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The Effects of Some Pre-treatment Methods on the Proximates, Sensory Properties and Vitamins Compositions of Okra

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors carried out the research in a collaborative manner. Author OOO designed the study, wrote the protocol, performed the statistical analysis and proofread the draft of the manuscript. Author UMT carried out the literature reviews managed the analyses of the study and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

The investigations carried out on blanching, un-blanching and methods of drying on the proximate, sensory properties and vitamins compositions of okra of Okra (*Abelmoschus esculentus*) were studied. The fresh okra were sorted, washed with portable water, some portions were blanched for 30 seconds while other portions were not pretreated prior to drying. The okra samples were dried using oven drying (60^{o}C) and sun drying methods. Proximate composition, the sensory properties and the vitamin contents of the dried okra were determined. Results showed there was significant difference ($p \leq 0.05$) in the vitamin contents and proximate composition of dried okra while there was no significant difference ($p \geq 0.05$) in the sensory properties of the dried okra samples. The

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proximate composition, blanched oven dried okra samples retained highest amount of moisture, fat, ash and protein (7.85%, 7.00%, 8.24% and 16.83% respectively). For the vitamin composition, un-blanched sun dried okra retained highest amount of vitamin B_9 and vitamin K (0.27% and 0.26% respectively). The blanched sun dried okra retained highest amount of vitamin A (36.34%) and un-blanched oven dried okra retained highest amount of vitamin C (9.65%). For sensory properties, blanched sun-dried okra retained the highest sensory properties (aroma, texture and sliminess) followed by un-blanched sun-dried okra, while oven dried okra has lowest sensory attributes.

Keywords: Blanched; un-blanched okra; sun; oven drying; proximate composition, vitamins contents and sensory properties.

1. INTRODUCTION

"Okra (*Abelmoschus esculentus L. Moench*) also known as bhindi, gumbo, guinogombo, lady's finger and guibeiro" [1]. "It belongs to the family *Malvaceae*" [2]. "It is mostly cultivated in the Africa, Middle East, Southern states of the USA, and the Southeast Asia" [3,4]. "The okra fruit/pod contains numerous seeds, greenish capsule with length of 10–30 cm long and a diameter of 1–4 cm, it is slightly curved, tapers to a blunt point, and a six-chambered pod of fibrous texture" [5].

"It is mainly grown and consumed as boiled vegetables when its tender green pods and leaves, which are cooked" [6]. "It is commercialized in the world with an estimated of 4.8 million tons, India and Nigeria are the major producers" [7]. "Okra has important nutritional value that contains averaging 85%, fat and protein in a small amount, high percentage of water and a fair proportion of carbohydrates which are present as cellulose, starch in small quantity and sugar" [8]. "It also contains non-cellulose, non-starch, polysaccharides" [8]. "It is a source of dietary fibre in high quantity, protein, vitamins C and A, iron and calcium are in low quantity" [9].

"Blanching is a form unit operation prior to canning or drying, freezing in which fruits and vegetables or their products are heated to inactivating enzymes, modifying texture, preserving color, flavor and nutritional value and removing trapped air" [10]. "The most commonly used heating media for blanching in the food industry are hot water and steam. Blanching temperature in hot water at temperatures ranging from 70^0C to 100^0C for 20 seconds" [11,12,13,14,15,]. "The study of low- temperature long-time (LTLT) blanching and the combinations of low-temperature long-time (LTLT) with high-temperature short-time (HTST) blanching have also been reported" (Rahman and Perera 1999). "Blanching should be stopped immediately after the prescribed time to avoid any overcooking" [11]. The mechanical operations used before blanching such as cutting and slicing have been reported by Madaleno [16] is an important role in achieving quality of the blanched material.

"Drying process offer an alternative way preventing the huge post-harvest losses of okra and make them available in the offseason at low cost" [17]. "Drying is efficient, reliable and a feasible method of post-harvest preservation of okra and other highly-perishable fruits and vegetables practically" [17,18]. "Drying aid the promoting and provide stable chain of okra powder production. Drying prompt some reactions that can adversely affect the quality of okra" [19,17]. "Drying alters physical, biological and chemical properties of foods" [17,20].

"Sun drying is the traditional method employed in developing countries because it offers a cheap method of drying but often results to inferior quality of products of agricultural produce due to its dependence of weather conditions" [17,18]. "Oven drying is an alternative method of drying with several advantages over the traditional method and it has been developed for various agricultural products. It improves product qualities, and makes it process more efficient by saving energy and time, and also protects the environment" [17]. "Oven drying is efficient and frequently used operations for dehydration of food" [9].

"Okra" mucilage is a thick and slimy substance found in fresh as well as dried pods. "Mucilaginous substances are chemically acidic polysaccharides associated with proteins and minerals concentrated in the pod walls. The nature of the polysaccharides varies neutral with galacturonic acid, sugars rhamnose, and galactose have been reported often" [21]. "Like a viscous gum is "Okra" mucilage which can extracted by using various procedures and to contribute to okra mucilage chemical composition" [22].

