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The Effects Of Food Processing Techniques On Nutrient Composition Of Okra (Abelmoschus Esculentus L. Moench)

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Abstract: ***Okra is a natural health enhancing food crop fortified with vitamins, minerals, beneficial nutrients and potential medicinal substances imperative for healthy living. The proximate, physicochemical and biochemical properties of mucilage producing crops such as okra are greatly influenced by storage conditions. Two varieties of okra were collected and processed using two distinct methods. The proximate analysis of the fresh and processed okra varieties was determined using standard AOAC techniques. The proximate analysis conducted showed that oven drying of okra pods best improved the crude protein (10.77%), ash (8.50%) and carbohydrate (69.34%) contents of Ila-Iwo okra variety, while the crude fat (4.63%) and crude fibre (2.25%) composites of Ila-Iwo was best preserved by sun drying. The converse was observed for the Kubewa okra samples. The crude fibre (2.26%), crude fat (3.57%) and crude protein (7.30%) contents was best enhanced by the process of sun drying (P<0.05). Oven drying of Kubewa okra samples only helped improved the ash content (8.00%) and carbohydrate composition (74.64%). The optimization of each nutrient components of okra depends solely on the drying techniques used.***

Keywords: Proximate analysis; AOAC techniques; Kubewa; Ila-Iwo; Mucilage

I. INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is a very important annual vegetable crop valued for its edible "slime" producing pods (National Research Council, 2006). It is a natural health enhancing food crop fortified with retinol, retinal, retinoic acid and several provitamin A carotenoids, iron, calcium (Benjawan *et al*., 2007), carbohydrate, protein, fat, thiamine [Vitamin B1], riboflavin [Vitamin B2], ascorbic acid [Vitamin C], niacin and β-carotene (Singh *et al*., 2014). It is also high in crude fibre, foliate, antioxidants and potassium (Duvauchelle, 2011). Okra is widely cultivated and consumed in Nigeria because of the edible mucilage produced by the pods which when combined with soups or stews or prepared as a delicacy, aides the consumption of staple food such as rice pudding [tuwo], pulverized yam or processed yam flour [pounded yam], processed fermented cassava tuber [Fufu or Akpu] and processed cassava flour [Garri prepared as Eba] (Fayemi, 1999).

Okra "mucilage" refers to the thick slimy substance produced by fresh as well as dried okra pods which can be used as food, *ad hoc* substance for chemical synthesis of other products, and as medicine for treatment of some human ailments (Gemede *et al*., 2015). As Food, okra mucilage can be used as whipping agent for reconstituted egg whites, as an additive in the formulation of flour-based adhesives, and for clarifying sugarcane juice (Gemede *et al*., 2016). As *ad hoc* substance pertinent for chemical synthesis of other products, okra mucilage can be applied as brightening agents in electrophoresis of metals, as a deflocculant in paper and fabric production, and as a protectant to reduce friction in pipe-flow (Ndjouenkeu *et al*. 1996). Finally, as medicine, okra mucilage can be used to extend serum albumin (BeMiller *et al*., 1993), used as binder in drug production (Ofoefule *et al*., 2001) and as suspending agent in syrups or other medicinal decoctions or concoctions (Kumar *et al*., 2010). Okra mucilage is used in Asian medicine as a protective food additive against stomach irritations and inflammatory gastric diseases (Lengsfeld *et al*., 2004).

Okra mucilage contains polysaccharides (which might be chemically acidic) associated with proteins and minerals (Woolfe *et al*., 1977) and though the nature of the polysaccharides varies greatly within accessions and cultivars of okra, neutral sugars such as rhamnose, galactose and galacturonic acid have been reported (Hirose *et al*., 2004; Sengkhampam *et al*., 2009). Most physical and chemical properties of mucilaginous substances especially those from natural origin are influenced by factors such as temperature, pH, sugar or salt contents, and storage time (Bhat and Tharanathan, 1987). The okra mucilage is no exception; it can be extracted as a viscous gum using various procedures. Such diversity in the extraction procedures seems to contribute to the observed variability in the mucilage chemical composition (Ndjouenkeu *et al*., 1996) and also its viscosity. Therefore this research was setup to determine the best processing technique for okra pods which can improve or better still preserve the physical and chemical properties of okra mucilage, without altering its high water solubility, plasticity, elasticity and viscosity.

