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Effect of Drying on the Blends of Tomato-Pepper-Turmeric Powder

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Abstract

Tomatoes and pepper are inevitable ingredients in food preparation and the need to minimize their losses cannot be over-emphasized. Matured red tomato, pepper and turmeric sourced locally were cleaned, sliced (10-15 mm) and dried using vacuum oven (60 °C for 14 h). Fresh blends of tomato, pepper and turmeric (RBA and RBB) and dried blends of tomato, pepper and turmeric (DBA and DBB) samples were analyzed for proximate, selected minerals, vitamin, phytochemical and sensory properties. Moisture, ash, protein, fat, fiber and carbohydrate content in DBA was 18.26 %, 11.95 %, 14.31 %, 3.77 %, 3.08 % and 48.89 %; and 16.80 %, 14.78 %, 13.04 %, 4.28 %, 3.21 % and 51.41 % in DBB. Calcium and iron content in DBA was 102.63 mg/100g and 78.90 mg/100g; while in DBB, 114.25 mg/100g and 81.35 mg/100g respectively. However, dried samples had no significant difference in magnesium, potassium, sodium and zinc content ($p > 0.05$). Ascorbic acid and β-carotene in DBA and DBB was 73.90 mg/100g and 66.48 mg/100g; and 71.28 mg/100g and 59.27 mg/100g respectively. Carotenoids, phenol and flavonoids in DBA and DBB were 510.38 mg/100g, 425.60 mg/100g and 1040.88 mg/100g; and 512.86 mg/100g, 429.10 mg/100g and 1035.26 mg/100g respectively. Inclusion of turmeric improves phytochemical properties of the blends and enhances consumer acceptability.

Keywords: Drying; Analyses; Properties; Vegetable; Spice.

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1. Introduction

Tomatoes (*Solanum lycopersicum*) are type of vegetable fruit that is abundantly farmed around the world and is one of the most popular foods, both fresh and cooked. Tomatoes are considered to be part of a healthy diet since they are low in fat and cholesterol-free. They are high in vitamin B, as well as important amino acids, carbohydrates, and dietary fibers [1, 2]. They are also high in carotenoids (especially lycopene), ascorbic acid (vitamin C), vitamin E, folate, flavonoids, and potassium which are helpful to one's health [3]. Carotenoids, ascorbic acid, and phenolic compounds are the major antioxidants found in tomatoes. Lycopene has been given a lot of attentions by medical researchers. And as a result, assertions have been made that lycopene may be beneficial in the treatment of cancer, coronary heart disease, and other chronic disorders [4]. The tomatoes' seeds and peel contain protein, dietary fibers and bioactive chemicals [5].

Cayenne pepper is a variety of *Capsicum annuum* that is used to flavor food [6]. It is a widely used spice in a variety of regional cooking methods, and they have been used medicinally for thousands of years. This pepper among others has a high nutritional profile, including a range of antioxidants that are good for health. The primary chemical in cayenne pepper is capsaicin which is responsible for its therapeutic qualities. In reality, the amount of capsaicin in a cayenne pepper determines how hot it is [7]. Cayenne pepper has traditionally been used as an analgesic, antimicrobial, and anti-irritant. It helps to correct digestive issues such as gas and intestinal spasms, as well as providing a stimulant impact that can help with nerve pain [8]. Cayenne pepper may give substantial antioxidant protection against malignancies like as lymphoma and leukemia due to presence of capsaicin [9].

Turmeric (*Curcuma longa*) is a Zingiberaceae herba perennial monocotyledonous herbaceous plant grown in Bangladesh, Thailand, Malaysia, Philippines, and Nigeria. It is widely used as a spice and as a medicinal crop [10]. Curcumin, dimethoxy curcumin, and bisdemethoxycurcumin are active biological compounds contained in turmeric [11]. Curcumin, has been proven to help in the reduction of blood sugar level, in the treatment and prevention of Type 2 diabetes, and therapy option for inflammatory disorders such as arthritis [12].

One of the most common methods for preserving fruits and vegetables is dehydration. Its major purpose is to eliminate enough water to keep microbial spoilage and deterioration reactions to a minimal. However, it is widely understood that when vegetables are dried, they get through the physical, structural, chemical, and nutritional changes that might impaired qualitative features like texture, color, and nutritional content [13]. Hot air drying (oven drying) is a common method used for obtaining dehydrated products, which allows for quick and mass processing, even though preservation of nutritional and commercial quality of products during processing has presented some serious concern in the past. The impact of drying conditions on the qualitative features of the dehydrated product has been established with a significant loss of color quality in the final product [14]. This is because undesirable color changes might lower the product's quality and market value. Tomatoes, pepper and turmeric are important ingredients in foods and these have been observed to be seasonal and perishable. Due to post harvest losses, this study aims to produce tomatoes-pepper-turmeric powder and determine effect of drying on proximate, minerals, vitamins, phytochemical and sensory acceptability of the blends.

