

EFFECT OF DRYING METHODS AND STORAGE CONDITIONS ON NUTRITIONAL VALUE AND SENSORY PROPERTIES OF DEHYDRATED TOMATO POWDER (*Lycopersicon esculentum*)

ABSTRACTS

Effect of drying methods and storage conditions on nutritional value and sensory properties of dehydrated tomato powder was carried out to establish the effects of two drying methods (oven drying and sun drying) on the nutrient composition, sensory properties and storage conditions of dehydrated tomatoes powder. Fresh tomatoes were obtained from Ankpa metropolis central market, Kogi state Nigeria. They were washed, weighed sliced into a non sticky pot dehydrated pressed through colander into and re-dehydrated into a thick moulding consistency, sliced and oven dried at 60° C at a constant stirring using skewer. The Nutrient composition was determined using standard methods, sensory evaluation was evaluated using 9 points hedonic scales and microbiological analyses were examined using pour plate methods. Triplicate values were expressed on dry weight basis. All data obtained were statistically analyzed using SPSS version 17.0 package. Means and standard deviation were calculated at significant level of $p \leq 0.05$. The Nutrient contents included proximate composition; moisture of oven dried and sun dried dehydrated tomato powder was (8.58±0.07 %) and (10.63±0.21 %), ash (3.53±0.06 %) and (3.88±0.08 %), crude fibre included; (6.37±0.15 %) and (5.15±0.10 %). Fat was (0.82±0.02 %) and (0.53±0.02 %), protein included; (3.70±0.07 %) and (2.60±0.07 %) and carbohydrates was (77.00±0.30 %) and (77.21±0.43 %). **Phytochemical** contents (mg/100g) included; Flavonoid [34.85±0.13] and [25.63±0.17], Tannin was (15.50±0.04) and (9.11±0.03), Phenolic acid (178.30±2.10) and (93.93±1.77) Saponin was (0.19±0.01) and [0.13±0.01] and Alkaloid [1.93±0.16] and [0.87±0.06]. Protein, fat, fibre and Phytochemicals (flavonoid, phenolic acid, tannin, alkaloid and Saponin) were significantly high in oven dried at $P \leq 0.05$ except moisture, ash and carbohydrates. The microbiological assay showed that the total viable count at the 3rd month was (5.7x10³) and (7.7x10⁵) no visible fungi growth was available. The 6th month storage included (6.3x10³) and (7.3x10⁵) bacterial while fungi was (1.9x10³) and (2.1x10⁵) colony forming units per g. Sensory evaluation revealed that taste was (7.04±0.20) and (6.16±0.22), flavour (8.2±0.20) and (5.03±0.15), consistency (7.00±0.04) and (5.15±0.26), colour included; (8.00± 0.20) and (7.31±0.14) and overall acceptability was (8.01±0.20) and (7.0±0.1). Sensory properties indicated higher rating in taste, flavour, consistency, colour and overall acceptability in oven dried sundried at a significant of $p \leq 0.05$. The cfu/ g of the oven dried was lower than sundried.

Keywords: Nutrients, storage, Chemical, Proximate, phytochemical, Sensory, dehydration.

1. INTRODUCTION

The use of modern technologies and equipments for drying food material is escalating from emphasis on food preservation to drawing of attention to the dehydration methods that retains the bioactive nutrients that can combat nutritional related diseases and promote a state of well-being of the consumer; prolong shelf life or good keeping quality. The study of effect of drying methods and storage conditions on nutritional value and sensory properties of dehydrated tomato powder was aimed at studying the effects of two drying methods (oven dried and sundried) on nutrient composition, sensory properties and microbiological assay of dehydrated tomatoes powder. Vegetables such as tomatoes (*Lycopersicon*

