

ORIGINAL RESEARCH

Processing and preservation of homemade tomato, pepper, and onion paste for combating household food wastage and economic sustainability

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Tomato, pepper, and onion have been widely used for meal preparation and consumption. However, post-harvest loss is a significant obstacle to the production of tomatoes, onions, and peppers in Nigeria. The shelf life of these veggies has to be extended in a secure and affordable method. Any technique for product storage and preservation that promotes the use of affordable, locally accessible materials and ensures that product quality is unchanged for a long time should be used. This paper examines the processing and preservation of homemade tomato, pepper, and onion paste for combating household food wastage and economic sustainability. Specifically, this study aimed at processing tomato, pepper, and onion into a paste, preserving the paste for 7 months at room temperature, preparing stew from both fresh and preserved paste, and also evaluating the sensory attributes of both fresh and preserved paste and stew. Two research questions and two hypotheses served as the study's guidelines. A total of 35 lecturers made up the population, and 15 lecturers were chosen as the sample. Data for the study were gathered using a nine-point Hedonic Scale rating questionnaire. The findings were presented as mean values, and the hypothesis was tested using the *t*-test. The significant differences were accepted at $P \leq 0.05$. Sensory evaluation revealed that there were no significant differences between the preserved and fresh paste and also no significant between the preserved paste stew and the fresh paste stew at $P \leq 0.05$. Processing and preservation of homemade tomato, pepper, and onion paste should be practiced in Nigeria, especially by homemakers. This will reduce the amount of domestic wastage of vegetables and reduce the amount of family resources spent on these vegetables during scarcity.

Keywords: preservation, postharvest wastage, tomato, pepper and onion, economic sustainability

Introduction

Tomato, and onion have been age-long food products worldwide for preparing sumptuous meals. There is hardly a home in Nigeria today that does not consume one or all of these vegetables/fruits in their daily food dishes for a healthy life (1, 2). Tomato, pepper, and onion provide families with daily needs of vitamins and minerals for the maintenance of health. The fleshy berry known as the tomato (*Lycopersicon solanum*) is a highly common perishable fruit and vegetable.

Despite being a vegetable in trade, it is a fruit according to botanical classification (3). One of the most significant and prevalent vegetables cultivated in Nigeria (4) and other parts of the world is the tomato. Tomatoes are of many varieties rich in nutrients such as vitamins A, B, C, and E and also contain a reasonable amount of minerals such as phosphorus, potassium, iron, niacin, folate, and dietary fiber (5). Additionally, they are rich in beta-carotene and lycopene, which are antioxidants that might strengthen the body's immune response by fending off the negative effects

of chemicals known as free radicals (6). Antioxidants are helpful in reducing the prevalence of cardiovascular diseases, cancer, and neurological disorders because they have anti-inflammatory, anti-allergic, and anti-thrombotic qualities (5). In processed goods such as tomato juice, puree, paste, ketchup/sauce, dry slices, powder, canned, bottled tomatoes, or when combined with fresh pepper and onion to form delectable meals, tomatoes are a significant raw resource.

One of the ingredients most frequently used in Nigerian cooking is pepper. Almost no meal is complete without at least one type of pepper. There are many different types of pepper grown across the world, but many of them are created according to geographical locations and environmental factors. Pepper is a member of the significant vegetable family Solanaceae, according to Alahira (7). Atarodo (*Capsicum annum*), sometimes known as the Scotch Bonnet pepper, is the most popular kind found in markets and supermarkets. It is used as a spice to enhance the flavor, color, and taste of food (7). Peppers have heart-stimulating properties that control blood flow, fortify the arteries, and may even lessen the risk of heart attacks. It has calming effects on the digestive tract, provides relief from cold, flu, and fever symptoms, improves movement, especially for chilly hands and feet, and acts as a post-dinner cure. Calcium and vitamin C are abundant in fresh peppers (7). Scotch bonnet can be used alone or in combination with onions and tomatoes to prepare food.