II. MATERIALS AND METHODS

MARKET DESCRIPTION

- ✓ *Address:* Mile 12 Major Market, along Ikorodu road, Lagos, Nigeria
- ✓ *Type:* Commercial market
- ✓ *Classification:* Mega size open grocery market
- ✓ *Latitude:* 6.6053^{o}N
- ✓ *Longitude:* 3.3923^{o}E
- ✓ *Market capacity:* Very High
- ✓ *Frequency of operation:* Daily

VARIETY OF OKRA COLLECTED

Two (2) local varieties of okra were used for this experiment. They are:

- ✓ Variety A: Ila-Iwo
- ✓ Variety B: Kubewa

SAMPLE COLLECTION

A total of 5kg of fresh and healthy (Disease free) green okra pods from each variety was randomly collected from three (3) major distributors in mile 12 market, Lagos State, Nigeria. The collected samples were physically screened for morphological distortion, aseptically packaged in sterile collecting vessels, labelled accordingly and transported to the food technology laboratory of the Department of Food Technology, Yaba College of Technology, Yaba, Lagos State, Nigeria for further analysis.

SORTING

Okra pods showing signs of infection (either by pests or diseases) and those with physical distortion were isolated and discarded. Fresh, healthy and viable green pods were vigorously washed with sterile warm water and Teepol (A mild but highly effective liquid detergent recommended for food industries) to remove germs and contaminants from the okra pod samples picked up within the market environment, rinsed in several changes of distilled water to remove excess detergent, plotted using absorbent papers and air-dried in a laminar air flow chamber for 1hr.

SAMPLE PREPARATION

Blanching: The air-dried samples were blanched using hot water at 100^{o}C for 15mins so as to deactivate enzyme producing cells and destroy chlorophyll pigments present in the green pods in order to avoid self-induced senescence which might result in nutrient depletion.

Shredding: The blanched okra pods were shredded to a thickness of about 2mm radial diameter using a manual shredding machine.

Preservation Technique: The method of Falade and Omojola (2008) was used. The shredded samples were weighed and 5kg from each sample was sundried between 11am and 4pm in a control environment (Microcosm) for one week. Also, 5kg of the remaining samples from each variety was oven dried at 50^{o}C for 48hrs.

Dry weight determination: Random samples from each drying techniques were collected intermittently, physically assessed and weighed (i.e. daily measurements for the sun-dried samples, while the oven dried samples were measured every 4hrs). At constant weight measurement after three (3) successive trials, the drying of okra pods was terminated. The dried okra pods were packed, labelled according to their varieties and stored in a controlled environment to avoid contamination.

Pulverization: After drying using the various preservation techniques, the samples were pulverized using the Mecdine food pulveriser Model Fl cooling crusher drinder machine.

III. PROXIMATE ANALYSIS

A. DETERMINATION OF CRUDE FAT CONTENT OF OKRA

PROCEDURE

- ✓ Pulverized okra sample weighing 1g was aseptically dispensed into a fat free extraction thimble and plugged with cotton wool. The thimble was placed in the extractor fitted with reflux condenser and a 250ml sterile soxhlet flask with known weight. The soxhlet flask was filled to ¾ of its volume with petroleum ether, and the setup was placed on the heater.
- ✓ The setup was heated at 60^{o}C for 6hrs, and the vaporized ether where allowed to condense in the collector chamber by constant running water from the tap.
- ✓ At the end of the experiment, the thimble was removed and dried on a clock glass on the workbench. The extractor, soxhlet flask and condenser were replaced on the heater and the distillation continues until the soxhlet flask was practically dry.

- ✓ The soxhlet flask which now contains the fat (or oil) is detached, its exterior cleaned and dried to constant weight in the oven.

The percentage fat/oil is obtained by the formula:

% Crude fat content = $W_1 - W_0$ x 100

Where,

W_0 = Initial weight of dry soxhlet flask

W_1 = Final weight in the oven (Dried flask + oil/fat)

B. DETERMINATION OF MOISTURE CONTENT

PROCEDURE

- ✓ The method of Owosu *et al*. (2004) was used for the experiment. 2g of okra powder was measured and aseptically introduced into a previously weighed crucible.
- ✓ The samples in the crucible were heated intermittently at 100^{o}C in the oven to a constant weight for 24 hours.
- ✓ At the end of the drying process, the crucible plus the dry powdered sample was removed from the oven and transferred to a desiccator, allowed to cool down and weighed.

The percentage moisture content was determined by the formula:

$$\% \text{ Moisture content} = \frac{W_1 - W_2}{W_1 - W_0} \times 100$$

W_0 = weight of empty

W_1 = Weight of crucible + fresh okra sample

W_2 = Weight of crucible + oven dried okra sample

W_3 = Weight of dried okra sample ($W_2 - W_0$)

C. DETERMINATION OF ASH CONTENT

PROCEDURE

- ✓ Dried okra powder weighing 2g was measured into a porcelain crucible. The sample was ignited using a low flame in the fume chamber to completely char its organic components.
- ✓ The crucible was then transferred into the muffle furnace set at 550^{o}C and left for about 4 hours. At this time, the ashen process had been completed.
- ✓ The crucible and its content were cooled to about 100^{o}C in the laminar airflow chamber and then to room temperature in a desiccator, after which it was weighed.

