



Effects of Different Drying Methods and Packaging Materials on Quality of Tomato Powder

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ABSTRACT

Tomato has a very limited shelf life because of its climacteric in nature, high respiration rate and moisture content that facilitate deterioration soon after harvest. This research was carried out to determine the effect of different drying methods and packaging materials on chemical characteristics of tomato powder. The fruits were harvested at fully matured and ripe. The harvested fruits were subjected to blanching prior to three different drying methods and packaging materials before storage for twelve weeks. The three drying methods were shade, sun and oven drying, while the packaging materials were polythene bag, plastic container and glass jar. The experiment was arranged in a Completely Randomized Design (CRD) and replicated three times. From the results, at four weeks of storage, significant difference ($P \leq 0.05$) was observed among the drying methods and shade dried had the highest Ash content of 7.70% while oven dried recorded the highest Carbohydrates content of 70.06%. Also, oven dried had the highest Calorific value of 318.80 kJ/cal. From the packaging materials, glass jar recorded the highest fibre content of 14.91%, and Vitamin C (11.73 mg/100g). Furthermore, glass jar was found to be statistically better in maintaining the nutritive value of the dried samples because of its static chemical property and low permeability to absorb moisture within the storage environment which ensures unimpaired taste, colour and other vital nutrients followed by plastic container and polythene bag. Therefore, blanching prior to drying and the use of glass container should be adopted for better quality and longer shelf life of the products.

Keywords: Tomato; Drying; Packaging; Physicochemical Properties; Sensory Quality

INTRODUCTION

Tomato (*Lycopersicon lycopersicum* L.) meaning “wolf-peach”, is a herbaceous, usually sprawling plant of the solanaceae or night shade family that is typically cultivated for the purpose of harvesting its fruits for human consumption (Agrios, 2005). Tomato is one of the most important commercial and dietary vegetable crops that is cultivated all over the world for its fleshy fruits. Tomato being a climacteric fruit, rapid rise in rate of respiration leads to fruit deterioration during handling. After harvesting further transpiration losses make the fruit shrivel and eventually becoming unmarketable (Adaskaveg, 2002). Tomato plays a major role in human nutrition as a vegetable, it constitutes an important component in human diet, especially in developing countries. It is the second most consumed vegetable in the world behind potato. Tomatoes are eaten fresh in salads or processed

and can be stewed, fried, baked and used to produce soup, or used as juice (Varela *et al.*, 2003). In addition to this versatility, tomatoes are also an important source of vitamins and minerals. They are an excellent source of phosphorus, iron and vitamin A, B and C. They also contain small amounts of the B complex vitamins; thiamin, niacin and riboflavin (Naika *et al.*, 2005). According to Keith (1999), antioxidants can prevent, stop, or reduce oxidative damage. Antioxidants are naturally occurring chemicals in many foods, especially fruits and vegetables. Foods rich in antioxidants help protect us from disease attack and they slow

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the aging process (Sun *et al.*, 2009). The balance between free radicals and antioxidants will determine the amount of oxidative stress a person is undergoing. Decreasing free radical production, increasing dietary antioxidant intake or both can reduce oxidative stress (Keith, 1999). Lycopene is the pigment responsible for the characteristic deep red colour of ripe tomatoes and their products (Ibitoye *et al.*, 2009). According to Lindshield *et al.*, (2006) lycopene has earned a plethora of interest for its use as a preventative measure and possible treatment for cardiovascular disease, skin health, eye health, and prostate cancer. These positive effects on human health are attributed in large part to the antioxidant compounds found in high quantities in fruits and vegetables (Ames, 1993).

Tomato may be preserved into paste and powders which is used for cooking and in production of fruit drinks, puree and ketchup (Ayandiji and Adeniyi, 2011). Tomato has a very short shelf life because of its climacteric nature, high moisture content and high respiration rate which predisposes the produce to loss of wholesomeness, also very high percentage of tomato suffers a lot of bruises and cracks because of its thin epidermis during harvesting which affect its quality and subsequent market value. Drying is a mass transfer process that consists of water moisture evaporation from foodstuffs. Moisture content is defined as the quantity of moisture contained in the product and water activity describes the amount of water available for hydration of foods and is defined as the vapour pressure of water in the food divided by that of pure water at the same temperature. The initial moisture content of the product influences its drying rate. During drying, the moisture contained in the product is vaporized under the effect of heat and transferred to the ambient air (Alamu *et al.*, 2010). Drying is an excellent way to preserve food and solar dryers are appropriate food preservation technology for sustainable development. Drying was probably the first ever food preserving method used by man, even before cooking (Alamu *et al.*, 2010). It involves the removal of moisture from agricultural produce so as to provide a product that can be safely stored for longer period of time. In view of these, this study was carried out in Yola with the objective to determine the effects of drying methods and packaging materials on the quality attributes of powder tomato.