The onion, sometimes referred to as the root of the onion or ordinary onion (*Allium cepa* L., from the Latin *cepa* "onion"), is a vegetable that is widely grown in Nigeria and across the world. Some meals also include onions as an ingredient. As a culinary item, onions are offered in savory or cooked meals as well as consumed raw in pickles or chutneys, according to Block (8). Some onion varieties have an energy value of 166 kJ (40 calories) per 100 g (3.5 oz) and include roughly 89% water, 9% carbohydrates (4 sugar and 2% dietary fiber), 1% protein, and minimal fat (9). In addition to adding flavor to food, onions have very less calories.

Tomatoes, onions, and peppers are of importance in the Nigerian economy in terms of both production mostly by small-scale farmers and consumption as the most commonly used vegetable in regular diets. However, Kasso and Bekele (10) observed that postharvest losses are major challenges that affect the production of tomatoes, onions, and peppers in most developing countries, which in no doubt prevent a sizeable proportion of these harvested vegetables from getting to the consumer, ending in the garbage. Matured ripe tomatoes and peppers are perishable crops with a high moisture content which gives them about 48 h short shelf life in tropical conditions (11), whereas onions have a longer shelf life of about 3–4 months provided they are kept dry. Several edible crops lose quality as well as quantity during harvest and delivery to the end consumer. When there are problems with mechanical damage, over-ripening, spoiling, and fungal infection in tomatoes and scotch bonnets, loss happens. According to Umar (12), Nigerian tomato

producers lose more than 40% of their harvest due to inadequate storage and processing facilities. This is due to the difficulty in preserving and storing tomatoes and peppers, particularly in Nigeria due to the country's inadequate transportation infrastructure and high temperatures, which accelerate degradation during preservation (13). Scientists and domestic workers alike have been very interested in finding ways to extend the duration of storage and preservation of these vulnerable crops.

Healthy family living must include preservation. It entails the processing or treatment of food in order to stop or slow down food spoiling (in terms of quantity loss, edibility, or nutritional content), hence extending the amount of time that food may be stored. According to Irokanulo et al. (14), processing and preservation are a collection of physical, chemical, and biological procedures used to extend the shelf life of food while preserving its color, texture, flavor, and notably nutritional content. By employing heat to kill enzymes and bacteria (i.e., pasteurization and blanching) or by reducing water content, boosting acidity, or utilizing extremely low temperatures, the preservation of foods is accomplished (15).

Nigeria uses sun drying as one of the most prevalent preservation techniques as it is so widely accessible all year long. It is a method for prolonging the shelf life of pepper and tomato after harvest. To save waste and generate unappealing dried tomato and pepper chips, a considerable portion of the tomatoes and peppers grown in the northern region of Nigeria are often sun-dried on plain ground (16). The Sun-drying process involves spreading tomatoes and peppers on bare ground for about 8 days whereby the vegetables are not protected from wind, rain, or animals. Consequently, many farmers incur huge losses of produce all the time, which can be minimized by the preservation and processing of tomatoes and peppers into paste. Tomato paste has been around for a while. It is created by chopping up ripe tomatoes and boiling the pulp to make a very thick paste. According to Bourdhrioua et al. (17), tomatoes are processed industrially to create ketchup and puree and are frequently canned or bottled. The fruit is blended and kept for weeks at freezing temperatures in the refrigerator as the most popular technique of preserving among middle-income families.

Tomatoes and peppers are particularly perishable commodities that are highly subject to price changes in the market; thus, they must be sold and removed from the market as soon as possible (5). The homemakers can take advantage of the surplus period by preserving them against the period of scarcity. The shelf life of tomatoes and peppers has to be extended in a safe and affordable method in Nigeria and other developing nations with epileptic power supplies. Therefore, it is important to employ any technique of storage and preservation that will ensure that the quality will not be impacted for a long time and that will promote the use of accessible, affordable, indigenous technology minus the use of synthetic substances. Processing and preservation of