esculentum) are perishable crops of which deterioration starts immediately after harvest and continued till they experience spoilage due to high moisture contents and enzymatic activities, because of these factors tomato has short shelf life coupled with inadequate processing facilities. In Nigeria, reasonable percentages of harvest (over 50%) of tomatoes lost yearly due to poor storage system, poor transportation and lack of processing enterprises (1). The percentage of tomatoes going into waste annually with no attentions paid to the loss of nutrients can lead to malnutrition due to food insecurity, decrease in market value, underutilization and heavy revenue loss to farmers. According to (2) marketing of fresh tomato during the season is a great problem which needs to be handled. Dehydration does not check losses only but, generate revenue for the farmers and Nigeria as a country at large and also combat nutritional related disease. (3) Reported that Tomato as fruits vegetables and other green leafy vegetables can be dried using various methods. According to (4), tomatoes contribute to a healthy and well-balanced diet as they are rich in, dietary fibres and other nutrients. Tomato as fruits vegetables and other green leafy vegetables can be dried using various methods (5).

2. Material and methods

2.1: Sample collection

Freshly harvested derika tomato fruits were purchased from Ankpa metropolis market, Kogi state Nigeria.

2.2: Sample preparation

Freshly and ripened derika tomatoes were sorted, washed and weighed. Eleven kilogram of the sample was divided into two giving (5.5) kg each. One portion was sliced, deseeded and poured into a non-sticky stainless pot and dehydrated for (1½ hours), it was **mashed** into a slurry and was pressed through a 55 mm colander and re-dehydrated into a mouldable texture and cut into 1 g sizes on trays and placed in a 200 °C pre-heated **dry air** electric oven and the temperature was lowered to 60 °C and dried to constant weight while stirring at every 30 minutes for two hours. It was cooled under laboratory condition, pounded and milled **using type 8k 31 Kenwood blender**, **packed** and labelled as **"oven dried"**. The second portion was blanched and sliced into ½ cm (5mm) thick using fruit slicer for uniform sizes and was sun dried for seven days and milled using harmer mill grinding engine, **packed** and labelled **"sun dried"**. Both samples (oven dried and sun dried) were kept for 3 and 6 months for **laboratory investigation**.

2.3: Sensory evaluation of dehydrated tomato powder

Both tomato powder products were reconstituted in 35 and 17 mL and tomato sauce was prepared and tested using (6) 9 points hedonic scale with 9=like extremely 1=dislike extremely. Twelve 12 panellist were trained on sensory attribute, the scores were based on the intensity of the taste, colour, flavour, texture and overall acceptability.

2.4: Storage study

Dehydrated tomato powder was packed and sealed with model No me-200H 220 v AC 50/60 Hz 260 w impulse sealer in black opaque polyethylene bags to prevent radiant energy and light rays that can affect the storage negatively and stored in an ambient temperature for 3 and 6 months. Samples were withdrawn at the 3rd month and 1 g each was weighed out and the polyethylene bags were resealed immediately. The weighed 1 g sample was analyzed for microbiological assay.

2.5: Microbiological assay

The total viable counts of each sample (oven dried and sundried) stored for 3 and 6 months were determined using the pour plate method as described by (7) methods. At the 3rd month one gram of the samples was homogenized in 17 mL of sterile peptone water to obtain 10¹ dilutions, the dilution was made to 10² and 10³. One millilitre of serial dilution of each sample was inoculated on nutrient agar plates and cultured at 37 °C for 24 hours. The number of colony forming units (cfu) on each plate was counted using colony counter and expressed as cfu/g. The procedure was repeated at the 6th month. The procedures included the following;

Total fungal counts

The total fungal count were determined by poor plating on potato dextrose agar plates supplemented with 10 % tartaric acid to inhibits bacterial growth. It was incubated at room temperature (28±2⁰ C) for 4 days. The colony forming units were counted and expressed as cfu/g. The different colony on each plate were isolated purified and stored on nutrient agar stand for (bacteria) and potato dextrose agar (PDA) stand for fungi for further characterization and identification. The bacterial were identified on the basis of their cultural, morphological properties and biochemical tests while fungal isolates were characterized by their cultural and morphological properties based on mycelium structure, and conidiophores presence and shapes.