2. Materials and Methods

2.1. Study Area

The products were developed at Food Science and Technology Laboratory, Bells University of Technology, Ota while analyses were carried out at Quality Control Department, Nestle Nigeria PLC, Agbara, Nigeria and Covenant University, Ota between July and December, 2021.

2.2. Preparation of Raw Material

To avoid contamination, matured fresh tomatoes (*Solanum lycopersicum*) were cleaned with portable water to remove dirt and sliced into 10-15 mm. Vacuum oven at 60°C was used for drying for 14 hours, milled into powder, packaged, and stored in a labeled air-tight sterile sampling bag. Matured fresh red peppers (*Capsicum frutescens*) were sorted, cleaned with portable water, stalks removed, and sliced before drying in a vacuum oven at 60^oC for 14 hours. Milling was done using a blender into powder, packaged in an air-tight sampling bag and labeled. Turmeric rhizomes (*Curcuma longa*) were carefully peeled and sliced into thin flakes to enhance fast drying in a vacuum oven at 60^oC for 14 hours followed by grinding into powder. The sample was packaged and labeled in air-tight polythene bag and kept at room temperature.

2.3. Research Design

Formulation of samples as described by Morris, *et al.* [15] using statistical simulation method given as:
Sample RBA: Fresh blend of tomato (75%), pepper (23%) and turmeric (2%)
Sample DBA: Dried blend of tomato (75%), pepper (23%) and turmeric (2%)
Sample RBB: Fresh blend of tomato (70%), pepper (27%) and turmeric (3%)
Sample DBB: Dried blend of tomato (70%), pepper (27%) and turmeric (3%)

2.4. Proximate Analysis

Proximate analyses were carried out to determine percentage of moisture, ash, protein, fat, crude fiber and carbohydrate content of the samples. Moisture content was determined by method described by AOAC [16] as shown in equation (1).

$$MC_{wb}(\%) = \frac{b-c}{b-a} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where MC_{wb} a is moisture content on wet basis, a is weight of empty crucibles, b is weight of sample and c is weight of dried sample. Ash, protein, fat, fiber and carbohydrate content were determined using rapid multi-component analyzer (Antaris FT-NIR analyzer). The crucible of the rapid multi-component analyzer was cleaned with brush and each sample was poured into the crucible. The analyzer was allowed to run a background check for accurate result and the parameters were measured by pressing the start button to analyze the samples, the results were displayed on the screen of the monitor.

2.5. Minerals Analysis

Calcium, potassium, magnesium, iron, and zinc levels were determined using Atomic Absorption Spectrophotometer, AAS (Bulk Scientific Model 2010) in accordance with AOAC [16].

2.6. Determination of Vitamins C

Into a 100 ml volumetric flask was weighed 10g of slurry and diluted to 100 ml with a 3% metaphosphoric acid (0.0033 M EDTA). The samples were filtered using Whatman filter paper 3. One hundred (100) ml of supernatant was pipette into a conical flask and titrated to a light-pink end point with a standardized solution of 2, 6 – dichlorophenol-in-diphenol. The ascorbic acid content of each sample was determined using the following equation 2:

$$Ascorbic\,acid\;(mg)\;per\,100\;g\;sample = \frac{V \times T}{W} \times 100 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where V = 100 ml dye used for titration of aliquot of diluted sample, T = ascorbic acid equivalent of dye solution expressed as mg per ml of dye and W = weight (g) of sample in aliquot titrated.