tomato, pepper, and onion at home is one of the cheapest methods of achieving this. Goldberg (18) opines that the advantages of processing and preserving tomatoes and peppers, among others, include protection against spoilage, long shelf life, added value, availability, easy transportation, profitability, lower cost, ease of storage, convenience, and safety. It is also a measure of food security for the family because it enables out-of-season consumption. If properly implemented, the usage of this indigenous technology will protect Nigerian households from domestic waste, boost overall utilization, make it available during times of shortage, decrease post-harvest losses, and conserve family resources while also assuring sustainable consumption and production patterns. Additionally, it is a means of meeting Goal 12 of the UN's Sustainable Development Goals, which calls for establishing sustainable patterns of consumption and production. It may be used to bring in money for the family, but more significantly, it will ensure that fresh tomato paste is consumed in the home and will assist to reduce domestic spending on tomatoes during times of shortage. Thus, the objective of this paper is the processing and preservation of homemade tomato, pepper, and onion paste for combating household food wastage and economic sustainability. Specifically, this study is aimed at processing tomato, pepper, and onion into paste, preserving the paste for 7 months at room temperature, preparing stew from both fresh and preserved tomato, pepper, and onion paste, and evaluating the sensory attributes of both samples.

Research questions

The following questions were answered in this study:

1. What are the mean ratings of the respondents in terms of sensory evaluation (i.e., general appearance, color, aroma, and consistency) between fresh tomato, pepper, and onion paste (FTPP) and preserved paste (PTPP)?
2. What are the mean ratings of the respondents in terms of sensory evaluation (i.e., general appearance, color, flavor, consistency, and general acceptability) between beef stew prepared with persevered tomato, pepper, and onion paste and beef stew prepared with FTPP?

Hypotheses

H₀₁: There is no significant difference between PTPP and FTPP in terms of general appearance, color, aroma, and consistency.

H₀₂: There is no significant difference between beef stew prepared with PTPP and beef stew prepared with

FTPP in terms of general appearance, color, taste, flavor, consistency, and general acceptability.

Materials and methods

Materials

Matured fresh tomatoes, fresh peppers (scotch bonnet), and onions, recycled bottle jars, aluminum sauce pan, double boiler, spoon, bowls, cooking spoons, and gas cooker were used to prepare the paste and groundnut oil, beef, and condiments were used to prepare the stew.

Population for the study

The population of this study was made up of both male and female members of staff of the School of Vocational Education, Delta State College of Education, Mosogar. There are 35 members of staff (20 males and 15 females) in the School of Vocational Education, Delta State College of Education, Mosogar (Office of the Dean, 2022).

Sample for the study

The sample size was 10 judges made up of five male and five female lecturers that are familiar with rice and stew and were purposively selected to make up the panel of judges.

Research instrument

A questionnaire was used to collect data for this study. The questionnaire was designed to measure the attributes of the preserved paste and the FTPP attributes (i.e., general appearance, color, aroma, and consistency). The same kind of survey was also used to gauge judges' preferences for both stew samples (PTPP and FTPP) in terms of their overall look, color, flavor, reliability, taste, and mouth feel. The questionnaire used a nine-point hedonic scale, with the points being (1) very dislike, (2) very dislike, (3) moderately hate, (4) slightly dislike, (5) neither like nor dislike, (6) slightly like, (7) moderately like, (8) very like, and (9) extremely like. Like highly (9) is the highest scale, and dislike severely (1) is the lowest. The threshold was 5 (neither liked nor despised).

Data collection techniques

Twenty copies of the questionnaires were printed, and two copies were given to each of the 15 judges separately. The judges were requested to rate the persevered sample

(PTPP) and the fresh sample (FTPP) in terms of general appearance, color, aroma, and consistency using the first copy of the questionnaire. Two hours later, the judges were also requested to taste each beef stew with rice, evaluate the samples for general appearance, color, flavor, consistency, taste, mouth feel, and overall acceptability, and rate them using the second copy of the questionnaire, rinsing their mouth after each taste. The rating was employed to both preserved and fresh paste stew samples.

