

PRODUCTION, STORAGE PROPERTIES, SENSORY PROPERTIES AND NUTRIENT CONTENTS OF DEHYDRATED TOMATO POWDER

ABSTRACTS

Production, storage, sensory and nutrient contents of dehydrated tomato powder was to establish a suitable processing method on the keeping quality of dehydrated tomato powder. Fresh tomatoes were obtained from Ankpa local government central market, Kogi state Nigeria. They were washed, weighed and dried and standard methods were used for the analysis. Triplicate values were obtained and expressed on dry weight basis. All data obtained were analyzed statistically using SPSS version 17.0 package and simple percentages (%). Means and standard deviation were calculated at significant level of $p \leq 0.005$. Microbial analyses of oven dried (sample code 201) and sun dried (sample code 202) were 63×10^{-3} and 71×10^{-5} . Sensory properties of samples 201 and 202 were (55.6%) and (44.4 %). Nutritional contents determined included proximate composition; moisture contents of sample code 201 was (8.58 ± 0.07) , while 202 was $(10.63 \pm 0.21 \%)$ ash content of 201 was (3.53 ± 0.06) and sample 202 was $(3.88 \pm 0.08 \%)$ crude fibre of 201 and 202 included $(6.37 \pm 0.15 \%)$ and $(5.15 \pm 0.10 \%)$. Sample 201 Fat content (0.82 ± 0.02) and sample 202 was $[0.53 \pm 0.02]$ samples 201 and 202 protein content included $[3.70 \pm 0.07]$ and $[2.60 \pm 0.07]$, carbohydrates for samples 201 and 202 were $[77.00 \pm 0.30]$ and $[77.21 \pm 0.43]$ respectively. Phytochemical contents (mg/100g) included Flavonoid $[34.85 \pm 0.13]$ and $[25.63 \pm 0.17]$ for samples 201 and 202 Tannin $[15.50 \pm 0.04]$ and $[9.11 \pm 0.03]$ Phenolic acid was $[178.30 \pm 2.10]$ and $[93.93 \pm 1.77]$ samples 201 and 202 Saponin was $[0.19 \pm 0.01]$ and $[0.13 \pm 0.01]$ while Alkaloid was $[1.93 \pm 0.16]$ and $[0.87 \pm 0.06]$.

Keywords: Microbial, Sensory, Storage properties, Chemical,; Proximate; phytochemical and dehydration.

1. INTRODUCTION

Vegetables such as tomatoes are perishable crops of which deterioration starts immediately after harvest and continued till they experience spoilage due to high moisture contents and enzymatic activities. In Nigeria, reasonable percentages of harvested tomatoes go into waste annually with no attentions paid to the loss which also leads to nutritional loss, decrease in market value and heavy revenue loss to farmers. According to [1] marketing of fresh tomato during the season is a great problem because of its short postharvest life and inadequate processing facilities. According to [2] fruit and vegetables post harvest loss in some African countries was estimated to 50% due to absence of proper storage facilities short shelf life coupled with also inadequate processing facilities which results in heavy revenue loss to the country. Dehydration does not check losses only but, generate revenue for the farmers and Nigeria as a country at large. Tomato as fruits vegetables and other green leafy vegetables can be dried using various methods [3].

48 **2. Material and methods**

49 **2.1: Sample collection**

50 Freshly harvested derika tomato fruits were purchased from Ankpa local government area
51 market, Kogi state Nigeria.

52 **2.2: Sample preparation**

53 Freshly and ripened derika tomatoes were sorted, washed, and weighed. The 11kg content
54 was divided into two equal parts of (5.5) kg each. One portion was sliced, deseeded and
55 poured into a non-sticky stainless pot and dehydrated for one hour, thirty minutes
56 ($1\frac{1}{2}$ hours), it was marched into slurry and was pressed through a 55 mm colander and re-
57 dehydrated into a mouldable texture and sized into 1 g size on a trays and placed in a 200 °C
58 pre-heated electric oven of which the heat was lowered to 60 °C and dried to constant
59 weight for two hours (2). It was cooled under laboratory condition, milled, packaged and
60 labelled as “oven dried” (sample code 201). The second portion was blanched and sliced
61 into ½ cm (5mm) thick using fruit slicer for uniform sizes, this was sun dried for seven (7)
62 days, cooled, milled, packaged and labelled “sun dried” (sample code 202). Both samples
63 (201 and 202) were kept for microbial, sensory evaluation and nutrient contents laboratory
64 analysis.