"Okra" mucilage is inexpensive and a renewable source of biodegradable food materials (Kumar

et al., 2009). “It high water solubility, plasticity, elasticity and viscosity are both the physical and chemical properties. Temperature, pH, sugar and salt contents, and storage time are factors that influenced the physical and chemical properties” (Ndangui et al., 2010). “It is used has as food, non-food products, and medicine; food applications include use as a whipping agent for reconstituted egg whites, as an additive in the formulation of flour-based adhesives”, [23]. “It is used in non-food applications e.g. in brightening agents in electro deposition of metals, fabric production and as deflocculant in paper” [24]. “It uses as an extender of serum albumin, as tablet binder and as suspending agent in formulations in medicinal applications” [23]. “Okra” mucilage can be used in Asian medicine as an inflammatory gastric diseases and protective food additive against irritating [25].

“Okra improves heart health, because soluble fiber within okra helps you to reduce serum cholesterol and decreases the chances of cardiovascular disease. The body’s cholesterol level can be managed by consuming okra. Okra reduced high blood cholesterol by the high content of pectin presence in it. That can help in simply by modifying the creation of bile within the intestines” [26].

“Okra is a source of vitamins and minerals, including potassium that is an essential aspect of human health and maintain fluid balance within the body. Also, potassium helps to relax the blood vessels and arteries, reduces blood pressure and reduces the strain on the cardiovascular system. This means that clothing and atherosclerosis will be greatly reduced” [27].

“The uses of okra, is based on 60% of it is for the fresh market while remaining 40% is used for processing. Okra is cooked inform of soups, gumbos, stews, and Creole dishes together with many other vegetables. In some countries, Okra is used in folk medicine as anti-ulcerogenic, gastro protective, diuretic agents” [28]. “The frequent eating of Okra reduced the rate kidney disease, because consumption Okra every day decreased clinical indications of kidney damage a lot more than the ones that simply consumed a diabetic diet” [25].

Okra can be used to treat digestive issues because, polysaccharides present in immature Okra pods contain anti-adhesive properties (i.e. they help remove the adhesive between bacteria and stomach tissue, preventing the cultures from spreading).

“Okra supports colon health by maintaining smoothly sails down colon, absorbing all toxins and excess water. It’s contains dietary fiber that is required for colon health and digestive health all together. It fiber cleanse the intestinal system, letting the colon to operate efficiently” [29].

2. MATERIALS AND METHODS

2.1 Materials Procurement

The okra (*Abelmoschus esculentus*) was procured from WUKARI main market, TARABA State, Nigeria. Other materials include; stainless steel knives, trays or meshes.

2.2 Methods

The samples (okra) were washed in clean water; then divided into two equal parts. One part was pretreated in the boiling water for 30 seconds, while other parts were not pretreated with boiling water prior to drying. The samples both the pretreated and not pretreated were sub divided into two portions each, one portion was sun dried and the other portion oven dried.

2.2.1 Sample preparation

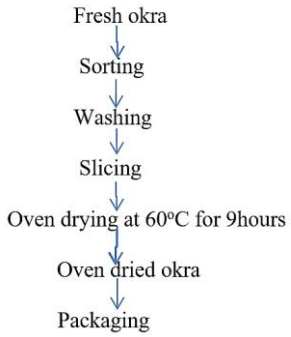

Fig. 1. Flow chart for the production of Un-blanched Oven-dried okra
Source: Adepoju et al. [30]

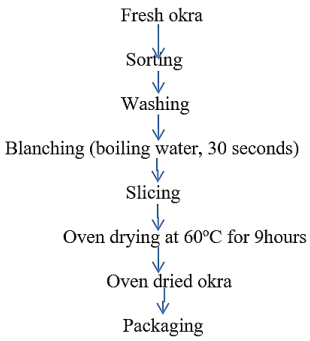

Fig. 2. Flow chart for the production blanched oven-dried okra

Source: Eze [9].

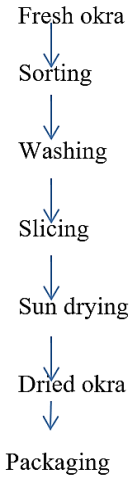

Fig. 3. Flow chart for the production of Un-blanched sun-dried okra
Source: Adepoju et al. [30]

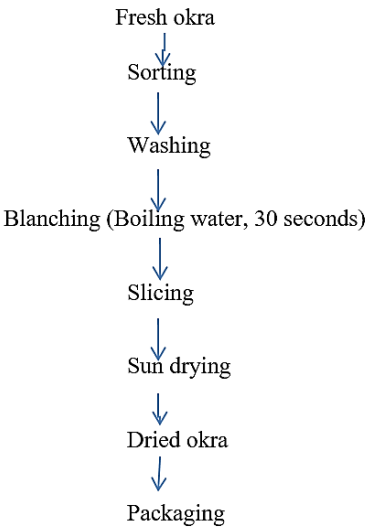

Fig. 4. Flow chart for the production of Blanched sun-dried okra
Source: Eze [9].

2.3 Determination of the Chemical Properties of Okra

Okra samples were analyzed for moisture, crude protein, ash contents, crude fiber and carbohydrate.