Sample for the study

The sample size was 10 judges made up of five male and five female lecturers that are familiar with rice and stew and were purposively selected to make up the panel of judges.

Method of sample preparation

Matured, fresh, and healthy tomatoes, peppers, and onions were purchased at the Effurun local market, Delta State. The tomatoes, peppers, and onions were sorted, washed, and grounded to a smooth paste using the local grinding engine. The paste was boiled on high heat for about 30 min, and then the heat was reduced and further boiled for about 30 min until the paste became concentrated. Before adding the tomato, pepper, and onion paste, cleaned bottle jars were rinsed, sanitized with boiling water, and then heated for roughly 10 min to prevent contamination. The jars were sealed before being placed in a kettle of hot water and boiled for about 15 min. After cooling, the jars were labeled and stored at room temperature in a cabinet. The paste had no preservatives or additives.

The tomato paste was kept between 2 January and 2 August 2022, with frequent inspections made for any physical color shifts or signs of microbiological activity (mold). After 7 months, FTTP was prepared and grounded. The samples were compared for general appearance, color, aroma, and consistency. The beef stew was prepared from both samples (fresh tomato paste and preserved paste), and sensory evaluation was done on both sauces separately to evaluate the general appearance, color, taste, flavor, consistency, and overall acceptability (Figure 1).

Data analysis

The data were obtained with mean for the research questions. Items with a mean of 5.00–9.00 were regarded as like, while items with a mean of 1.00–4.99 were regarded as dislike,

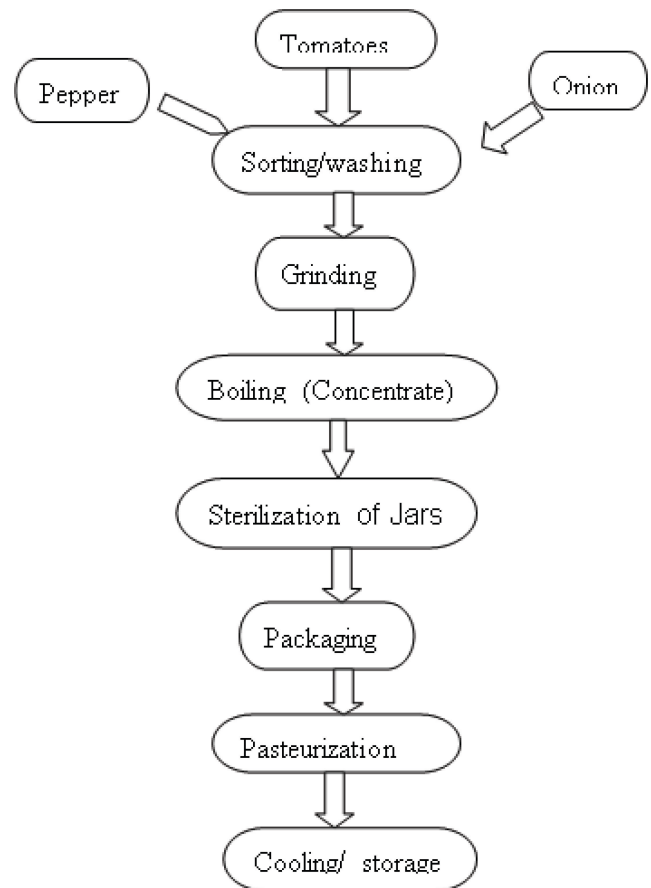


FIGURE 1 | Flowchart for the production of fresh tomato, fresh pepper, and onion paste.

TABLE 1 | Mean ratings of the respondents in terms of sensory evaluation (i.e., general appearance, color, aroma, and consistency) between FTTP and PTPP.

Samples	Parameters			
	General appearance	Color	Consistency	Aroma
PTPP	8.50 ^a	8.60 ^a	8.40 ^a	8.40 ^a
FTTP	8.40 ^a	8.30 ^a	8.20 ^a	8.30 ^a

Mean values with different superscripts are significantly different ($P < 0.05$). FTTP means fresh tomato, pepper, and onion paste. PTPP means preserved tomato, pepper, and onion paste.

and a t -test was used to test the hypotheses. The significant differences were accepted or rejected at $P \leq 0.05$.