65 **Microbial analysis procedures**

66 The microbial analysis was carried out twice (1st 3 months after production and the 6th
67 month using the method described by [4]. Ten (10g) of both tomato (samples 201 and 202)
68 were dissolved each into 250ml of distilled water and shaken to ensure homogenization,
69 Seven (7 g) of nutrient agar was dissolved in water in a conical flask and covered with cotton
70 wool, It was taken to autoclave for sterilization. One (1) ml of the dissolved sample was
71 pipette into ten (10) of 9ml water test tube in a serial dilution and kept for two (2) days and
72 the readings were taken.

73 **Storage study**

74 Samples were withdrawn and the procedures were repeated at the 6th months of storage
75 and the readings were also taken respectively and the total plate count of the samples (201
76 and 202) were evaluated using [4] methods.

77 **Sensory scores of dehydrated tomato powder**

78 The sensory scores of dehydrated tomato powder was determined using Iwe, (2002) [5]
79 9points hedonic scale test. Eleven grams (11) of each samples, oven dried (sample code 201)
80 and sun dried (sample code 202) of the dehydrated tomato powder was reconstituted into
81 tomato paste with thirty five (35) and seventeen (17) mills of distilled water respectively and
82 kept. The two samples were prepared into tomato source and were evaluated for taste,
83 texture, flavour and colour.

84 **Chemical analysis procedures**

85 **Proximate composition**

86 **2.3: Determination of Moisture Contents**

87 Moisture content of each sample was determined as described by [6] using vacuum oven
88 method. Two grams of the sample was rapidly weighed into a pre-weighed dried dish (w₁)
89 and weighed with the dish (W₂), It was dried to a constant weight at 100 °C at a pressure that
90 was not exceeding 100 mHg for 5 hours. When the drying procedures were completed, the
91 dish was placed in the desiccators to cool and reweighed (W₃) and the recorded loss in
92 weight, was the moisture. The percentage moisture was calculated as below;

93
$$\frac{w_2 - w_1 \times 100}{W_3 - w_1}$$

94

95 Where;
 96 W_1 = Initial weight of the empty crucible
 97 W_2 = Weight of the crucible plus (+) the sample before drying
 98 W_3 = Final weight of crucible + sample after drying
 99 % total solid (dry matter) = 100 % moisture.

100 **2.4: Ash Content Determination**

101 Ash content was determined; using incineration at 600°C in a muffle furnace, according to
 102 the method described by [7]. Two grams of each sample was weighed into a weighed and
 103 ignited tarred crucible (w_1). The crucible and weighed sample were placed on a hot plate
 104 inside a fume cupboard to prevent smoke accumulation, the remaining residue was
 105 transferred to a preheated muffle furnace and maintained at 600°C for 6 hours to ash until
 106 the sample was reduced to a light ash, the crucible was removed, placed in the desiccators,
 107 cooled and weighed (w_2) and the ash content was calculated:

$$108 \text{ \% Ash (on dry basis)} = \frac{W_2 - w_1 \times 100}{2.0 \text{ g}}$$