METHODOLOGY

The study was carried out in the Department of Crop Production and Horticulture and Food Science and Technology Department, Modibbo Adama University of Technology (MAUTECH), Yola Adamawa State. Tomato fruits at a fully matured ripe stage were harvested from the cultivated farm at Dumne, Song Local Government Area of Adamawa State. Fruits of almost uniform colours, undamaged, free from disease and bruises were selected for the experimental purpose. The treatments included were drying methods (oven drying, sun drying and shade drying) and packaging materials (glass jar, plastic container and polythene). The experiment was arranged in a Split-Plot in a Completely Randomized Design (CRD) and replicated three times with drying methods placed in the main plot while the packaging materials were placed in the sub-plot and replicated three times. The selected tomato fruits were dipped in boiling water for 5 minutes and into cold water (blanching) to deactivate microbial activity on the surface of the fruits and retain its colour after drying. The fruits were sliced into almost uniform sizes so as to maintain uniform drying until constant weight was achieved. After drying, the dried products were ground into powder.

The proximate analysis was determined according to the standard methods of Association of Official Analytical Chemists (AOAC) (2007). The moisture content was determined as described by (AOAC). The samples were dried at 105°C for 3 hours using the preset oven. The (AOAC) method was employed for ash content. The crucible containing the pre-weighed samples was placed in a heated furnace at 600°C for 6 hours after they were cooled at ambient temperature in desiccators and weighed. The protein content (% nitrogen x 6.25) and fat content were (1g was extracted for ether extract determination using diethyl ether (64°C solvent) as described by (AOAC). The carbohydrate was determined by subtracting from 100 the sum of the percentage moisture, ash, protein, fat and fibre from 100. Energy value was calculated using Atwater factor method (9 x % lipid) + (4 x % protein) + (4 x % carbohydrate) as described by Osborne and Voogt (1978). The data obtained from the study were subjected to statistical analysis of variance (ANOVA). Means that were significantly different at ($P \leq 0.05$) were

separated using Least Significant Difference (LSD).

RESULTS

The results of the effects of drying methods and packaging materials on chemical composition of dried samples of tomato at four and twelve weeks of storage are presented in Table 1 and 2, respectively. From the results, there was no significant difference ($P>0.05$) among the drying methods on moisture content, fibre, lipid, and protein at both four and twelve weeks of storage. Ash content indicated highly significant difference ($P\leq 0.05$) at four weeks of storage, but there was no significant difference ($P>0.05$) at twelve weeks of storage. At four weeks of storage, shade dried had the highest Ash content of 7.70%, while sun dried with 6.60% and was not statistically different from oven dried sample of the Ash content.

Carbohydrates content indicated significant difference ($P\leq 0.05$) among the drying methods at four weeks of storage but there was no significant difference ($P>0.05$) at twelve weeks of storage. At four weeks of storage, oven dried recorded the highest Carbohydrates content of 70.06% while the least was obtained from shade dried sample (67.53%). Calorific value showed significant difference ($P\leq 0.05$) among the drying methods at four weeks of storage but there was no significant difference ($P>0.05$) at twelve weeks of storage. At four weeks of storage, oven dried had the highest Calorific value of 318.80 kJ/cal followed by sun dried sample with 314.25 kJ/cal, while the least of value (308.76 kJ/cal) was obtained from shade dried sample. Vitamin C content showed highly significant difference ($P\leq 0.05$) at four weeks of storage, but there was no significant difference ($P>0.05$) at twelve weeks of storage. At four weeks of storage, the highest vitamin C content was obtained from oven dried sample (12.07 mg/100g) followed by shade dried with 11.08 mg/100g while sun dried had the least of value (9.77 mg/100g) (Table 1).