- MEAN = N/n
- Where N is = Total Mark Scored; n = Total Numbers of Responses (Judges)

Results

Research question 1: What are the mean ratings of the respondents in terms of sensory evaluation (i.e., general appearance, color, aroma, and consistency) between freshly

TABLE 2 | Mean ratings of the respondents in terms of general appearance, color, aroma, and consistency between FTTP and PTPP beef stew.

Samples	Parameters					
	General appearance	Color	Flavor	Consistency	Taste	General acceptability
PTPP	8.13 ^a	8.20 ^a	8.60 ^a	8.53 ^a	8.27 ^a	8.27 ^a
FTTP	8.07 ^a	8.07 ^a	8.53 ^a	8.40 ^a	8.07 ^a	8.20 ^a

Mean values with different superscripts are significantly different ($P < 0.05$). FTTP means fresh tomato, pepper, and onion paste. PTPP means preserved tomato, pepper, and onion paste.

TABLE 3 | *t*-test for parameter measured for PTPP and FTTP.

Parameters	PTPP	PTP	FTTP	SD	<i>t</i> -value	<i>t</i> -cal	Remark
General appearance	8.50 ^a		8.4	0.316		1	Accepted
Color	8.60 ^a		8.30 ^a	0.483	2.262	1.961	Accepted
Consistency	8.40 ^a		8.20 ^a	0.422		1.509	Accepted
Aroma	8.40 ^a		8.30 ^a	0.316		1	Accepted

t-value at 5% = 2.262, \bar{x} = mean, SD = standard deviation, and *t*-cal = *t*-calculated value.

TABLE 4 | *t*-test for all the parameters measured for beef stew prepared with PTPP and FTTP.

Parameters	PTPP	FTTP	SD	<i>t</i> -cal	<i>t</i> -value	Remark
General appearance	8.13 ^a	8.07 ^a	0.26		0.895	Accepted
Color	8.20 ^a	8.07 ^a	0.38	2.187	0.369	Accepted
Consistency	8.53 ^a	8.40 ^a	0.36		0.787	Accepted
Flavor	8.6	8.53 ^a	0.26		1.045	Accepted
Taste	8.27 ^a	8.07 ^a	0.39		1.389	Accepted
General acceptability	8.27 ^a	8.20 ^a	0.26		0.778	Accepted

t-value at 5% = 2.187, \bar{x} = mean, SD = standard deviation, and *t*-cal = *t*-calculated value.

grounded tomato, pepper, and onion paste (FTTP) and preserved paste (PTPP)?

Table 1 shows the mean rating of judges in terms of appearance, color, aroma, and consistency between FTTP and PTPP. The findings indicate that both FTTP and PTPP samples have a mean rating between 8.20 and 8.60. The table shows that PTPP has higher mean ratings in all the parameters measured and, therefore, is highly liked by the judges.

Research question 2: What are the mean ratings of respondents in terms of general appearance color, flavor, consistency, taste, and general acceptability between PTPP and FTTP beef stew?

Table 2 shows the mean rating of judges in terms of appearance, color, consistency, flavor, taste, and general acceptability between beef stew prepared with FTTP and PTPP. The findings indicate that both FTTP and PTPP stew samples have a mean rating between 8.07 and 8.60. The table shows that PTPP was rated higher in all the parameters measured and, therefore, is highly liked by judges.

H₀₁: *There is no significant difference between PTPP and FTTP in terms of general appearance, color, aroma, and consistency.*

Table 3 shows that the null hypothesis for no significant difference in the preference of judges between PTPP and FTTP samples in terms of general appearance, color, aroma, and consistency was upheld at $P \leq 0.05$.

H₀₂: *There is no significant difference between beef stew prepared with PTPP and beef stew prepared with FTTP in terms of general appearance, color, taste, flavor, and general acceptability.*

Table 4 shows that the null hypothesis for no significant difference in the preference of judges between stews made from PTPP and FTTP in terms of general appearance, color, aroma consistency, taste, and general acceptability samples was upheld at $P \leq 0.05$.

