FUNCTIONAL PROPERTIES OF LOCALLY PROCESSED TOMATO PASTE AND TOMATO POWDER

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Abstract
Extending the shelf life of tomatoes is very important for domestic and export marketing, which can be achieved through different preservative techniques such as dehydration and processing into different forms. The research is aimed at determining and comparing the functional properties of locally processed tomato paste and tomato powder sourced from Eke market in Afikpo, Ebonyi State. The parameters assessed are Water Absorption Capacity (WAC), Oil Absorption Capacity (OAC), Water Soluble Index (WSI), Bulk Density (BD) and pH value. The data obtained were subjected to analysis of variance (ANOVA) and mean separation done using Tukey's method at 5% level of probability. From the results between the two samples, the water absorption capacity of tomato powder (9.55±0.01), was significantly different at $p < 0.5$ from that of the tomato paste (3.78±0.02), while that of the oil absorption capacity was higher in tomato powder (4.56±0.03) and was significantly different from that of the tomato paste (4.02±0.02). The water solubility index of the tomato powder was (90.64 ±0.01) while the tomato paste had a value of (0.13± 0.02). However, the bulk density was found to be highest in tomato powder (0.44±00) while the tomato paste was observed to record no bulk density value. The pH value was higher in tomato powder (4.23±0.04) when compared to tomato paste (4.07±0.03). In conclusion, locally processed tomato powder had higher functional properties than tomato paste, and can be used as an enriching additive for food fortification and a thickening agent in the formulation of commercial foods like tomato ketchup.

Keywords
Tomatoes Paste, Tomato Powder, Functional properties, Food fortification, shelf life.

Introduction

Tomato is a fleshy berry known as a highly perishable fruit as well as vegetable grown throughout the tropical and temperate regions of the world. Tomato (*Lycopersicum solanum*) stands out as one of the major agricultural crops cultivated many places in Nigeria but mainly in the northern parts of the country. Adenike (2012) reported that 50% of more than six million tonnes of tomatoes produced annually are lost along the food chain between rural point of production and the destination town of consumption in the tropical areas. Tomatoes are over 90% water and in many cases the shelf life of fresh tomatoes has a short duration of days before they begin to deteriorate during postharvest activities. They begin to undergo high rates of respiration, resulting in moisture loss, quality deterioration and potential microbial spoilage (Abdullahi, Abdullahi, Abdu & Ibrahim, 2016). Tomatoes are either eaten fresh or processed into paste, puree, ketchup and powder. Post-harvest activities such as sorting, storage and processing technologies have been utilized for centuries to transform perishable fruits and vegetables including tomato into safe, delicious and stable products. Tomato has a limited shelf life at ambient conditions and is highly perishable this makes its preservation inevitable. Many methods of food preservation rely on removal of water in order to decrease water activity below a level that causes growth retardation of spoiling microorganisms. Decreased water content also influences unwanted chemical reactions affecting not only the nutritive value of food but also its sensory properties. In some cases, processed tomatoes are said to have same or even higher nutrient content (Ismail *et al* 2016). Sun drying of tomatoes is one of the most common methods of preservation in Nigeria due to its vast availability all the year round. Among the drying techniques, open sun drying is a seasoned, simple (requires less technology), cost effective and familiar food preservation method used to reduce the moisture contents of all agricultural commodities (Durance & Wang, 2002). Nonetheless, the quality of products can be seriously tainted and occasionally rendered inedible in open sun drying because of the potential risk from environmental problems (rain, storm, windborne dirt, dust) and biological hazards (infestation by insects, rodents and other animals).Preservation and storage of tomatoes can be difficult especially in Nigeria because of the prevailing situation of poor transportation networks coupled with high temperatures that enhance decay during storage (Ibironke & Rotimi, 2013). Tomatoes contain a variety of phytochemicals, the well-known being lycopene a carotenoid antioxidant and in addition other carotenoids like beta carotene, phytoene, phytofluene, phenolics, minerals, vitamin C, A and vitamin E etc. These phytochemicals are powerful antioxidants that neutralizes free radicals, which may cause damage to cell components (e.g. DNA, protein and lipids), and protect against chronic diseases like of prostrate cancer , cardiovascular diseases, etc by mitigating oxidative damage.