2.3.1 Determination of moisture content

The Moisture content was determined using the procedure described by AOAC [31]. Five gram of the sample was weighed into the aluminum dish. The sample was then dried in oven at 105±2^{0}C for 8 h in hot air. The moisture content was calculated as:

% Moisture content = (Weight of dish + sample before drying) – (weight of dish + weight of sample after drying))/(Weight of sample before drying)×100

2.3.2 Determination of crude protein content

The macro Kjeldhal method as described by the AOAC [31] method was used to determine the moisture content. Ten gram of the sample was weighed into a conical flask (250m1), 0.8g potassium sulphate was poured into the conical flask and 5m1 of sulphuric acid and three glass beads (anti bumps) were dropped inside the conical flask and swirled. The mixture was heated for 2 hours at 100°C, until it turned bluish white. The digest were allowed to cool in the air and diluted with 10ml distilled water. This was distilled using Markham distillation apparatus. l00 ml conical flask containing 5ml of boric was attached. 5ml of the digest was introduced into the body of the apparatus and followed by l0m1 of 45% sodium hydroxide solution. Distillate was collected as ammonium sulphate was titrated against 0.1 M hydrochloric acid. A blank titration was carried out using distilled Water instead of the sample. Percentage nitrogen was calculated using the formula:

$$\% \text{ Nitrogen} = \frac{Titre\ value - Blank \times 0.0014g \times 100 \times 25}{Weight\ of\ sample \times 5ml}$$

The protein content was calculated as : % Crude protein = %N × 6.25 (conversion factor)

2.3.3 Determination of ash content

The ash content was determined by the AOAC [31] method. Two gram of the sample was weighed into a dried pre-weighed porcelain crucible. The sample was transferred into a preheated Muffle furnace (carbolite Bamford S30 2AU) and heated at 550°C for 2h. The ash was removed and cooled in desiccator and weighed. The percentage ash was calculated as:

$$\%\text{Ash} = \frac{\text{Weight of Ash}}{\text{Weight original food}} \times 100$$

2.3.4 Determination of crude fibres content

The crude fiber content was determined using the method described by the AOAC [31]. Two grams of the sample was digested in a conical flask with 200ml of 1.25% H_2SO_4 solution and

boiled for 30 minutes. The solution and content were poured into Buchner funnel equipped with muslin cloth secured with an elastic band. This was allowed to filter out, and then the residue was washed with hot water to free the acid. The residue was scooped into the conical flask and digested with 200ml of 1.25% NaOH solution. The residues obtained were put in a clean, dried crucible and dried in the moisture extraction oven to a constant weight. The dried residues were placed in a muffle furnace until they turned into ash. They were cooled in desiccator and weighed to enable calculate the percentage crude fiber.

$$\% \text{ Crude fiber } = \frac{\text{Weight of sample before incineration} - \text{Weight of sample after incineration}}{Weight\ of\ original\ sample}$$

2.3.5 Determination of carbohydrate

The procedure described by AOAC [32] was used in determining the carbohydrate content. This was calculated by subtracting the sum total of the moisture, fat, protein and ash content from 100.

Carbohydrate (%) = 100 – (%P + %F + %A + M)

2.4 Vitamin Analysis

2.4.1 Determination Vitamin C

Vitamin C content was determined by using vitamin C indophenols titration procedure of AOAC [33]. 50g of sample was transferred into volumetric flask of 100ml, 25ml of 25% Meta phosphorus acid was added into the mark with water. Solution of 10ml was pipetted into a flask and acetone of 2.5ml was added and was titrated with a standard indophenols solution until a faint color persists for 15secs. The vitamin C content in the sample was calculated as milligram per 100ml.

2.4.2 Determination of Vitamin B_9 and K

The proposed spectrophotometric method was applied to determined vitamin K and B_9 (Folate/ Folic acid) [34]. 1g of the samples were grinded with mortar and pestle and vitamins K and B_9 were extracted twice with 5.0 ml methanol. Samples were taken in a glass tube protected from the sun light, with addition of a 1.0 ml of 0.5m KOH, 50% and 2.0 ml of ethanol and incubated in the water bath at 45^{o}C for 2h with intermittent mixing and purging of nitrogen gas. After incubation, 1.0 ml of water was added and extracted five times with 5.0ml ether. The organic layer was recovered and evaporated to dryness in a water bath at 37^{o}C under a stream of nitrogen. The residue was re-dissolved by vortex-mixing in 5.0ml methanol and diluted appropriately with a solution, methanol 5% solution containing triton X-100.

2.5 Determination of Sensory Properties OF Dried Okra Samples

Panelists of 25 members comprising of students of the Department of Food Science and Technology Federal University WUKARI and students from Federal University WUKARI, TARABA State, to evaluate the sensory properties of dried okra samples. The panelists were asked to rate each sensory attribute using the control of dried okra samples as the basis for evaluation of surface color, appearance, texture, taste/flavor, interior color and overall accetability on a 9-point hedonic scale (nine. Like extremely, eight. Like very much, seven. Like moderately, six. Like slightly, five. Neither like nor dislike, four. Dislike slightly, three. Dislike moderately, two. Dislike very much, one. Dislike extremely). Water was provided to rinse the mouth between evaluations. Okra samples were coded with letters and served to the panelists at random to avoid any bias.

2.6 Statistical Analysis

All experiments were performed in triplicate, and the results were expressed as means ± standard error (SE). Analysis of variance (ANOVA) was carried out to determine any significant differences in measurements using the SPSS statistical software (SPSS 20.0 for Windows; SPSS Inc., Chicago, IL, USA) and considering the confidence level of 95%. The significance of the difference between the means was determined using the Duncan's Multiple Range Test, and the differences were considered to be significant at $p \leq 0.05$ [17].