2.7. Determination of Phytochemical Properties

Determination of total carotenoid: In a centrifuge tube, 100 mg of sample was weighed; 10 ml of 80% acetone was added thoroughly mixed and centrifuged for 10 minutes at 3000 rpm. It was filtered using 80% acetone, the supernatant was increased to a volume of 10 ml using a UV visible spectrophotometer, and the optical density OD (absorbance) was measured at a wavelength of 480 nm.

$$Total\ carotenoid\ content\,(mg/kg) = \frac{4 \times OD \times Total\ vol.\ of\ sample \times 1000}{Sample\ weight} ....(3)$$

Determination of lycopene and beta carotene: A centrifuge tubes were filled with 100 mg of ground materials; 100 ml of distilled water was used to make the blanks. Eight (8) ml of hexane, ethanol, and acetone (2:1:1) were added into each tube, mixed quickly by shaken and incubated for at least 10 minutes in the dark. One (1) ml of distilled water was added to each tube, shaken one more time and allowed to stand for another 10 minutes to enable phase separation and bubble disappearance. Cuvette was rinsed with one of the blanks upper layers and discarded; the spectrophotometer was zeroed at 503 nm using a new blank. At 503 nm, the absorbance of the top layer of the samples was measured. The absorbance of beta carotene was measured at 450 nm. The beta carotene extinction coefficient was at 2505 [17].

$$Lycopene\ content\,(mg/kg) = \frac{Abs.\,@503nm \times 537 \times 8 \times 0.55}{W \times 172} ....(4)$$

Where 537g/mole is the molecular weight of lycopene and beta carotene, 8 is the volume of the mixed solvent, 0.55 is the volume ratio of the upper layer to the mixed solvent, W is the weight in g of the sample and 172 is the extinction coefficient of lycopene in hexane.

Determination of total phenol: Sample extraction was carried out by filling a conical flask with 1g of sample, 10 ml of ethanol added and a container covered with aluminum foil. The mixture was vigorously shaken, allowed to stand for 30 minutes to ensure proper extraction and centrifuged. The total phenol content was determined as follows: One (1) ml of supernatant, 1.5 ml of 7% $NaCO_3$ solution and 0.5 ml 2N Folin-Ciocalteu reagent were added into a test tube made up to 10 ml mark with distilled water, shaken and left to stand for 90 minutes. A calibration curve was created from tannic acid standard concentrations at 20, 40, 60, 80, 100, and 120 mg/l and the absorbance measured at 765 nm. The concentration was determined from a graph of the sample's absorbance against the concentration [18].

$$Phenol\ content\,(mg/kg) = \frac{Conc.\ obtained\ in\ mg/l \times vol.\ of\ sample \times DF}{Sample\ weight} ....(5)$$

Where DF=Dilution factor. If not diluted, then DF = 1

Determination of curcumin: One hundred (100) ml volumetric flask containing 50ml of 95% ethanol was weighed with 100 mg of turmeric and mixture was rapidly agitated for 10 minutes before being filled to the 100 ml mark with 95% ethanol. The solution was filtered, and 2 ml was transferred to a new volumetric flask, which was then filled with 95% ethanol. A UV visible spectrophotometer was used to measure the absorbance of the final solution at 425 nm. A standard curve was prepared using curcumin standard at a concentration ranging from 1 ug/ml to 4 ug/ml using a UV visible spectrophotometer, the absorbance was measured at 425 nm. The sample concentration was determined. According to the standard graph, the amount of curcumin present in the samples was determined using the volumes and dilutions of the samples [18].

2.8. Sensory Evaluation

Sensory analysis of the fresh and dried blended samples RBA, DBA, RBB and DBB were carried out by the use of 9-point hedonic scale [19]. Rehydration of tomato and pepper powder was carried out using 5 g of each sample in 300 ml of water at 80^{o}C. Each rehydrated sample were compared with fresh blends and presented to 20 semi-trained panelists in random order. Qualitative descriptive analysis was used to determine the sensory attribute and acceptability of the samples. The sensory attributes were appearance, aroma, texture, and overall acceptability.

2.9. Statistical Analysis

Statistical analysis was conducted with the SPSS software version 22.0. The mean and standard deviation of duplicate of the parameters was calculated and differences between the means was evaluated by analysis of variance (ANOVA) with a significant level being considered at $P < 0.05$. Mean comparison was assessed by Duncan’s multiple range test, and the values were expressed as means ± standard deviations.

3. Results and Discussion

3.1. Effect of Drying on Proximate Composition of Tomato, Pepper and Turmeric Powder

The results of the proximate composition of fresh and dried (powder) tomato, pepper and turmeric are shown in Table 1, while the proximate composition of the blended samples is in Table 2. The moisture content of the fresh and dried tomato, pepper and turmeric was 89.97%, 80.53% and 69.94%; and 10.36%, 12.01% and 9.11%, respectively. The result of the moisture content for fresh blended samples (RBA and RBB) and dried blended samples (DBA and DBB) was 76.44% and 76.16%; and 18.26% and 16.80%, respectively. At 5% level of significance, there was no significant difference in the fresh blended samples while in the dried blended samples, there was significant difference. The results of the dried samples are closely related to that of Kim and Chin [20] who reported 12% moisture content for dried tomato. However, the results of the fresh samples are comparable to Correia, *et al.* [21] who reported a moisture range 90%- 93%.in fresh tomato.