The percentage ash content was calculated from the formula below:

$$\% \text{ Ash content} = \frac{Weight\ of\ Ash}{Weight\ pulverized\ sample} \times 100$$

D. CRUDE FIBRE DETERMINATION

Reagents: 0.255M of NaH_2SO_4, 0.313M of NaOH and acetone

PROCEDURE

- ✓ The method of AOAC (2005) was used to determine the crude fibre content of the okra samples. A total of 2g of the sample was weighed and aseptically dispensed into the fibre flask and 100ml 0.255N NaH_2SO_4 was added.
- ✓ The mixture was heated under reflux for 1hr on the heating mantle and the hot mixture was filtered through a fibre sieve cloth.
- ✓ The residue collected was returned to the fibre flask to which 100ml of 0.313N NaOH was added and heated under reflux for another 30mins and 50ml hot water was passed twice through the sieve cloth before it was finally transferred into the crucible.
- ✓ The crucible and residue was oven-dried at 105^{o}C for 24hrs to remove any trace of moisture. The oven-dried crucible and residue was cooled in a desiccator and weighed (W_1).
- ✓ The crucible with weight W_1 was transferred to the muffle furnace for ashing at 550^{0}C for 4 hours. The crucible containing white or grey ash (free of carbonaceous material) was cooled in the desiccator and weighed (W_2). The difference $W_1 - W_2$ gives the weight of fibre.

The percentage fibre was obtained by the formula:

$$\% \text{ Crude fibre} = \frac{W_1 - W_2}{\text{Original Weight of Okra Samples}} \times 100$$

E. CRUDE PROTEIN DETERMINATION

PROCEDURE

- ✓ Powdered okra sample (0.2g) was weighed into a 75ml capacity digestion tube and catalyst (one tablet of Selenium) was added. 4ml of cone H_2O_2 and H_2O_2 was added to prevent froth. The setup was placed inside a digester and allowed to digest.
- ✓ After digestion, 75ml of distilled water was added and 1ml was pipette from this solution into a clean test-tube and 3 drops of mineral stabilizer was also added (This is to stabilize the mineral content in the sample). 3 drops of Polyvinyl Alcohol and 25ml of distilled water were further added. 1ml of Nesseler Reagent was finally added and left for 5mins for colour development. The result was read on Spec at 460nM wavelength.

Calculation (For Dry Sample)

$$\% \text{ N} = \frac{0.0075 \times A}{B \times C} \times 100$$

Where,

A = Absorbance from the spectrophotometer

B = Weight of the sample

C = ml of Digest Analysed (i.e. 1ml).

IV. DATA ANALYSIS

The data collected were characterized and analysed using COSTAT 6.451 analytical software for statistical analysis, and the homogeneity of statistical significant means was determined using Duncan Multiple Range Test (DMRT). The data obtained from the experiment were in replicates and was represented as means and standard deviation in a table.

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V. RESULTS

The proximate analysis conducted showed that oven drying of okra pods best improved the crude protein (10.77%), ash (8.50%) and carbohydrate (69.34%) contents of Ila-Iwo okra variety compared to the sun dried Ila-Iwo variety [Crude protein (9.14%), ash (7.50%) and carbohydrate (66.58%) contents, respectively] and the freshly harvested Ila-Iwo variety [Crude protein (2.56%), ash (1.38%) and carbohydrate (7.04%) contents, respectively] of the okra samples used for this experiment ($P<0.05$) as shown in Table 1. Although, the crude fat (4.63%) and crude fibre (2.25%) composition of Ila-Iwo was best preserved by sun drying rather than oven drying [Crude fat (1.93%) and crude fibre (0.76%) composition, respectively], and far more better than those present in the freshly harvested Ila-Iwo okra pods [Crude fat (0.18%) and crude fibre (0.37%) composition, respectively], it is not advisable to store okra (Ila-Iwo) in its raw form or freshly harvested state because of its high moisture content [88.47%] (Table 1).

