analysis

The result of the proximate composition is shown in Table 2. The analysis was carried out on fresh okra as control as well as the dried okra samples. The moisture content of the dried samples were significantly different and were drastically reduced from 84.01 % in the fresh samples to between 8.20% - 9.05% representing an index of good storage quality. The oven dried sample had the least moisture content probably due to the effect of depth penetration and rapid rate of heating. The slight high value of moisture content of sun dried was due to irregular drying temperature and prolonged drying time while the fresh sample had higher moisture. High moisture content in food is important to act as a solvent to aid in all biochemical reactions and physiological activities during digestion. However, foods with high moisture contents are prone to easy microbial spoilage and subsequent short shelf life. Moderate moisture content of $\leq 12\mathrm{mg/g}$ or 10% is preferred for shelf stability of food on long storage (Ijeoma, 2012).

The percentage Ash content increases in the dried samples from 1.13%fresh sample to 7.32% sundry to 7.35% oven dried samples having the highest. The result of the ash corroborates the finding of Adetuyi et al.,2008 (7.19 to 9.63 % for ash). Fat content increases from 0.46%.to 2.27%oven dried to 2.34%sundried having the highest value. The result corroborate with the work of (Kouassiet.al.,2013) The result of the fat show that the okra contain moderate quantities of fat.

Table 2: Proximate Composition of Fresh and Dried Okra (% dry weight basis)

Sample (%)	Moisture (%)	Ash (%)	Fat (%)	Protein (%)	Crude fibre (%)	Carbohydrate (%)
Fresh	84.01± 0.03	1.13±0.04	0.46±0.04	2.27±0.03	1.12±0.03	11.01±0.09
Oven dried	8.20 ± 0.01	7.35±0.06	2.27±0.02	16.17±0.04	16.00±0.00	50.01±0.03
Sundried	**9.05** ± 0.03	7.32±0.08	2.34±0.12	17.42±0.04	16.05±0.01	47.82±0.03

Values are mean of triplicate determination

Crude fibre content increases from 1.12% to 16.00%oven dried and 16.05%sundried sample. There was no significant difference between the dried samples and was slightly higher than the values obtained from (Kouassiet.al.,2013).

Protein content increases from 2.27% in the fresh samples to 17.42%.The samples subjected to sun drying had the highest protein content with a value of 17.42%which was significantly higher than oven drying methods. Samples subjected to oven drying had the least protein content of 16.17%. These values are consistent with those reported by (Kouassi et al.,2013, Adetuyi et al.,2011and Agbo et al.,2008).Ukegbu and Okereke (2013) observed that increase in protein content of sun dried vegetables compared to solar dried samples may occur as a result of loss of moisture which in turn has an influence on dry matter The dried okra can be considered as a vegetable rich in protein compared to *Talinum triagulare, Amaranthus hybridus and Celosia Argentia* (Kouassi et.al., 2013).

The percentage carbohydrates content vary from 11.01% fresh okra with the oven dried sample had the highest total carbohydrate 50.01%while sun dry okra has 47.82%. A significant difference was observed in for these two drying methods Thus, dried vegetables studied can be considered as good source of carbohydrates. However, there was no appreciable significance difference in the values of Fat, Ash, Crude fibre obtained from the two method used. The protein content of sundried sample was found to be higher than that of oven dried and this may be due to protein being denatured. Dehydrated did not alter the chemical composition of vegetables except by concentrating all constituent.

Sensory Analysis

The sensory evaluation result as shown in Table 3. Indicates that there was a significance difference in the taste, colour, draw ability, aroma and overall acceptability of the two samples at 0.5% confidence level. From the sensory result the oven dried sample was generally accepted by the panelist.

Table 3. Sensory Evaluation of Fresh and Dried Okra

Samples	Taste	Colour	Draw ability	Aroma	Overall acceptability
Fresh	4.02^{b}	4.05^{c}	4.08^{a}	6.10^{a}	4.20^{a}
Sundried	1.24^{a}	2.24^{c}	2.10^{c}	5.40^{c}	2.05^{a}
Ovendried3.	15^{c}	3.10^{a}	3.15^{b}	3.05^{b}	3.10^{b}

CONCLUSION

The research work shows that sun dried okra fruit has the highest count of microbes while the oven dried okra fruits has the lowest count due to the method of drying. Oven drying and sun drying method of dehydration can be successfully used in the formulation of okra and into powdered for soup making as these increases the nutrient content and hence makes it more shelf stable.

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