110 **2.5: Fat Content Determination**

111 Fat content was estimated using Soxhlet extraction method according to [8]. Two grams of
 112 the sample was weighed into a thimble (w_1), dried and cooled boiling flask was weighed,
 113 filled with 300 mL petroleum ether (w_2) and boiled at 60°C with the extraction thimble in
 114 soxhlet apparatus which was allowed to reflux for 6 hours. The thimble was carefully
 115 removed, while the extracted oil in the petroleum ether flask was dried between 105-110°C
 116 for 1 hour. It was then transferred from the oven to the desiccators, cooled, weighed and
 117 calculated as below;

$$118 \frac{w_2 - w_1 \times 100}{\text{Weight of sample (2.0 g)}}$$

119

120 **2.6: Crude Protein Determination**

121 The crude protein of the sample was determined using the micro-Kjeldahl method
 122 described by [9]. Two grams was weighed along with 20 mL of distilled water into a micro –
 123 Kjeldahl digestion flask. It was shaken and allowed to stand for some times. One tablet of
 124 selenium catalyst and 20 mL tetra oxo sulphate (vi) acids were added. The flask was heated
 125 on the digestion block at 100°C for 4 hours until the digest became clear. The flask was
 126 removed from the block and allowed to cool and the content was transferred into 50 mL
 127 volumetric flask and diluted to the mark with water. An aliquot of the digest (10 mL) was
 128 transferred into another micro-Kjeldahl flask along with 20 mL of distilled water, placed in
 129 the distilling outlet of the micro – Kjeldahl distillation unit. A conical flask containing 20 mL
 130 of boric acid indicator was placed under the condenser outlet and sodium hydroxide
 131 solution of 20 mL was added to the content in the Kjeldahl flask by opening the funnel
 132 stopcock. The distillation started and the heat supplied was regulated to avoid sucking back.
 133 Distillate was collected in 4% boric acid and the distillation was stopped. Nitrogen in the
 134 distillate was determined by titrating with 0.014 M mL of H_2SO_4 ; the end point was
 135 obtained when the colour of the distillate changed from green to pink.

136 Calculation;

137 % Crude protein = % N x 6.25 (conversion factor)

138 The nitrogen content of the sample is given by the formula below.

$$139 \% N = TV \times Na \times 0.014 \times V_1 \times 100 \times G \times V_2$$

140 Where

141 TV = Titre value of acid (cm^3)

Na = Normality of acid

V1 = Volume of distilled water used for distilling the digest (50 mL).

V2 = Volume of aliquot used for distillation (10 mL)

G = Original weight of sample grams

2.7: Crude Fiber Determination

A non-enzymatic method of [10] was used to determine crude fiber 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 fiber.

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

2.8 Carbohydrate Content Determination

Carbohydrate content was determined by difference as described [11] where the total proportion of carbohydrate in the sample was obtained by calculation, using the percentage weight method by subtracting the % sum of food nutrients: (% protein, % crude fiber, fat % and % ash) from 100%.

Where, percentage (%) of carbohydrates (=) (CF + CP + F + A + M – 100 %) where; CF = Crude Fibre, CP= Crude Protein, M = Moisture, F = Fat and A = Ash.

Phytochemical Analysis Procedures

2.9: Flavonoid Determination

Flavonoid was determined using spectrophotometer (Aluminum chloride method) as described by [12]. Nine milliliter of the sample was weighed and treated with ethyl acetate and mixed with 1 mL of Aluminum chloride (AlCl₃) and methanolic solution (2% w/v) incubated at a room temperature for 15 minutes, the absorbance was read at 430 nm. The amount of the TFC (total flavonoid contents) was estimated from the standard calibration curve of 10 – 100 µg/ mL – 1 quercetin

2.10: Alkaloid Determination

Alkaloid was determined using gravimetric method, [13], 2.0 g of sample was weighed (w₁) and dispensed into 50 ml of 10% acetic acid solution in ethanol. The mixture was well shaken and allowed to stand for 4 hours and filtered. The filtrate was evaporated to ¼ of its original volume. Concentrated NH₄OH was added and alkaloid precipitated. The filter paper was weighed (w₂) and the precipitate was scrapped off and washed with 1% NH₄OH solution. This was weighed with filter paper (w₃); the precipitate was dried in a filter paper in the oven at 60°C for 30 minutes and reweighed (w₄). By weight difference, the weight of the alkaloid was determined and expressed as a percentage of sample weight analyzed, given by formula;

$$\frac{W_1 - W_2 \times 100}{W_3 - W_4}$$

Where;