Discussion of findings

After 7 months of preservation of the tomato, pepper, and onion paste (PTPP), there were no visible changes in the paste. The physical appearance, color, and aroma of the sample remained the same and no appearance of any physical microbial growth (mold). The trapped gas that assisted in the paste's preservation is released when the container containing the preserved tomato paste is opened. The tomato, pepper, and onion paste was able to stay whole because of the airtight container and sanitation. This method has been successful in preventing spoilage organisms from producing any kind of deterioration in the tomato paste while it is being stored. It was also observed that the preserved sample maintains its firm consistency, freshness, and aroma throughout the preservation period. This was also reported in Urowayino reported in vanguard (April 1, 2018), about local women in Bauchi state who preserved tomato paste using the same method as in this research, and McClellan (19) who preserved tomatoes and tomato paste for 1 year using a similar method recorded similar results. Montcho and Fagbohoun (20) reported no contamination by yeast and mold in tomato puree samples after 12 months of preservation.

The findings of the results demonstrate that both PTPP and FTTP received good ratings from the judges in every variable assessed, and there was no discernible disparity in the judges' observations. This implied that the physical attributes of homemade tomato paste can remain stable for up to 7 months and beyond without any adverse effect on the product as long as it is stored in air-tight bottled jars. This is in agreement with the Urowayino reported in vanguard (April 1, 2018). McClellan (19) also reported that there was no difference in color after one year of preservation at room temperature. Tomato paste, as stated by Thanjavur (5), may be kept for 240 days (8 months) in a variety of storage conditions with less to no impact on the quality of the item and at the lowest feasible cost.

The study also revealed that the panel of experts preferred the stews cooked with preserved paste and were unable to tell the difference between stews made with fresh and stored tomato paste. Their assessment of the samples as highly liked was proof of this. Ukponmwan (6) observed a similar outcome and came to the conclusion that stewed fresh tomatoes kept by sun drying, hot water therapy, and paste bottling did not lose their flavors. Joseph also confirmed the result in an interview (August 5, 2022), that there is no difference between FTTP and PTPP. Without affecting the sensory qualities of the stewed goods, the storage technique was able to maintain the tomatoes in a fresh state. Although there was no significant difference in taste, some of the judges rated preserved tomato paste stew higher in taste than the fresh tomato paste stew, which may have resulted from individual preference. This report was also confirmed by Joseph that preserved tomato, pepper, and onion stew tastes better than fresh paste.

Conclusion

This study has shown that tomato, pepper, and onion paste can be preserved for 7 months and above without losing their original characteristics such as color, flavor, consistency, and taste. Stew prepared from the preserved paste was even rated higher in taste by panelists as shown in their hedonic rating. Homemade processing and preservation of tomato and pepper paste, if well practice, will save Nigerians especially homemakers from domestic wastage, increase overall utilization, make it available during scarcity, and reduce post-harvest losses. In addition to being able to reduce domestic spending on tomatoes and peppers during times of limited availability while ensuring that family members have access to fresh tomato, pepper, and onion paste all year long, homemade tomato paste has another major advantage.

Recommendations

1. Processing and preservation of homemade tomato, pepper, and onion paste should be encouraged in Nigeria, especially by homemakers. This will reduce the amount of domestic wastage of vegetables.
2. Local food sellers and food canteen should be encouraged to use the homemade method of tomato and pepper preservation instead of using rotten tomatoes to cook for the general public and compromising the health of their customers.
3. Nigerian and other African countries should also reduce the importation of tomato paste and encourage the use of homemade tomato, pepper, and onion paste. This will reduce the wastage of post-harvest losses which has been a major problem in Nigeria.
4. Youths and especially women should be encouraged to invest in tomato, pepper, and onion paste preservation during surplus as this can serve as an avenue to generate income during scarcity, thereby curbing unemployment in the country.

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