The result of the fat content was 1.25%, 1.25% and 1.05% for fresh tomato, pepper and turmeric, respectively, while that of dried tomato, pepper and turmeric was 1.63%, 4.56% and 6.40%, respectively. The fat content of the fresh blended samples (RBA and RBB) and dried blended samples (DBA and DBB) was (3.80% and 3.87%); and (3.77% and 4.28%) respectively. There was no significant difference ($p > 0.05$) in the fresh blended samples, but a remarkable significant difference was observed in dried blended samples.

The amount of minerals in food is determined by the ash content of the food [22]. The value of ash content of fresh tomato, pepper and turmeric was 2.56%, 2.05% and 3.09%, respectively. The dried ash content of tomato, pepper and turmeric was 8.18%, 2.11% and 2.78%, respectively. The ash content of the dried blended samples increased because minerals generally are heat stable. The heat transfer from the oven during the drying process increased the protein content of the fresh samples from 0.77%, 4.99% and 3.48% to 13.17%, 12.54% and 11.98% for tomato, pepper and turmeric, respectively. The result of the protein content of the fresh blended samples was 1.61% for RBA and 1.86% for RBB; apparently, there was no significant difference ($p > 0.05$) in the fresh samples. However, the protein content of dried blended samples, DBA (14.31%) and DBB (13.04%) increased significantly and this could be a result of heat treatment. Conversely, there was no significant difference in the dried blended samples. The results are in accordance with the findings of Aggarwal, *et al.* [23] who reported 13.96% protein content for dried tomato powder.

The fiber content of fresh and dried tomato, pepper and turmeric was 1.17%, 4.56% and 2.31%; and 6.79%, 9.92% and 2.75%, respectively. The bioavailability of the fiber in the fruits (tomato and pepper) might be enhanced by high temperature during drying. The results are in variance with Hussein, *et al.* [1] who reported 9.50% and 13.0% for dried tomato and pepper, respectively. This could be a result of differences in the variety of crops, time of harvest and site of cultivation. The fiber content of dried blended samples (DBA and DBB) was significantly low (3.08 and 3.21), respectively, due to the blends' combined effect. The fiber content of fresh blended samples (RBA and RBB) was 2.06% and 2.33% respectively, and there was no significant difference ($p > 0.05$). Moreover, high fiber content in food protects against metabolic conditions such as diabetes mellitus [24].

The carbohydrate content of tomato, pepper and turmeric increased from 2.75%-59.89%, 6.62%-59.89% and 24.61%-66.95% respectively during drying process. The carbohydrate content increased to 48.89% and 51.41% in dried blended sample A and B respectively. The increase could be a result of the concentration of dry matter. However, there was no significant difference ($p > 0.05$) in fresh blended samples, but there was a significant difference in the dried blended samples. The decrease in carbohydrate content of dried blended samples was found to be in conformity with 49.78% reported by Ho, *et al.* [25].

Table-1. Proximate composition of fresh and dried tomato, pepper and turmeric

Sample (%)	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
Fresh tomato	89.97±0.06	2.56±0.22	0.77±0.78	1.25±0.04	1.17±0.10	2.75±2.13
Powder tomato	10.36±0.18	8.18±0.35	13.17±0.10	1.63±0.06	6.79±0.08	59.89±0.71
Fresh pepper	80.53±0.06	2.05±0.06	4.99±0.11	1.25±0.01	4.56±0.13	6.62±0.12
Powder pepper	12.01±0.03	2.11±0.03	12.54±0.07	4.56±0.13	9.92±0.06	59.89±0.03
Fresh turmeric	69.94±0.69	3.09±0.25	3.48±0.03	1.05±0.04	2.31±0.08	24.61±0.75
Powder turmeric	9.11±0.19	2.78±0.15	11.98±0.21	6.40±0.21	2.75±0.08	66.95±0.08

Values are mean standard ± deviation of duplicate determination.