Functional properties are the essential physiochemical properties of foods that reflect the complex interactions between the structures, molecular conformation, compositions and physicochemical properties of food component with the nature of the environment and conditions in which these are measured and associated (Suresh & Samsher, 2013). Functional properties explain how food ingredients behave during the preparation and cooking, how they impact the finished food products in terms of appearance, texture, structure, and tastes. The functional properties of foods are influenced by the components of the food material, especially the carbohydrates, proteins, fats and oils, moisture, fibre, ash, and other ingredients, as well as the structures of these components. Each ingredient used in a food has a specific function, which often impact the functional property of the food (Awuchi, Igwe & Echeta, 2019). Functional properties are unique quality attributes of foods and food products.

Water absorption capacity is the amount of water (moisture) taken up by a food to achieve the desirable consistency and create quality food product. Very low or excessive water absorption can negatively affect the quality of foods. Water absorption capacity is important in consistency and bulking of products (Iwe *et al*, 2016). Oil absorption capacity is an essential functional property that contributes to enhancing mouth feel while retaining the food products' flavour. The major chemical component affecting oil absorption capacity is protein which is composed of both hydrophobic and hydrophilic parts. The non – polar side chains of amino acids can form hydrophobic interactions with hydrocarbon chains of lipids.

Bulk density indicates the porosity of a food product which imparts the design of the package and can be used in determining the type of the required packaging material (Iwe *et al*., 2016). In food system, solubility is the property of solid, liquid or gaseous food (chemical) substances known as solute to dissolve in liquid, gaseous, or solid solvent. Substance solubility fundamentally depends on the chemical and physical properties of the solvent and solute as well as on pressure, pH, temperature, and presence of other chemicals of the solution. The extent of the solubility of a food substance in a specific solvent is commonly measured as the saturation concentration, in which addition of more solute does not increase concentration of the solution and rather starts to precipitate the excess quantity of solute (Awuchi, Igwe &Echeta 2019). Water Solubility Index is linked to the estimation of the behaviour of the material if further processed for use as a binder, stabilizer, or as a source of protein in human diets.

Materials and Method

Fresh tomatoes were purchased from Eke market located in Afikpo, Ebonyi State.

Preparation of Tomato Powder

Prior to drying, Fresh and healthy tomatoes were selected and washed, and individual tomato fruits were measured by callipers and cut into 8mm thickness slices using sharp stainless steel knife (Jayathunge et al., 2012) , laid on a tray and put out under the sun. Drying process was done at normal atmospheric temperature of 25^0C for 2 days until the sample was thoroughly dried. The dried tomatoes were blended into a powder form and packaged in polythene bag for analysis and stored in dry place for the determination of its functional properties.

Preparation of Tomato Paste

Fresh and healthy tomatoes were selected and washed. The tomatoes were blended into a homogenous mixture. Continuous boiling and stirring of the tomatoes was done until the tomato paste was achieved. After cooling, the tomato paste was packaged for analysis and stored in dry place for the determination of its functional properties.

Methodology

Water Absorption Capacity

Approximately 2 g sample was dispersed in 20 ml of distilled water. The contents were mixed for 30s every 10 min using a glass rod and after mixing five times, centrifuged at 4000 g for 20 min. The supernatant was carefully decanted and then the contents of the tube were allowed to drain at a 45° angle for 10 min and then weighed. The water absorption capacity was expressed as percentage increase of the sample weight (AACC , 1995).

Oil Absorption Capacity (OAC)

Oil absorption capacity of the tomato samples were determined by the centrifugal method with slight modifications. One gram of sample was mixed with 10 ml of pure canola oil for 60 s, the mixture was allowed to stand for 10 min at room temperature, centrifuged at 4000 g for 30 min and the oil that separated was carefully decanted and the tubes were allowed to drain at a 45° angle for 10 min and then weighed. Oil absorption was expressed as percentage increase e of the sample weight (Beuchat, 1977).

Water Solubility Index

Water solubility index determines the amount of polysaccharides or polysaccharide release from the granule on the addition of excess of water. WSI is the weight of dry solids in the supernatant from the water absorption index test expressed as percentage of the original weight of the sample (Filli, Nkama, Jideani& Abubakar, 2013).

$$\text{WSI (\%)} = \frac{\text{Weight of dissolved solid in supernatant}}{\text{Weight of dry solids}} \times 100$$

Bulk Density

The bulk density was determined according to the method described by(Udoro and Kehinde, 2014). A 20 g sample was put into 50 ml measuring cylinder. The cylinder was gently tapped on the bench top 10 times from a height of 5 cm. The bulk density was calculated as weight per unit volume of sample.
Calculation: Bulk Density (BD) g/ml = Weight of sample/Volume of sample after tapping

pH determination

The pH of the samples was measured with a pH meter. Ten gramsof each sample collected were homogenized in 50ml of distilled water. The resulting suspensions were decanted and their pH were determined using pH meter already standardized with buffer solutions of pH 4.0 and 7.0 at 250C. The pH value of tomato juice was measured using a calibrated electrode (Horwitz & Latimer 2000).