In respect to packaging materials, the results showed that there was no significant difference ($P>0.05$) among the packaging materials used on the parameters measured except the fibre content and Vitamin C that recorded significant differences ($P\leq 0.05$) among the packaging materials used at four weeks of storage and also Fibre content, protein and lipid recorded highly significant differences ($P\leq 0.05$) among the

packaging materials used at twelve weeks. For the fibre content at four weeks of storage, there was significant difference ($P\leq 0.05$) observed among the packaging materials used but highly significant difference ($P\leq 0.05$) was recorded at twelve weeks of storage. At four weeks of storage, glass jar recorded the highest fibre content of 14.91% while the least value of 14.69% was obtained from polythene bag. At twelve weeks of storage, glass jar recorded the highest of (14.68%) followed by polythene bag with (14.15%) while the least of (13.38%) was obtained from plastic container. For Vitamin C, there was highly significant difference ($P\leq 0.05$) among the packaging materials used at four weeks. Glass jar recorded the highest value of Vitamin C (11.73 mg/100g) followed by plastic container (11.46 mg/100g) while the least was obtained from polythene bag (9.75 mg/100g), but there was no significant difference ($P>0.05$) at twelve weeks of storage on Vitamin C. Lipid content indicated highly significant difference ($P\leq 0.01$) at twelve weeks of storage. Glass jar recorded the highest of (2.86%) followed by plastic container with (2.83%) while the least of (2.80%) was obtained from polythene bag (Table 2). Protein content indicated highly significant difference ($P\leq 0.05$) among the packaging materials at twelve weeks of storage. Glass jar recorded the highest of (3.14%) while the least of (2.95%) was obtained from polythene bag on the protein value.

Table 1: Effects of Drying Methods and Packaging Materials on the chemical characteristics of Tomato powder at Four Weeks of Storage

Treatment	Moisture (%)	Ash (%)	Fibre (%)	Lipid (%)	Protein (%)	CHO (%)	Energy (kj/cal)	Value	Vit.C (mg/100g)
Drying Methods									
Shade	3.86	7.70	14.85	2.88	3.18	67.53	308.76		11.08
Sun	3.76	6.60	14.70	2.89	3.13	68.93	314.25		9.77
Oven	3.09	6.23	14.78	2.88	3.16	70.06	318.80		12.07
P<F	0.219	0.008	0.125	0.836	0.347	0.027	0.023		<.001
LSD	1.077	0.671	0.156	0.017	0.090	1.555	5.866		0.385
Packaging Materials									
Polythene Bag	3.51	6.90	14.69	2.88	3.11	69.12	314.84		9.75
Plastic Container	3.59	6.79	14.74	2.88	3.16	68.85	313.96		11.46
Glass Jar	3.61	6.85	14.91	2.88	3.20	68.56	312.96		11.73
P<F	0.839	0.839	0.028	1.000	0.120	0.285	0.364		0.001
LSD	0.370	0.406	0.159	0.022	0.086	0.732	2.769		0.220

Table 2: Effects of Drying Methods and Packaging Materials on the chemical characteristics of Tomato powder at Twelve Weeks of Storage

Treatment	Moisture (%)	Ash (%)	Fibre (%)	Lipid (%)	Protein (%)	CHO (%)	Energy Value (kj/cal)	Vit.C (mg/100g)
Drying Methods								
Shade	10.78	6.56	14.37	2.83	3.07	62.95	289.55	8.77
Sun	11.44	6.83	14.38	2.84	3.03	61.48	283.60	10.16
Oven	10.39	6.49	14.46	2.82	3.06	62.79	288.78	9.30
P<F	0.448	0.486	0.439	0.385	0.662	0.191	0.168	0.168
LSD	2.107	0.770	0.184	0.027	0.011	1.971	7.590	1.620
Packaging Materials								
Polythene Bag	11.50	6.37	14.15	2.80	2.95	62.24	285.96	9.30
Plastic Container	9.94	6.92	13.38	2.83	3.07	63.19	290.51	9.20
Glass Jar	11.17	6.59	14.68	2.86	3.14	61.79	285.46	9.72
P<F	0.095	0.065	<.001	<.001	0.003	0.214	0.234	0.607
LSD	1.487	0.463	0.167	0.024	0.098	1.662	6.780	1.173