Table-2. Proximate composition of fresh and dried blends of tomato pepper and turmeric

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Fiber (%)	Carbohydrate (%)
RBA	$76.44±0.14^{c}$	$4.91±0.50^{a}$	$1.61±0.62^{a}$	$3.80±0.32^{a}$	$2.06±0.11^{a}$	$11.17±1.40^{a}$
RBB	$76.16±0.12^{c}$	$5.45±0.16^{ab}$	$1.86±0.98^{a}$	$3.87±0.01^{a}$	$2.33±0.11^{a}$	$9.92±0.06^{a}$
DBA	$18.26±0.78^{b}$	$11.95±0.16^{bc}$	$14.31±0.08^{b}$	$3.77±0.18^{a}$	$3.08±0.57^{b}$	$48.89±0.27^{a}$
DBB	$16.80±0.06^{a}$	$14.78±4.86^{c}$	$13.04±0.32^{b}$	$4.28±0.10^{b}$	$3.21±7.13^{c}$	$51.41±0.51^{b}$

Values are means ± standard deviation of duplicate determinations. The mean values of the samples within a column with different superscripts (letters) are significantly different ($p < 0.05$).
RBA -Fresh blended sample A; RBB - Fresh blended sample B; DBA - Dried blended sample A;
DBB – Dried blended sample B.

3.2 Effect of Drying Method on Mineral Content in Fresh and Dried Blends of Tomato, Pepper and Turmeric

The composition of selected minerals such as calcium, magnesium, iron, potassium, sodium and zinc in fresh and dried blends of tomato, pepper and turmeric as shown in Table 3, revealed that calcium content in fresh blended samples was 75.64 mg/100g in RBA and 74.58 mg/100g in RBB and showed no significant difference ($p > 0.05$). However, the calcium content in dried blended samples was 102.63 mg/100g in DBA and 114.25 mg/100g in DBB and significantly different ($p < 0.05$). Magnesium content in fresh samples was 115.36 mg/100g in RBA and 121.28 mg/100g in RBB, while that in dried samples was 220.07 mg/100g in DBA and 217.65 mg/100g in DBB. The magnesium level in fresh samples was significantly low and differs when compared to dried samples. At 5% level of significance, there was a significant difference in the iron content of both fresh and dried blended samples. The iron content in fresh blended samples (RBA and RBB); and dried blended samples (DBA and DBB) was (35.16 mg/100g and 40.05 mg/100g); and (78.90 mg/100g and 81.35 mg/100g) respectively. Potassium content in fresh blended samples was 137.28 mg/100g in RBA and 144.64 mg/100g in RBB, while in dried blended samples, potassium level was 252.20 mg/100g in DBA and 252.01 mg/100g in DBB, which showed no significant difference. Sodium content in dried samples was significantly the same with 329.55 mg/100g in DBA and 328.63 mg/100g in DBB, but higher than the value of 121.60 mg/100g reported from blends of dried tomato and pepper by Soma and Kalpana [26]. The difference could be due to the effect of drying. Zinc content in fresh blended samples was significantly different with 4.99 mg/100g in RBA and 4.51 mg/100g in RBB ($p < 0.05$). Obviously, zinc content of dried blended samples was significantly the same with 3.01 mg/100g in DBA and 3.08 mg/100g in DBB ($p > 0.05$). Minerals in the body are helpful in the prevention of high blood pressure and enhance growth, cell division, and wound healing [26].

Table-3. Mineral composition in fresh and dried blends of tomato, pepper and turmeric

Sample	Ca (mg/100g)	Mg (mg/100g)	Fe (mg/100g)	K (mg/100g)	Na (mg/100g)	Zn (mg/100g)
RBA	75.64 ± 0.71^{a}	115.36 ± 0.65^{a}	35.16 ± 0.17^{a}	137.28 ± 1.02^{b}	201.28 ± 1.50^{c}	4.99 ± 0.20^{b}
RBB	74.58 ± 0.17^{a}	121.28 ± 1.02^{b}	40.05 ± 0.66^{b}	144.64 ± 0.54^{c}	189.35 ± 0.52^{b}	4.51 ± 1.49^{c}
DBA	102.63 ± 2.23^{b}	220.07 ± 1.68^{c}	78.90 ± 0.92^{c}	252.20 ± 2.02^{a}	329.55 ± 1.64^{a}	3.01 ± 1.49^{a}
DBB	114.25 ± 0.20^{c}	217.65 ± 1.65^{c}	81.35 ± 0.65^{d}	252.01 ± 0.42^{a}	328.63 ± 0.57^{a}	3.08 ± 0.42^{a}

Values are means ± standard deviation of duplicate determinations. The mean values of the samples within a column with different superscripts (letters) are significantly different ($p < 0.05$).
RBA -Fresh blended sample A; RBB - Fresh blended sample B; DBA - Dried blended sample A;
DBB – Dried blended sample B.