Chemical analysis procedures

2.6: Proximate composition

The proximate examination of moisture, ash, protein, fats and carbohydrate contents were determined as described in various standard methods; Moisture content was determined as described by [6] using vacuum oven method. Ash by incineration in muffle furnace at 550°C for 8 hours (8) and Fat content was estimated using Soxhlet extraction method according to (9) while crude protein was determined using the micro-Kjeldahl method as described by (10). The available carbohydrates content was determined by difference, using the average values of moisture, dietary fibre, protein, fat and ash contents (8)

Crude Fibre Determination

A non-enzymatic method of (11) was used to determine crude fibre content. Two grams of the dried sample was defatted with petroleum ether and boiled under reflux for 30 minutes with 200 mL of solution containing 1.5 g of H₂SO₄ /100 mL of the solution. The solution was filtered through linen on a fluted funnel and washed with boiling water until the washing was no longer acidic. The residue was transferred to a beaker and boiled for 30 minutes in 200 mL of solution containing 1.25 g of carbonate-free NaOH per 100 mL. Final residue was filtered through a thin but closed pad of washed and ignited asbestos in porcelain crucible. It was dried in electric oven, weighed, incinerated, cooled and reweighed; The loss in the weight after incineration x 100 was calculated as the percentage (%) of the crude fibres.

$$\% \text{ crude fibre} = \frac{\text{Loss in weight (g)} \times 100}{\text{Original mass (2.0)}}$$

Phytochemical Analysis Procedures

Flavonoid Determination

Flavonoid was determined using (12) methods. One gram of the sample was weighed and repeatedly extracted with 100 cm³ of 80 % methanol at room temperature. The mixture was then filtered through filter paper into a 250 cm³ beaker and the filtrate was transferred into a water bath and allowed to evaporate to dryness and weighed. The % flavonoid was calculated using the formula below;

$$X = \frac{w_2 - w_1}{w_3} \times 100$$

w_3

Where x = percentage flavonoid,

w_1 = weight of empty beaker,

w_2 = weight of empty beaker + flavonoid and

w_3 = weight of sample.

Alkaloid Determination

Alkaloids determination was carried out by using (12), alkaline precipitation gravimetric method. Two grams of the sample was soaked in 20 cm³ of 10 % ethanolic acetic acid. The mixture was allowed to stand for 4 hours ambient temperature and was filtered through Whatman filter paper no. 40. The filtrate was concentrated by evaporating it over a steam bath to $\frac{1}{4}$ ^{QT} of its original volume. For alkaloids was precipitated by adding concentrated ammonia solution in drops wise. The resulting alkaloid precipitate was recovered by filtration using a previously weighed filter paper and the precipitate was washed with 1 % ammonia solution and dried in the oven at 60°C for 30 min, cooled in desiccators and reweighed. The weight of alkaloids was determined by difference and expressed as a percentage of the weight given by following formula;

$$\% \text{ alkaloid} = \frac{W_1 - W_2}{W_1} \times 100$$

Where; w^1 = Weight of filter paper

w^2 = weight of paper + alkaloid precipitate.

Determination of Phenolic Acid

A total of 2.5 g of the sample was boiled with 25 ml of ether for 15 min. five millilitre of the extract was pipette into a 50 ml volumetric flask and 10 ml of distilled water, 2 ml ammonium hydroxide and 5 ml amyl alcohol was added sequentially. The solution was made up to the mark with distilled water and allowed to stand for 30 min for colour development. The absorbance of the solution was read at 505 nm using a UV spectrophotometer and tannic acid was used as the standard (13)