DISCUSSION

Studies on the effect of drying methods and packaging materials on chemical parameters which includes moisture content, ash, fibre, protein, lipid, carbohydrate energy value and ascorbic acid have shown variation in The lower content of moisture of oven and sun dried samples is expected. Drying involves lowering the amount of moisture to below 1-15% in fruits and vegetables (Dupriez and Coener, 1992). Moisture content of food is very important on nutrients density and shelf life of agricultural produce. In general, the reduction of moisture leads to an increase in the shelf life and concentration of other nutrients, therefore, for fruits and vegetables to be preserved for long periods of time before use, the moisture content has to be reduced (Morris *et al.*, 2004). According to Kolawale *et al.* (2011), food substances, especially food crops with high moisture content will favour the growth and multiplication of pathogenic microbes, and moisture content of greater than 15% is said to promote enzymatic reactions of other constituents of the dried products leading to loss of vitamins.

Therefore, it was observed that the moisture content of all the three drying methods for shade, sun and oven dried samples respectively were within the acceptable moisture level for dried fruits and this are in conformity to that obtained by (Ukegbu *et al.*, 2013). At both four and twelve weeks of storage, neither the drying methods nor the packaging materials found to be significant and this could be as a result of proper drying.

The percentage Ash content was found to be highly significant at four weeks after storage. At four weeks after storage, oven dried sample was found to be better than sun and shade dried samples in terms of ash content and this could be attributed to high drying efficiency of the oven. There was no significant difference observed at twelve weeks after storage, likewise no significant difference observed among the packaging materials both at four and twelve weeks of storage and this finding is similar to that obtained by (Onwuka, *et al.*, 2002). The variation in the ash content could be attributed to the type of drying methods used and high ash content indicate the mineral content of food.

Crude fibre was not significantly difference found among the drying methods at four and twelve weeks after storage and could be attributed to appropriate drying of the product. Dietary fibre is necessary for healthy condition, curing of nutritional disorders and increase food digestion (Ifon *et al.*, 2009). There was significant difference and highly significant difference observed at four and twelve weeks of storage respectively among the packaging materials. At four weeks, glass jar was found to be better with and the trend continues the same way at twelve weeks of storage glass jar was observed to be better in maintaining the physicochemical properties of dried tomato than other packaging materials and this is in conformity with the findings of Marsh and Bugusu (2007), who reported that glass jar has a static chemical property and low permeability to absorb moisture from the storage environment which ensures unimpaired taste, colour, and other vital nutrients. Neither the drying methods nor the packaging materials were observed to be statistically difference in terms of lipid content at four weeks after storage but there was highly significant difference found in the packaging materials at twelve weeks of storage. The protein content at both four and twelve weeks of storage was no significantly difference among the drying methods. In the case of packaging materials, no significant difference observed at four weeks of storage, but there was highly significant difference observed at twelve weeks of storage. Glass jar was better than its counterparts plastic container and polythene bag respectively.

After drying the carbohydrate content of fruits and vegetables increases, low carbohydrate of fresh fruit and vegetables showed that they supply little or no energy when consumed except when supplanted with other foods (Rosello *et al.*, 2000). Oven dried was found to be higher even though not statistically difference in terms of carbohydrate content and this could be attributed to the high drying efficiency of oven to reduce higher moisture content during the drying process. Rosello *et al.* (2000) reported that low carbohydrate of fresh fruit and vegetables showed that they supply little or no energy value when consumed. In the case of packaging materials, no significant difference observed both at four and twelve weeks of

storage. In all the drying methods, vitamin C was depleted in the sun dried sample at four weeks of storage and could be as a result of oxidative destruction in the presence of oxygen, light, heat, moisture and metal ions as reported by (Russell and McDowell, 1989). In general, glass jar was observed to be better in maintaining the physicochemical properties of dried tomato than other packaging materials and this is in conformity with the findings of Marsh and Bugusu (2007), who reported that glass jar has a static chemical property and low permeability to absorb moisture from the storage environment which ensures unimpaired taste, colour, and other vital nutrients

Conclusion

In this study, the various drying methods used were capable of preserving the nutrients in the food crops without total loss of any nutrient. Shade dried and oven dried samples were found to be more nutritive than sun dried samples, on the other hand, oven drying and sun drying were faster than the shade drying method. Oven drying was more cost effective and gave the lowest moisture content in this study, proving lower moisture content and higher nutritive value, thus confers a greater increase in shelf-life on the dried samples. On the other hand, glass container was found to be better in terms of maintaining chemical properties of the dried samples followed by plastic container.

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