3.3. Phytochemical Composition in Fresh and Dried Blends of Tomato, Pepper and Turmeric

The result of phytochemical composition in fresh and dried blends of tomato, pepper and turmeric as shown in Table 4 indicated that carotenoids content in fresh blended samples was 358.30 mg/100g in RBA and 349.38 mg/100g in RBB. In dried blended samples, carotenoids content was 510.38mg/100g in DBA and 512.86 mg/100g in DBB. There was significant difference ($p < 0.05$) in all the samples. Lycopene content was high in fresh blended samples with 13.02 mg/100g in RBA and 13.59 mg/100g in RBB. In dried blended samples, lycopene content was 10.36 mg/100g in DBA and 9.88 mg/100g in DBB. Low lycopene in dried blended samples could be as a result of heat on the carotenoids. Phenol in fresh samples was 316.24 mg/100g in RBA and 325.16 mg/100g in RBB. In dried blended samples, phenol content was 425.60 mg/100g in DBA and 429.10 mg/100g in DBB. Flavonoids content in fresh blended samples; RBA and RBB, (398.24 mg/100g and 421.54 mg/100g) respectively while in dried samples; DBA and DBB, (1040.88mg/100g and 1035.26 mg/100g) respectively. Curcumin content was low in all the samples observed and this might be due to small proportion of turmeric used in the blends. The results are in variance with the founding of Farag, *et al.* [27] who reported 24.40 mg/100g in carotenoids, 20.72 mg/100g in lycopene, 289.20 mg/100g in Phenol and 100.76 mg/100g in flavonoids for dried tomato. The variance could be effect of the blends. Phytochemicals serves as a major source of bioactive compounds that combat degradative effects of reactive oxygen [28].

Table-4. Phytochemical composition in fresh and dried blends of tomato, pepper and turmeric

Samples	Carotenoids (mg/100g)	Lycopene (mg/100g)	Phenol (mg/100g)	Flavonoids (mg/100g)	Curcumin (mg/100g)	Ascorbic acid (mg/100g)	β-carotene (mg/100g)
RBA	358.30 ± 0.22^{b}	13.02 ± 0.03^{b}	316.24 ± 0.57^{a}	398.24 ± 0.07^{a}	3.54 ± 0.07^{b}	18.29 ± 0.07^{a}	17.89 ± 0.17^{b}
RBB	349.38 ± 0.18^{a}	13.59 ± 0.07^{b}	325.16 ± 0.24^{b}	421.54 ± 0.07^{b}	4.29 ± 0.04^{c}	19.58 ± 0.03^{a}	16.88 ± 0.01^{a}
DBA	510.38 ± 0.08^{c}	10.36 ± 0.51^{a}	425.60 ± 0.70^{c}	1040.88 ± 0.10^{d}	0.35 ± 0.07^{a}	73.90 ± 1.91^{b}	66.48 ± 0.04^{d}
DBB	512.86 ± 0.27^{d}	9.88 ± 0.57^{a}	429.10 ± 0.04^{d}	1035.26 ± 1.07^{c}	0.50 ± 0.07^{a}	71.28 ± 0.44^{b}	59.27 ± 0.06^{c}

Values are means ± standard deviation of duplicate determinations. The mean values of the samples within a column with different superscripts (letters) are significantly different ($p < 0.05$).
RBA -Fresh blended sample A; RBB - Fresh blended sample B; DBA - Dried blended sample A;
DBB – Dried blended sample B.

3.4. Ascorbic Acid and β-carotene Content in Fresh and Dried Blends of Tomato, Pepper and Turmeric

The result of ascorbic acid and β-carotene in fresh and dried blends of tomato, pepper and turmeric in Table 4 showed that ascorbic acid level in fresh blended samples was 18.29 mg/100g in RBA and 19.58 mg/100g in RBB. However, ascorbic acid level in dried samples was 73.90 mg/100g in DBA and 71.28 in DBB. Apparently, ascorbic acid level of dried samples was high compared with 51.36 mg/100g in dried tomato and pepper reported by Aggarwal, *et al.* [23]; and 6.7 to 9.2 mg/100g in fresh blends of tomato and pepper reported by Joseph, *et al.* [29]. Increase in ascorbic acid (vitamin C) level in this research could be seen to be effect of inclusion of turmeric in the blends. β-carotene, a precursor of vitamin A was low in fresh blended samples with 17.89 mg/100g in RBA and 16.88 mg/100g in RBB. In dried blended samples, β-carotene was 66.48 mg/100g in DBA and 59.27 in DBB. Vitamin A was showed to be high in this study compared with the value 26.75mg/100g reported by Obadina, *et al.* [5] for blends of tomato and pepper powder. All the samples are significantly different ($p < 0.05$). Increase in ascorbic acid and β-carotene in dried blended samples could be attributed to effect of moisture removal during the drying process and inclusion of turmeric.