Statistical Analysis Initially, all the collected data from objective measurements and subjective assessments were checked for normality, and variance homogeneity and Analysis of Variance (ANOVA) was done by SAS version 9.2 (SAS Institute Inc., 2008). Data were compared on the basis of standard deviation of the mean values. Every significant treatment effect within the evaluated parameters was compared using Tukey at 5% probability level

Results and Discussion

Table 1: Functional Properties of Tomato Paste and Tomato Flour

Sample	g/g WAC	g/g OAC	% WSI	g/ml BD	PH
TP	9.55^{a}±0.01	4.56^{a}±0.03	90.64^{a}±0.01	0.44^{a} ±0.00	4.22^{a}±0.04
TT	3.78^{b}±0.02	4.02^{b}±0.02	0.13^{b}±0.02	-	4.07^{b}±0.03

TP = Tomato Powder TT= Tomato Paste
*Values are mean ±standard derivation of 3 replications. Mean with different superscript along the same column are significantly different (P<0.05)

Functional Properties of Tomato Flour and Tomato Paste

The result of the functional properties of tomato paste and tomato powder is presented in Table 1. The result shows that there was significant difference (p<0.05) in the functional properties of tomato paste and tomato powder determined.

Water absorption capacity refers to the amount of water, which remains bounded after application of external force such as centrifugation (Shanna et al., 2002). The water absorption capacity was observed to range from 3.78 - 9.55 g/g with the highest water absorption capacity recorded in tomato powder and lowest value obtained in tomato paste. The moisture content of a powder plays a significant role in the flow and other mechanical properties of the food. However, it depends largely on the method, extent of drying and the humidity in the surrounding atmosphere (Lawal, 2004). Water absorption capacity is an important parameters which determines sample consistency and are dependent on the compositional structure of the sample (Ayo-Omogie&Ogunsakin, 2013). Akubor and Owuse (2020) and Surendra *et al.,* (2018) all reported a water absorption capacity value of 52.50% and 87% respectively for tomato flour.

The tomato powder (4.02 g/g) had a higher Oil Absorption Capacity than the tomato paste (4.56 g/g). Oil absorption capacity is another property of fibre rich ingredient that can be used for food product development. The ability of fiber to bind oil is related more to porosity of the fiber structure than affinity of the fiber molecule for oil (Relhaneh and Mehdi, 2010). Oil absorption capacity (OAC) is important because it acts as flavor retainer and increases the mouth feel of foods.

The water solubility index of the tomato powder was 90.64g/g while the tomato paste had a value of 0.13g/g. The higher water solubility index recorded in tomato flour is expected since flours are produced at higher temperature due to their negative effect time on moisture content. However, the bulk density was found to be highest in tomato powder (0.44 g/ml) while the tomato paste was observed to record no bulk density value.

The pH value of the tomato samples were observed to range between 4.07 - 4.23. Highest pH value was obtained in tomato powder (4.23) while tomato paste recorded a lower value (4.07). These values are in agreement with the values (3.99 - 4.38) reported by Eke-Ejiofor (2015). The parameter indicates hygienic quality of tomato powder and paste. The pH value obtained in this study did not exceed the maximum pH (4.5) as recommended by Codex Alimentarius Commission (CAC) for tomato paste (CAC, 2011). According to Giordano et al. (2000), pH below 4.5 is an advantageous attribute, since it arrests the development of microorganisms in the finished product during industrial processing. According to Campos et al. (2006), appropriate pH values for industrially dried tomato are ranging between 4.3 and 4.4

Conclusion

Local processing methods for fresh tomatoes reduce postharvest losses and help to preserve their nutrients and make tomatoes readily available throughout the year. Functional characteristics (properties) are required to possibly help, predict and precisely evaluate how proteins, fat, carbohydrates (starch and sugars) and fibre may behave in specific food systems. The functional properties of foods are characterized by the structure, quality, texture, nutritional value, acceptability and appearance of the food product. Functional property of a food is often determined by the organoleptic, physical and chemical properties of the food product. The study has shown that significant differences exist between the functional properties of tomato paste and tomato powder evaluated. The results obtained during the present study indicates that tomato powder have higher functional properties than tomato paste and can be used as a thickening agent and an enriching additive in the fortification of foods. Finally tomato products can be used in the production of reconstituted juice and tomato beverages and also as a functional ingredient adding antiplatelet activities to processed foods.

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