3. RESULTS AND DISCUSSIONS

3.1 Proximate Composition of Dried Okra Samples

The proximate compositions of the dried samples of okra are shown in Fig. 5. The moisture contents were observed; 7.25% (the un-blanched sun dried), 7.25% (blanched sundried), 7.30% (un-blanched oven dried) and 7.85% (blanched oven dried). A moisture content of the dried okra samples varies slightly due to absorption of water during blanching in oven drying. The blanched oven dried sample having the highest moisture

value similar observation has been as reported by Hussein et al., [35]. Drying conditions shows no significant effect on the moisture content after dehydration in both un-blanched and blanched sundried. The high moisture content shows short shelf-life and can easily lead to microbial attack. Blanching could cause a significant increase in the moisture content of okra. In the result there was significant difference (P≤0.05) between the moisture content of the dried okra samples.

Ash contents of the dried okra samples includes; 7.71% (un-blanched sundried), 7.21% (blanched sundried), 7.63% (un-blanched oven dried) and 8.24% (blanched oven dried), blanched oven dried sample has the highest value compared to the other samples as has also been reported by content Hussein et al. [35]. Mineral content of okra is unaffected in blanching process. There was no significant difference (P≤0.05) between the ash content of the dried okra samples.

The fat content of the samples were 6.50% (un-blanched sundried), 6.72% (blanched sundried), 6.87% (un-blanched oven dried), and 7.00% (blanched oven dried) with blanched oven dried sample having the highest value (Audu et al., 2015). There was significant difference (P≤0.05) between the fat content of the dried okra samples. Fat is found within the dry matter in food couldn't concentrate during drying.

The carbohydrate contents are 57.18% (un-blanched sundried), 54.75% (blanched sundried), 58.73% (un-blanched oven dried) and 53.21% (blanched oven dried). The un-blanched oven dried sample has the highest value of carbohydrate than the other samples. This was in line with the findings of Hussein et al. [35]. There was significant difference (P<0.05) between the carbohydrate contents of the dried okra samples. This could be as a result of the breakdown of amino acids (ketogenic) to glucose, thereby increasing the carbohydrate content of okra. Non-cellulose, non-starch, polysaccharides are present in it. Dehydration of un-blanched and blanched okra samples resulted in increases in carbohydrate, fat, and ash contents which could due to the concentration of these components, as moisture was evaporated through sundried and oven dried from the okra samples [36].

Protein contents of the dried okra samples are 14.35% (un-blanched sundried), 16.43 (blanched sundried), 13.25% (un-blanched oven dried) and 16.83% (blanched oven dried). Blanched - oven dried sample (16.83%) having the highest value which is similar to the result of Ikwu [37]. There was significant difference (P<0.05) between the crude protein contents of the dried okra samples. The decrease in the protein contents of the dehydrated okra samples could be due to Maillard reaction which to losses of water (H_2O) and carbon dioxide (CO_2). This reaction could lead to decrease in the nutritional value of proteins by interaction of free amino acid groups of proteins with the reducing sugars [36].

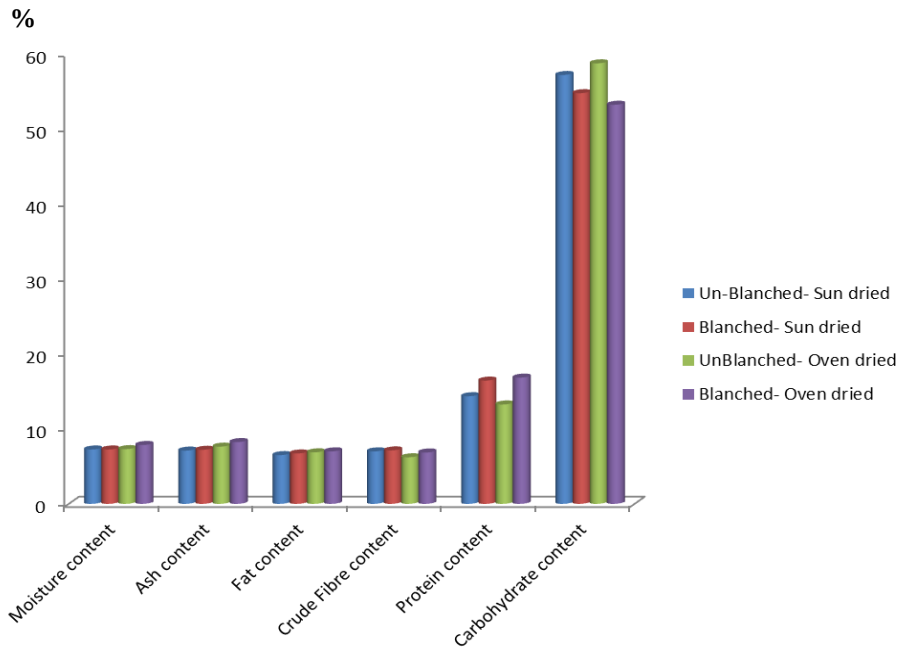

Fig. 5. The proximate composition of the dried okra samples

The crude fibre contents were 7.00% (un-blanched sun dried), 7.13% (blanched sundried), 6.21% (un-blanched oven dried), and 6.85% (blanched oven dried), blanched sundried sample having the highest value, this was close to the range of Hussein et al. [18] result. There was significant difference ($P<0.05$) between the crude fibre content of the dried okra samples.