3.5. Sensory Evaluation of Fresh and Dried Blends of Tomato, Pepper and Turmeric

The sensory attributes evaluated are consistency, aroma, color and overall acceptability. The result as shown in Figure 1 revealed that in RBA, sensory attributes ranged from 7.15 to 8.00 and there was no significant difference in consistency, color and overall acceptability. In RBB, sensory attributes ranged from 7.15 to 7.65 with similarity in consistency, color and overall acceptability at 5% level of significance. In DBA, sensory attributes ranges from 6.75 to 7.75 and there was no significant difference in all the attributes. In DBB, the rating ranged from 7.55 to 8.63 while color and overall acceptability showed no significant difference ($p > 0.05$). The unpleasant color changes in dried products, predominantly in tomato as presented in Figure 2 could be attributed to the drying method. However, blend of tomato, pepper and turmeric powder (DBA) gave a desirable aroma while DBB showed acceptable color and overall acceptability.

Figure-1. Sensory evaluation of fresh and dried tomato, pepper and turmeric blends RBA -Fresh blended sample A; RBB - Fresh blended sample B; DBA - Dried blended sample A DBB – Dried blended sample B

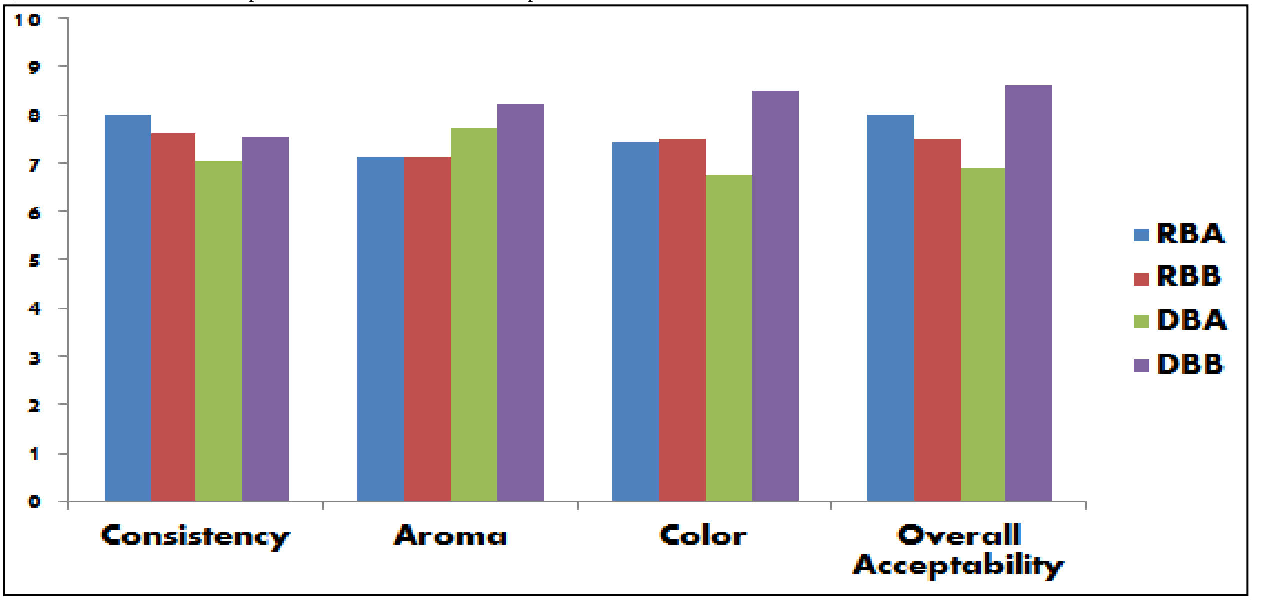
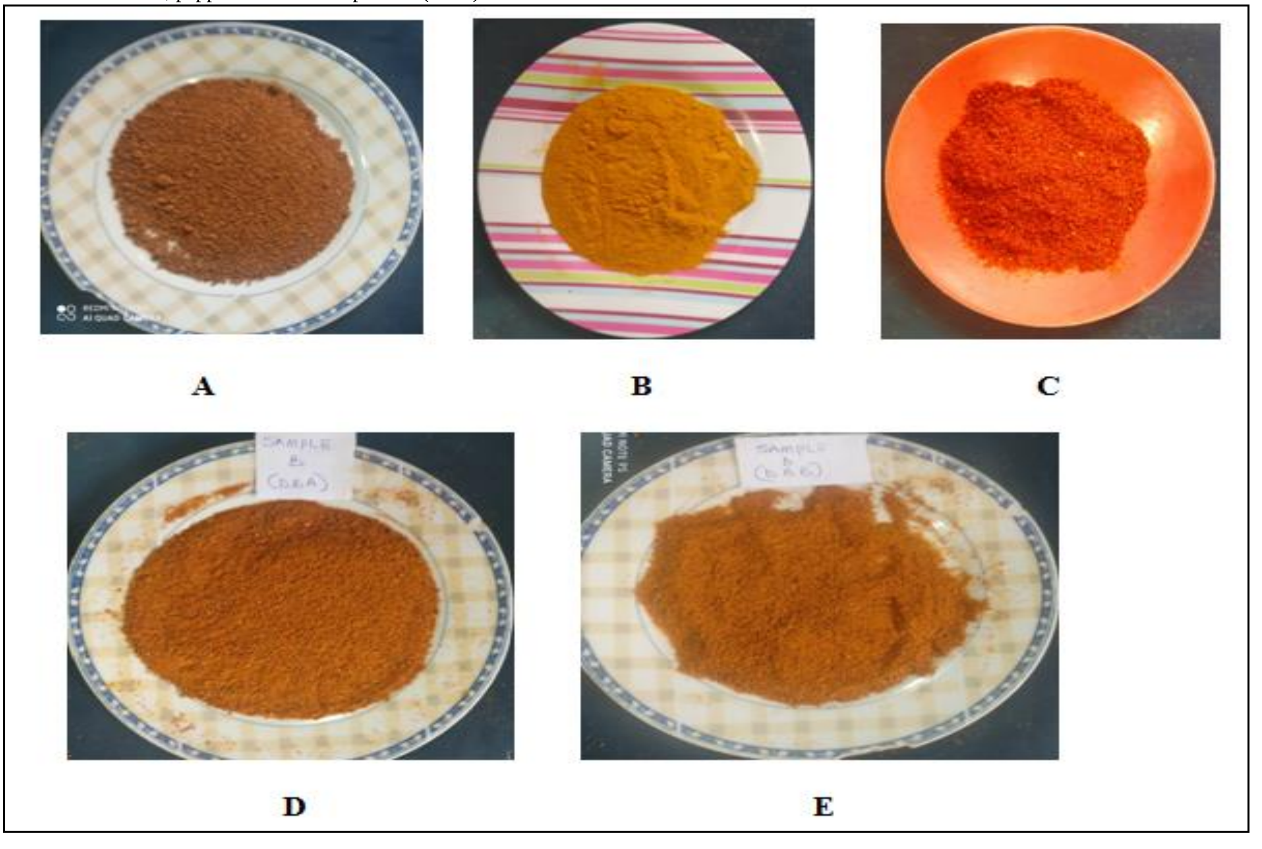


Figure-2. Dried samples A- Tomato powder; B- Turmeric powder; C- Cayenne powder; D- Blend of tomato, pepper and turmeric powder (DBA); E- Blend of tomato, pepper and turmeric powder (DBB)



4. Conclusion and Recommendations

This study indicates that tomato and pepper powder blended with turmeric contained appreciable amount of nutrients such as vitamins and minerals that could enhance the quality and acceptability of the products. Drying of the blend of tomato, pepper and turmeric improved the nutritional, phytochemical, ascorbic and β-carotene content of the final powder. Inclusion of turmeric also enhanced color retention. Consumer perception of the dried products indicates that overall acceptability was high and at 5% level of significance, there was no significant difference in all attributes evaluated in dried blended sample A (DBA). Consumer perception of the tomato-pepper-turmeric products indicated that DBB was most preferred and acceptable to the panelist and thus recommended for commercialization. However, to further establish the marketability of this product, it is therefore necessary to determine color analysis and shelf stability, this will further explore packaging material suitable for the product and appealing to the consumers.

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Conflict of Interest

The authors declare that they have no known competing interests or personal relationship that could have appeared to influence this research.

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