Saponin Contents Determination

A total of 50 mL of the sample was weighed into a conical flask and 100 cm³ of 20 % aqueous ethanol was added to the sample. The sample was heated over a hot water bath for 4 hours with continuous stirring at about 55⁰ C. The mixture was filtered and the residue re-extracted with another 200 mL of 20% ethanol. The combined extracts were reduced to 40 mL over water bath at 90⁰ C. The concentrated filtrate was transferred into a 250 mL separating funnel and 20 mL of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated. Sixty millilitre of n-butanol was added. The combined n-butanol extract was washed twice with 10 mL of 5 % aqueous sodium chloride. The resultant solution was heated in a water bath. After evaporation, samples were dried in the oven to a constant weight and the weight of Saponin was determined. (13)

Tannic Acid Determination

The determination of tannin was carried out using the method of (14). One gram of the sample was weighed into 40 ml of 50% methanol. The mixture was shaken vigorously and placed in a hot water bath at 80°C for 1 h. The extract was filtered into 100 ml volumetric flask, 20 ml distilled water, 2.5 ml Folin-Denis reagent and 10 ml of 17% sodium carbonate was added and shaken vigorously. The mixture was then made up to the mark with distilled water and allowed to stand for 20 min for colour development. The absorbance was read at 760 nm on a UV spectrophotometer and tannic acid of concentrate ranges from 0- 10 ppm

was prepared and used as standard. A standard graph was plotted and the calibration curve $Y = 0.0593x - 0.0485$, $R^2 = 0.9826$ was obtained,

Where;

x = absorbance

Y = tannic acid equivalent

2.9: Statistical Analysis

All data obtained were analyzed statistically, using SPSS version 17.0 package. One way analysis of variance (ANOVA) and Bonferroni [15] multiple comparison tests were used for the comparison of means. Differences between means were calculated at significant level if $P \leq 0.05$.

3.0: RESULTS AND DISCUSSION

3.1: RESULTS

Table 1: PROXIMATE COMPOSITION OF OVEN DRIED AND SUN DRIED SAMPLES (%)

Proximate analysis	Tomato powder oven dried(%)	Tomato powder sun dried %
Moisture	8.58±0.07 ^a	10.63±0.21 ^b
Crude protein	3.70± 0.07 ^b	2.60 ±0.07 ^a
Fat	0.82 ±0.02 ^b	0.53 ± 0.02 ^a
Ash	3.53±0.0 ^a	3.88± 0.08 ^a
Carbohydrates	77.00 ± 0.30 ^a	77.21 ±0.43 ^a
Crude fibre	6.37 ± 0.15 ^b	5.15 ± 0.10 ^a

Values represent means of triplicate values ± sd (standard deviation)

Means with different superscripts in a column are significantly different $p \geq 0.05$

Table 2: Phytochemical analysis of dehydrated tomato powder (mg/100g)

Phytochemical compound	Tomato powder oven dried (mg)	Tomato powder sun dried (mg)
Flavonoid	34.85± 0.13 ^b	25.63±0.17 ^a
Phenolic acid	178.3±0 2.10 ^b	93.93 1.77 ^a
Tannin	15.50 ± 0.4 ^b	9.11 0.03 ^a
Alkaloid	1.93± 0.16 ^b	0.87 0.06 ^a
Saponin	0.19± 0.01 ^b	0.13 0.01 ^a

Values represent means of triplicate values ± sd (standard deviation)

Means with different superscripts in a Column are significantly different $p \geq 0.05$

Table 3 : Microbial assay of dehydrated tomatoes sample at 3rd and 6th months

Parameters Tested	Total bacteria(cfu /g) at the 3 rd month	Mould and yeast (cfu /g) at the 3 rd month	Total bacteria (cfu /g) at the 6 th month	Mould and yeast (cfu/g) at the 6 th month
Oven dried	5.7 x 10 ^{3a}	* * *	6.3x10 ^{3a}	1.95 x 10 ^{5a}
Sundried	7.7 x 10 ^{5b}	* * *	7.3 x 10 ^{5a}	2.06x 10 ^{5b}

Values represent means of triplicate values ± sd (standard deviation)

Means in vertical column with different superscripts are significantly different at $P \leq 0.05$