W_1 = Weight of sample
 W_2 = Weight of empty filter paper

2.11: Determination of Phenolic Acid

Total phenol contents was determined using the procedures described by [14] 1 mL aliquot of the extracts were taken into 10 mL glass tube and made up to a volume of 3 mL with distilled water, 5 mL of Folin Ciocalteu reagent (1:1) with water and 2 mL. 20% of Na_2CO_3 were added sequentially in each tube. Blue color was developed in each tube because the phenols undergo a complex redox-reaction with phosphomolibdic acid in Folin Ciocalteu reagent in alkaline medium resulted in blue colored complex molybdenum blue. The test solutions were warmed for 1 minute, cooled and absorbance was measured at 650 nm against the reagent, used as blank. A standard calibration plot was generated at 650 nm using a concentration of catechol. The concentration of phenol in the test samples were calculated from the calibration plot and expressed as mg catechol equivalent of phenol/100 g of sample.

2.12: Saponin Contents Determination

Saponin content was determined as described by [15]. Five grams of each sample was dispersed in 50 mL of 20% ethanol. The suspension was heated over a hot water bath for 4 hours with continuous stirring at 55°C. The mixture was filtered and the residue re-extracted with another 200 ml of ethanol prepared in distilled water (20% v/v). The combined extracts were reduced to 40 mL over water bath at 90°C and the concentrate was transferred into 250 ml separator funnel, 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 and 60 mL of n-butanol was added and the mixture was washed twice with 10 mL of 5% aqueous sodium chloride. The remaining solution was heated in a water bath at 90°C. Samples were dried in an oven at 100°C until a constant weight was obtained and Saponin content was calculated in percentage

$$(\%) \text{ Saponin} = \frac{\text{absorbance of sample} \times \text{gradient factor} \times \text{Dilution factor}}{\text{Wt of sample} \times 10,000}$$

2. 13: Tannic Acid Determination

The total tannin content was determined according to method described by [16]. This involved the use of butanol /HCl reagent (95.5 w/v and 37% HCl) and ferric reagent (2% ferric ammonia sulphate in NH_4Cl) where 0.5 mL of extract was diluted with 70% acetone to make absorbance not to exceed 0.6 in a tube of 30 mL. And incubated at 97-100°C for 60 minutes, the tube was cooled and read absorbance at 550 nm using unheated suitable blank and condensed tannin (96% of dry matter) and calculated using; $A_{550nm} \times 78.26 \times$ dilution factor.

Where; 1 cm, 550 nm of leucocyanidin = 406.

(The formula assumed that 1 cm, 550 nm of leucocyanidin is equal to 460) and
 A =absorbance.

Statistical Analysis

All data obtained were analyzed statistically, using SPSS version 17.0 package. Means were separated using [17] multiple comparison test at $P < 0.05$.

RESULTS AND DICUSSION

RESULTS

Table 1: Microbial analysis of dehydrated tomato powder at the 3rd months of production

Samples code	201	202
Total microbial counts	57×10^{-3}	77×10^{-5}
Mould and yeast count	**	**

Key:

213= Oven-dried tomatoes sample

214= Sun-dried tomatoes sample

* *= No growth resistance

Table 2: Microbial analysis of dehydrated tomato powder at the 6th months of production

Samples code	201	202
Total microbial counts	63×10^{-3}	71×10^{-5}
Mould and yeast count	195×10^{-3}	206×10^{-3}

Key:

213= Oven-dried tomatoes sample

214= Sun-dried tomatoes sample

Table 3: Sensory evaluation of tomato soup

Parameters	Taste	Flavour	Texture	colour
Sample code 201	7	8	7	8
Sample code 202	6	5	6	7

Key:

213= Oven-dried tomatoes sample

214= Sun-dried tomatoes sample

Table 4: Proximate composition of dehydrated tomato powder at 6th month

Parameters	Moisture	Ash	Crude fibre	Fats	Proteins	Carbohydrates
Sample code 201	8.58 ± 0.07^a	3.53 ± 0.0^a	6.37 ± 0.15^b	0.82 ± 0.02^b	3.70 ± 0.07^b	77.00 ± 0.30^a
Sample code 202	10.63 ± 0.21^b	3.88 ± 0.08^a	5.15 ± 0.10^a	0.53 ± 0.02^a	2.60 ± 0.07^a	77.21 ± 0.43^a