The converse was observed for the Kubewa okra samples. The crude fibre (2.26%), crude fat (3.57%) and crude protein (7.30%) contents was best enhanced by the process of sun drying ($P<0.05$) rather than oven drying [Crude fibre (0.77%), crude fat (2.44%) and crude protein (5.25%) contents, respectively] and freshly harvested Kubewa okra [Crude fibre (2.44%), crude fat (0.46%) and crude protein (2.51%) contents, respectively] as shown in Table 1. Oven drying of Kubewa okra samples only helped improved the ash content (8.00%) and carbohydrate composition (74.64%) better than sun drying [ash content (7.50%) and carbohydrate composition (70.07%), respectively] and freshly harvested Kubewa okra samples [Ash content (1.17%) and carbohydrate composition (11.17%)]. As advised initially, it is very important that Kubewa okra samples are not stored in their raw form because of their very high moisture contents (82.25%) as shown in Table 1.

		Proximate Composition of Okra (%)					
Preservation	**Variety**	**Moisture**	**Ash Content**	**Crude fibre**	**Protein**	**Crude Fat**	**Carbohydrate**
Sun dried	*Ila-Iwo*	9.90 ± 0.05^{c}	7.50 ± 0.06^{c}	2.25 ± 0.10^{b}	9.14 ± 0.03^{b}	4.63 ± 0.01^{a}	66.58 ± 0.11^{d}
	Kubewa	9.30 ± 0.03^{d}	7.50 ± 0.04^{c}	2.26 ± 0.01^{b}	7.30 ± 0.20^{c}	3.57 ± 0.18^{b}	70.07 ± 0.38^{b}
Oven dried	*Ila-Iwo*	8.70 ± 0.20^{f}	8.50 ± 0.15^{a}	0.76 ± 0.01^{c}	10.77 ± 0.18^{a}	1.93 ± 0.03^{d}	69.34 ± 0.54^{c}
	Kubewa	8.90 ± 0.10^{e}	8.00 ± 0.15^{b}	0.77 ± 0.02^{c}	5.25 ± 0.02^{d}	2.44 ± 0.02^{c}	74.64 ± 0.01^{a}
Fresh	*Ila-Iwo*	88.47 ± 0.11^{a}	1.38 ± 0.06^{d}	0.37 ± 0.02^{d}	2.56 ± 0.02^{e}	0.18 ± 0.00^{f}	7.04 ± 0.02^{f}
	Kubewa	82.25 ± 0.06^{b}	1.17 ± 0.01^{e}	2.44 ± 0.03^{a}	2.51 ± 0.16^{e}	0.46 ± 0.02^{e}	11.17 ± 0.17^{e}

Means with the same alphabets down the COLUMN are not significantly different at $P<0.05$ using Duncan Multiple Range Test (DMRT) for separation of statistically significant means. Data collected were represented as "Means ± SD" only

Table 1: The effects of processing techniques on the nutrient content of Okra

VI. DISCUSSION

The observations drawn from this study showed that different varieties of okra samples require different processing techniques in other to best improve or rather enhance their nutrient contents, and further protect the okra samples from decay and spoilage. This was initially observed by Tsado (2015) who determined the effects of several drying methods on the proximate composition of different varieties of okra and who also came to the conclusion that the optimization of the individual nutrient components of okra depends solely on the drying techniques used. The nutrient composition of Ila-Iwo okra samples was majorly enhanced by the process of sun drying and partially by oven drying. For Kubewa okra varieties, oven drying was very effective in optimising the nutrients composites of the processed okra sample, whereas, sun drying only increased the energy producing potentials Kubewa okra variety. This was also acknowledged by Tsado (2015) who noted that sun drying of okra pods was essential in the preservation of the nutrient composition of okra collected from Kaduna State, while oven drying was effective in optimizing the proximate composite of okra pods collected from Niger State.

The preservation techniques used for this experiment was able to improve the proximate composites of the okra samples, with added nutrient fortification and better concentration of each basic nutrient components required as food, or *ad hoc* substances for chemical synthesis of organic or inorganic products and as natural medicines to combat diseases and other ailments. This earlier acknowledged by the Food and Agricultural Organization [FAO] (2003) who noted that sun drying of okra can enhance its quality and shelf life. Also, the processing techniques used in this experiment was very effective in the reduction of moisture contents of the okra samples without altering or deactivating other beneficial nutrients inherent in the okra samples. This was also observed by Tsado (2015). The reduced moisture content of the okra samples was pertinent in the preservation of the okra varieties for a very long time against microbial insurgence, decay, nutrient depletion, and discolouration while in storage. This was further advocated by Okos *et al*. (1992), who stated that the reduction of the moisture content of food samples can ensure safe storage over an extended period of time.

VII. CONCLUSION

The optimization of each nutrient components of okra depends solely on the drying techniques used. In order to enhance the quality and shelf life of okra, prevent microbial deterioration, decay, nutrient depletion, and discolouration while in storage, the moisture content of the okra samples must be reduced considerably either by sun drying or oven drying depending on the nutrient component of paramount interest.

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