3.2 Vitamin a Compositions

Vitamin A composition of dried okra result is shown in Fig. 6. The vitamin A contents are 24.34µg (un-blanched sun-dried), 36.34µg (blanched sun-dried) and 31.43µg (un-blanched oven-dried) 29.65µg (blanched oven-dried). Blanched sun-dried sample has the highest value greater than the other samples Adepoju et al. [30]. There was significant ($P<0.05$) difference between the vitamin A content of the dried okra samples. Vitamin A is a fat soluble vitamin. The decreases in the values of vitamin A contents in the un-blanched sun-dried and oven-dried samples as compare to blanched sun-dried and oven-dried samples could lead to heating effect and oxidation when exposed to air (oxygen). Vitamin A can be found in liver, kidneys, butter, eggs, fish oils, and the beta-carotene of green and yellow fruit and vegetables. Intakes of carotenoid (provitamin A) rich fruits and vegetables protect from cancer, and cardiovascular disease [38].

The factors that affect vitamin A oxidation are exposure to air, heat, storage time, will also lead to the destruction of the vitamin A compounds and leaching of soluble solids [38].

Vitamin B_9 compositions results of dried okra is shown in Fig. 7. Vitamin B_9 (Folate) content were 0.27 µg (un-blanched sun-dried), 0.24 µg (blanched sun-dried), 0.23 µg (un-blanched oven-dried) and 0.25 µg (blanched oven-dried), with un-blanched sun-dried sample had the highest value as compared to the other samples [37]. There was significant difference ($P\leq0.05$) between the vitamin B_9 content of the dried okra samples. Vitamin B_9 (Folate) being water-soluble, is lost during the water blanching of vegetables due to both thermal degradation and leaching into the blanch effluent [39]. The losses of folate by leaching increases with amount of blanch water used. Blanching before these treatments inactivated endogenous enzymes like conjugase, preventing the conversion of polyglutamyl folate to the monoglutamate and reducing the net loss of folate.

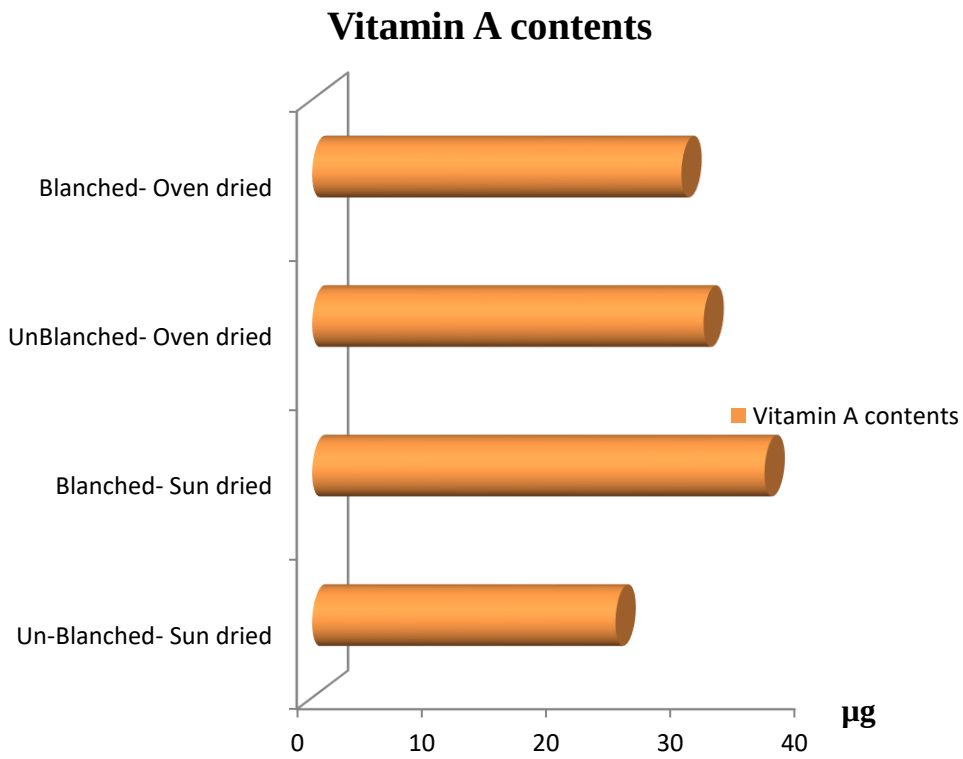

Fig. 6. The Vitamin A contents composition of dried okra samples

A deficiency in folate leads to a lack of adequate DNA replication and consequent impaired cell division, especially in the hemopoietic tissue of the bone marrow and the epithelial cells of the gastrointestinal tract [38]