Values represent means of triplicate values $\pm$ sd (standard deviation)

Sample means with the same superscripts in a Column are not significantly different $p \geq 0.05$

Key:

213= Oven-dried tomatoes sample

214= Sun-dried tomatoes sample

Table 5: Phytochemical contents of dehydrated tomato powder

Parameters	flavonoid	Tannin	phenolic acid	Saponin	Alkaloid
Sample code 201	34.85 ± 0.13^b	15.50 ± 0.4^b	178.30 ± 2.10^b	0.19 ± 0.01^b	1.93 ± 0.16^b
Sample code 202	25.63 ± 0.17^a	9.11 ± 0.03^a	93.93 ± 1.77^a	0.13 ± 0.01^a	0.87 ± 0.06^a

Values represent means of triplicate values $\pm$ sd (standard deviation)

Sample means with the same superscripts in a Column are not significantly different $p \geq 0.05$

Key:

213= Oven-dried tomatoes sample

214= Sun-dried tomatoes sample

DISCUSSION

Table 1 represents the microbial growth of dehydrated tomato powder, the analysis showed that sample code 202 showed an increase in microbial growth than sample 201 which is obvious that the high rate of mould and bacteria presented in 202 may be due to environmental contaminants such as live stock and exposure to weather, house hood pests, rodents, insects and moisture absorption due to long duration drying. The analysis also showed that drying rate of sample 201 was 12 hours while sample 202 was 7 days; the drying method used to dry sample 201 was faster than 202. The slow rate of dehydration in sample 202 can encourage moisture absorption that can also encourage microbial growth.

Proximate composition of the dehydrated tomato powder showed that moisture content of sample 201 was 8.58 ± 0.07 and sample 202 was 10.63 ± 0.21 the analysis revealed that sample 201 has lower moisture content which can encourage the keeping quality of dehydrated tomato through prevention of the growth of microorganisms, and conservation of nutrients. Low moisture which is an index of extended shelf life also according to [18] and [19] Low moisture content after dehydration provides concentrated nutrients while high moisture enhances water activities that can increase spoilage microorganism. Fat contents of the two samples were low; sample 201 was 0.82 ± 0.02 while 202 was 0.53 ± 0.02 sample 201 contained the highest fat content but, not enough to cause oxidation that can lead to annoying flavour in the stored product.

The mean sensory score for the taste was sample code 201 were [7, 8, 7 and 8] [55.6%] while sample code 202 were [6, 5, 6 and 7] [44.44%]. Sample 201 had the highest score while sample 202 was the least this is an indication that oven dried sample code 201 was more acceptable than sun dried sample code 202 in all parameter tested.

The increase in **protein** [$3.70 \pm 0.07\%$], **crude fiber** [$6.37 \pm 0.15\%$], **flavonoid** [34.85 ± 0.13 mg/100g], **phenolic acid**, and **alkaloid** [1.93 ± 0.16 mg] while sample 202 included protein [2.60 ± 0.07], fiber was [5.15 ± 0.10], **flavonoid** [25.63 ± 0.17] and **phenolic acid** [93.93 ± 1.77] and alkaloid was [0.87 ± 0.06] at various significant level of $p \leq 0.005$. The higher nutrient content of sample 201 is an indication that sample (201) conserves more nutrients than sample 202.

Conclusion

Since sun dried [sample 202] showed an increase in microbial growth [71×10^{-5}] high moisture content and sample 201 has the lowest microbial count of 63×10^{-3} , low moisture content, higher percentage [55.6%] acceptability of sensory scored in taste, flavour, texture, colour and higher nutrient conservation more than sample 202, it could be an indication that the method of dehydration of [sample 201] signified that the processing method is an index of extended shelf life of dehydrated tomato powder than sample code 202 therefore, 201 could be recommended.

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