Table 4: Sensory properties of oven dried and sundried dehydrated tomato powder

Parameters	Taste	Flavour	Consistency	Colour	Overall Acceptability
Oven dried	7.04±0.20 ^a	8.2±0.20 ^a	7.00±0.04 ^a	8.00± 0.20 ^a	8.01±0.20 ^a
Sun dried	6.16±0.22 ^c	5.03±0.15 ^b	5.15±0.26 ^b	7.31±0.14 ^b	7.0±0.14 ^b

Values represent means of triplicate values ± sd (standard deviation)

Means in vertical column with different superscripts are significantly different at $P \leq 0.05$

DISCUSSION

Table 1 represents proximate composition of the two processing methods (oven dried and sundried) dehydrated tomato powder, the result showed that the moisture content (8.58±0.07%) was low in oven dried but, higher in sundried (10.63±0.21) other higher nutrient component in sun dried included carbohydrates and ash (77.21 ±0.43) but significant at $p \leq 0.05$, protein (3.70± 0.07), fibre (0.82 ±0.02) fat (0.53 ± 0.02) were higher in oven dried. it is therefore obvious that the low moisture contents observed in the processing method of oven dried may be the rationale behind the high nutrients conservation in the sample. this current study therefore, agrees with the study of Amadi and Adebola (2008) [16] in the study of 'Effect of moisture content and storage conditions on the storability of garri,' where high moisture contents of 17.8% depreciated the nutrient components and physical properties.

Table 2: showed the phytochemical content of oven dried and sundried dehydrated tomato powder, the results showed that Flavonoid was 34.85± 0.13 and 25.63±0.17, phenolic acid was between 178.3±0 2.10 and 93.93 1.77 Tannin included 15.50 ± 0.4 and 9.11 0.03 the Alkaloid was 1.93± 0.16 and 0.87 0.06 while Saponin included 0.19± 0.01 and 0.13 0.01, from the analyses all phytochemical contents (flavonoid, phenolic acid, tannin, alkaloid and Saponin) were significantly high in oven dried at $P \leq 0.05$ but, lower in sundried. The higher phytochemical content in oven dried sample in this study can neutralize the free radicals and inhibit the oxidative activity and also high protein contents, fat and fibre is an indication that oven dried processing methods may combat non-communicable disorder.

Table 3: represents the record of microbiological counts in oven dried and sundried at the 3rd and 6th month's storage; these included (5.7x10³ and 7.7 x 10⁵) bacteria but no visible fungi were present. the 6th month was (6.3x10⁻³ and 7.1x10⁻⁵) viable count in cfu/g and the fungal count was 1.95x10⁻³ and 2.06x10⁻⁵ cfu/g. The study showed that bacteria and fungi growth has increased even then the microbiological assay in oven dried, was significantly lower than sundried which is obvious that the moisture content (10.63±0.21%) in sundried contributed to increase in the growth of bacteria and fungi colony forming units / g. The findings in this study conforms to the study of Hettiarachchi et al 2001[17] where moisture contents of 10 % contain no microbial growth but 13.5% showed fungal growth of 3 cfu/10 g.

Table 4: represents both oven and sun dried mean sensory scores of the dehydrated tomato powder. Taste assessment included; 7.04±0.20 and 6.16±0.22 flavour was 8.2±0.20 and 5.03±0.15, consistency was 7.00±0.04 and 5.15±0.26, colour included 8.00± 0.20 and 7.31±0.14 and overall acceptability included; 8.01±0.20 and 7.0±0.14 respectively. All the parameters tested in terms of (taste, flavour, consistency, colour and overall acceptability) showed that oven dried was most preferred and were significantly different at $p \leq 0.05$.

Conclusion;

The study has revealed that oven dried significantly increased the nutrient component of dehydrated tomato powder, decreased cfu/g of bacteria and fungi, , enhanced the keeping quality and could have extended the shelf life if the product could have been stored further for one year the study have the sensory properties especially in terms of taste, flavour, consistency colour and overall acceptability.

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