Vitamin C composition results of dried okra are shown in Fig. 8. The vitamin C contents are 8.11 (non-blanched sun-dried), 9.05 (blanched sun-dried), 9.65 (non-blanched oven-dried) and 9.05 (blanched oven-dried). The un-blanched oven-dried sample has the highest value than the other samples. The result show a significant difference ($P<0.05$) between the vitamin C content of the dried okra samples. Vitamin C is water soluble vitamin and can be easily affected by blanching and heating process. Vitamin C with or without in the presence of oxygen is heat labile. Oxidation of vitamin C increases with sun-drying and oven-drying temperature. Vitamin C can affect the levels of genetic variation, maturity, climate, sunlight, methods of harvesting, and storage. Also, factors contributing to vitamin losses are irradiation (light or ionizing radiation), heat (temperature and time), and catalytic effect of metals, pH, and action of enzymes, moisture, oxidation (air exposure). Dehydroascorbic acid possesses full vitamin C activity because it is reduced to ascorbic acid in the animal body [38].

Vitamin K composition results of dried okra are shown in Fig. 9. Vitamin K contents were 0.26 µg un-blanched sun-dried, 0.23 µg blanched sun-dried, 0.2 µg 1 un-blanched oven-dried, 0.25 µg blanched oven-dried. The un-blanched sun-dried sample has the highest value than the other samples. The results show a significant difference ($P\leq0.05$) between the vitamin K content of the dried okra samples. Phylloquinone contents are present in green leafy vegetables and increase during plant maturation. Naturally occurring phylloquinone contain C-20 double bond in the *trans* configuration [38]. Vitamin K compounds is decompose by Ultra-violet radiation, alkali, strong acids, and reducing agents, but are stable to oxidizing conditions and heat, when subjected to temperatures of 185–190^{0}C for 40 minutes, 7% of the original phylloquinone was lost during 20 minutes of heating and 11% during 40 min of heating [38].

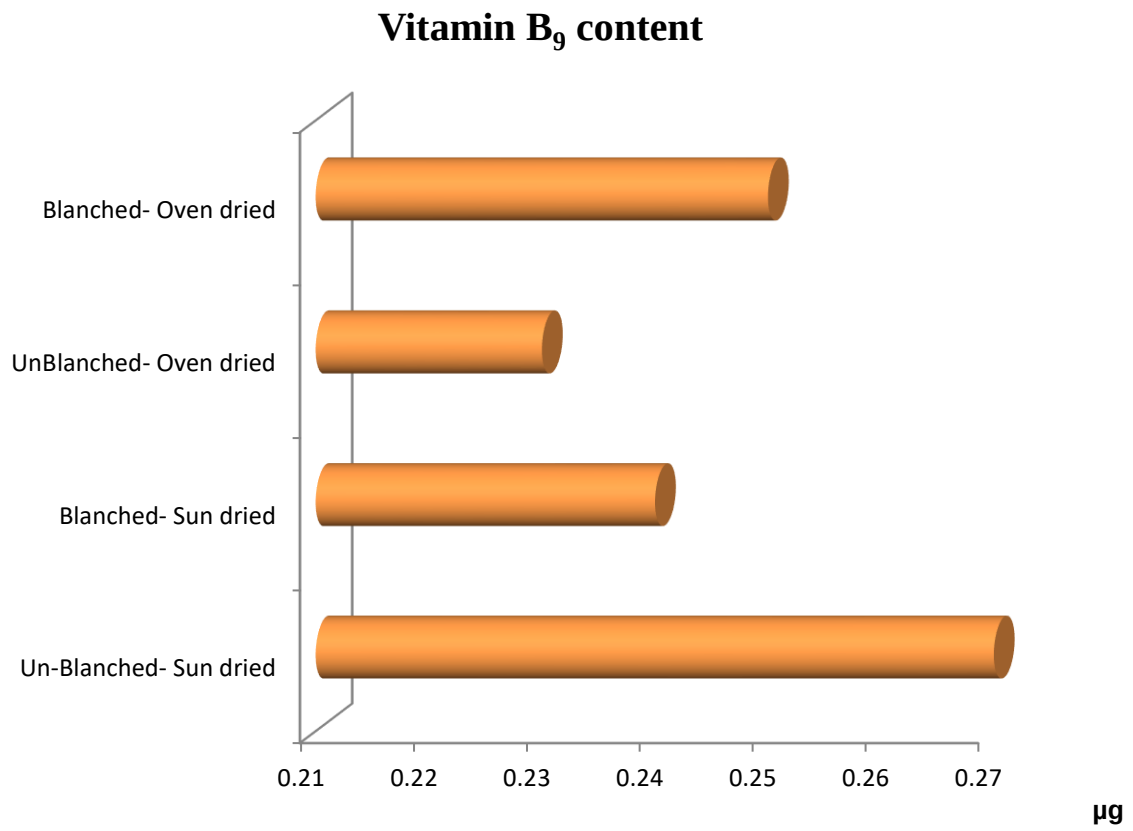

Fig. 7. The Vitamin B_9 content composition of dried okra samples

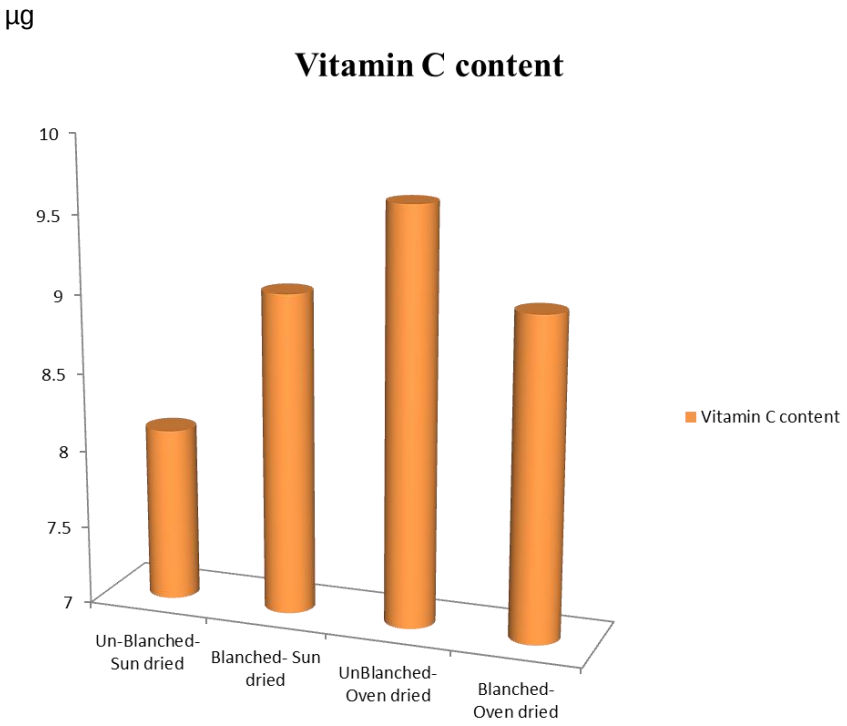

Fig. 8. The Vitamin C content composition of dried okra samples

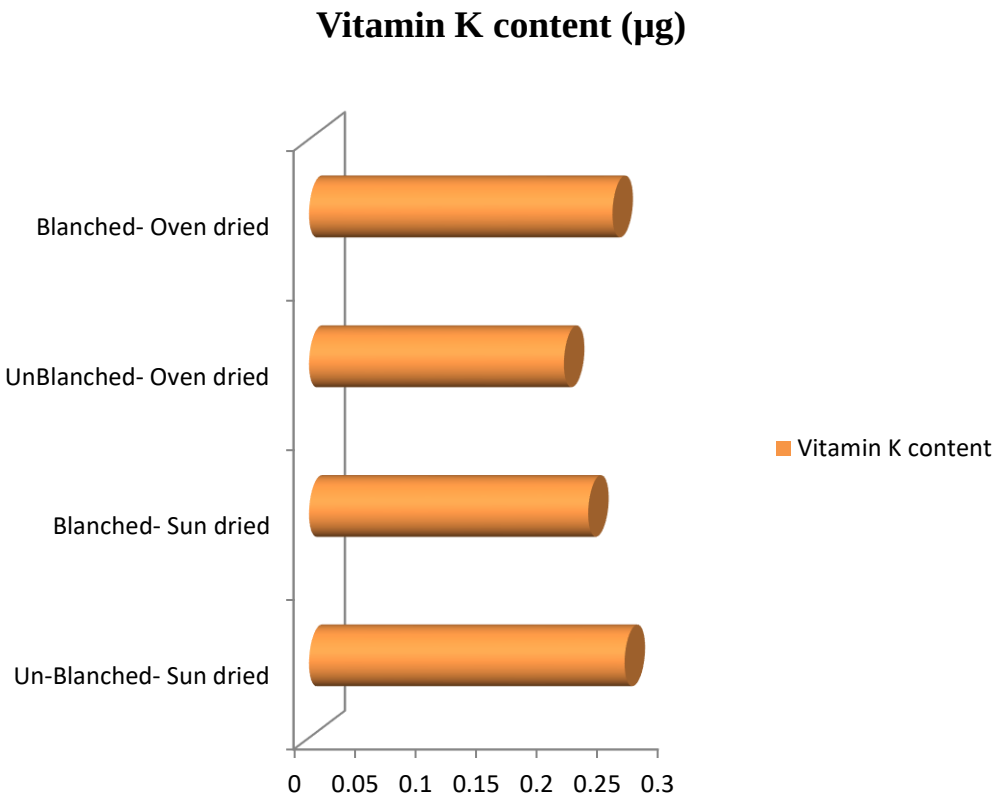

Fig. 9. The Vitamin K content composition of the dried okra samples

3.3 Sensory Properties of Dried Okra

Sensory properties of dried okra samples are shown in Fig. 10. There was little variation in the dried okra samples.

In terms of appearance, blanched sun-dried okra has the highest value (7.60) followed by un-blanched sun-dried okra (7.13), blanched oven dried okra (4.53) and un-blanched oven-dried okra (3.80). The non-blanched oven-dried okra has lowest value in appearance with dull appearance and this may be due to inactivates of enzymes on the okra sample during processing (Hussein et al., 2018). Green vegetables, during blanching change colour from bright green to a dull olive green such as peas, spinach or green beans. This is due to the conversion of chlorophyll to pheophytin. Water activity is one of the important factors degrading chlorophyll. The formation of dark pigments via enzymatic browning is caused by the enzyme polyphenol oxidase (PPO) during storage.

In terms of aroma, the blanched sun-dried okra has the highest (7.60) followed by un-blanched sun-dried okra (7.00), blanched oven-dried okra (4.46) and un-blanched oven-dried (4.13). The aroma of blanched sun-dried okra was better than the other samples Hussein et al. [14]. Heat causes loss of volatile components from the food, because dried foods have less flavour than the original material. The factors that affect volatile loss are the temperature, moisture content of the food, the vapour pressure of the volatiles and their solubility in water vapour. Volatiles with high volatility and diffusivity are lost at an early stage in drying.

For the texture, blanched sun-dried okra has the highest (7.60) followed by un-blanched sun-dried (7.40), blanched oven-dried okra (4.40) and un-blanched oven-dried okra (4.06). Blanching cause cell disruption which leads to loss of turgor pressure and softening of tissue, while gelatinization of starch and solubilisation of hemicelluloses causes softening of the tissues. Texture changes are caused by water loss, protein denaturation which may result in loss of water-holding capacity or coagulation, hydrolysis and solubilisation of proteins.

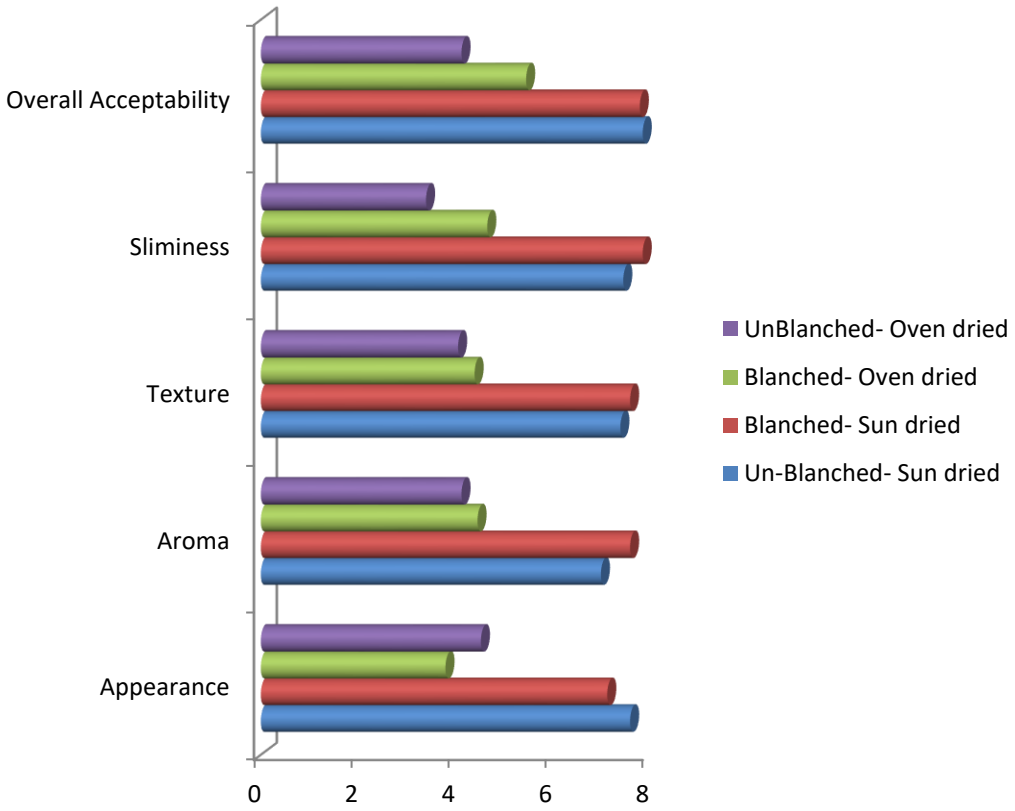

Fig. 10. The sensory properties of dried okra samples

For the sliminess, blanched sun-dried has the highest (7.86) followed by un-blanched sun-dried (7.46), blanched oven-dried (4.66) and un-blanched oven-dried (3.40). These show that blanched sundried okra sample was the best in terms of sliminess according Tsado (2015). Since mucilage and gums are water-soluble polysaccharides, which lead to decrease in viscosity could be attributed to leaching out of okra mucilage into the blanch water during blanching processing. Drying of both blanched and un-blanched okra samples has a decrease in viscosity.

For overall acceptability, un-blanched sun-dried has the highest (7.86) followed by blanched sun-dried (7.80), blanched oven-dried (5.46) and un-blanched oven-dried (4.13). The result shows that, un-blanched sun-dried okra has the best overall sensory properties.

4. CONCLUSION

The most outstanding finding of this study is that, blanched oven-dried okra pods were found to be the source of vital nutrients such as protein, fat ash and moisture more than the other samples. The investigation shows that the blanched sun-dried okra pod was a good source of vitamins, and also produced the best sensory properties (aroma, texture, and sliminess) when compared to the other samples. The result shows that drying had variable effects on the chemical composition, vitamins and sensory properties on the processed okra samples. Blanching helped in inactivating activities of enzymes in the okra and retaining nutrients. There is a significant difference ($P \leq 0.05$) in the chemical composition and vitamins composition of okra and the sensory properties has no significant difference ($P \geq 0.05$).

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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