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ORIGINAL ARTICLE

Comparative Evaluation of the Qualities of some Selected Tomato-Paste Brands Sold in Kano Market

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Abstract

Tomato fruits suffer postharvest losses due to poor storage facilities. One of the few efficient ways of preserving the nutrients, ensuring the availability of tomato all year round and increasing the bioavailability of lycopene is through processing tomato into a paste. In this study, selected tomato-paste brands sold in Kano market were evaluated for their qualities with the aim to identify possible adulteration. A total of eight different tomato-paste brands were collected from Yankura market in Kano. The physicochemical properties, proximate, lycopene and vitamin C contents and microbial quality were determined. The results showed that the tomato pastes had high moisture content (89.27 - 91.11 %) and low amount of ash (1.06 - 0.72 %), protein (3.28 - 1.64 %), fat (1.09 - 0.81 %) and carbohydrate (6.32 - 4.42%). The pH (3.73 - 4.35) and acidity (0.36 - 0.49%) of the samples were within the Codex Alimentarius Commission (CAC) recommended limit for tomato pastes. The total solids (8.89 - 12.26%) of the tomato pastes were below the CAC recommended limit which is evident in their low viscosity (210.70 - 270.20 mPas) values. Microbiologically, the tomato pastes exceeded the CAC maximum limit (10 cfu/g) for coliform content. However, the tomato pastes were rich in vitamin C (19.36 - 23.58 mg/100 g) and contain an appreciable concentration of lycopene (20.35 - 27.92 mg/kg). Importantly, they are free from adulteration.

Practical application

The tomato pastes evaluated in this study is largely popular in the Nigerian market, particularly Kano, leading to their wide consumption. The data obtained can be used to provide informative assessment on the quality of tomato pastes sold in Kano, thereby informing end-users on their quality status, providing recommendations to manufacturers on possible improvements on the quality of their products as well as attract the attention of regulatory agencies on the need to critically assess the quality of imported and locally produced tomato pastes and ensure they meet quality standards before they are launched into the market.

Keywords: Tomato-paste, Quality, Comparative evaluation, Lycopene.

1. Introduction

Tomato (*Lycopersicom esculentum*) is an important vegetable crop that is widely grown in many home gardens and large farms for fresh consumption and commercial processing (Aditi *et al*., 2011). They are highly perishable and large wastage is recorded in fresh tomato fruit yearly. Processing operations such as concentration and heat treatment has been applied to ensure their availability all year round (Khachik *et al*., 2002).

Fresh or canned tomato is primarily priced for its colour which is due to the presence of the pigment lycopene. Lycopene being a terpene is a red pigment characterized by an acyclic symmetrical structure containing eleven conjugated double bonds and two unconjugated double bonds that gives the molecule its red colour (Nguyen & Schwartz, 1999). It is a member of the carotenoid family of phytochemicals, a hydrophobic molecule located within the tomato matrix (Clinton, 1998) and a powerful antioxidant. It is the most prevalent carotenoid present in the human serum, accounting for roughly 50% of all plasma carotenoid content (Daniel, 2015). Most of the dietary lycopene consumed by population in the Western world comes from tomato or their derived products (Khachik *et al*., 2002; Giovannucci, 1999). It has been found to be beneficial in neutralizing harmful radicals responsible for cancer, heart disease, macular degeneration and other age-related illnesses (Agarwal & Rao, 2000). The concentration of lycopene gives an indication of a quality of tomato paste.

Aside being a rich source of lycopene, tomato is also a good source of vitamin C. These antioxidants fight against free radicals and oxidative stress. This implies that commercially sold processed tomato paste should contain a good amount of these phytochemicals. However, adulterated tomato paste, lacking in these important nutrients have polluted the market and consequently resulting to economic losses and possibly food poisoning. Umeofia (2016) lamented that the country loses huge sums of money to importation of fake tomato products. He reported that a good number of tomato products imported into the country from Asia were often adulterated with starch which could have adverse effects on the health of Nigerians. The infiltration of poor-quality tomato products into the country has been attributed to the activities of unpatriotic marketers conniving with unethical foreign companies to bring into the country tomato pastes loaded with starch and treated with food colour additives in order to achieve the deep red colour. Furthermore, the focus of the National Agency for Food and Drugs Administration and Control (NAFDAC) on the scrutiny of drugs imported into the country to the neglect of food and cosmetics has also enhanced the activities of unpatriotic marketers of tomato products (Shehu, 2013).

The main quality parameters of tomato pastes, as perceived by consumers are colour, consistency and flavour but less emphasis is laid on the nutritional and health benefits derived from consuming the processed tomato. Well-structured studies which examine the quality of different tomato brands sold in Nigeria are limited. Thus, this work is therefore aimed at providing data on the comparative evaluation of selected commercial tomato pastes obtained from Kano market with the intent of establishing the quality profile of available tomato pastes in the market and to identify possible adulteration.

2. Materials and Methods

2.1. Source of raw materials

Eight (8) tins of branded tomato pastes were randomly purchased from Yankura major market in Kano. Tomato brands, having corresponding sachets were also selected. This gave a total of seven cans and one sachet of different tomato brands. The selected tomato brands were all registered with the National Agency for Food and Drug Administration and Control (NAFDAC). Codes representing each tomato paste brands are presented in Table 1.

2.2 Sample selection criteria

The selection criteria of the studied tomato paste brands are presented in Table 2.

Table 1: Sample codes representing each tomato paste brand

Samples	Codes
La-mama tomato paste (Tin; P.R.C)	LAMAMA
Amaria tomato paste (Tin; Ghana)	AMARIA
Cito tomato paste (Tin; China)	CITO
St-rita tomato paste (Tin; China)	RITA
Sarah tomato paste (Tin; China)	SARAH
Sonia tomato paste (Sachet; Nigeria)	SONIA
Tasty-tom tomato paste (Tin; Nigeria)	TASTY
Luna tomato paste (Tin; Nigeria)	LUNA

2.3. Sample preparation

Each Tomato paste brand was opened by the use of a sterilized knife and the content was transferred into an already sterilized beaker and mixed thoroughly prior to analysis.

Table 2: Sample selection criteria

Sample	Packaging	Country	MAN. Date	BB. Date	NAFDAC No.	Batch No.
SONIA	Sachet	Nigeria	01-06-017	01-06-018	A1-7373	2016159
SARAH	Metal tin	China	06-05-016	06-05-018	01-3581	15GE194/6
LAMAMA	Metal tin	P.R.C	12-06-016	10-06-018	B-0003	3302/0103
LUNA	Metal tin	Nigeria	16-02-016	16-06-018	Bi-0462	0801A10:33
TASTY	Metal Tin	Nigeria	09-016	09-018	26084	8488
AMARIA	Metal tin	Ghana	05-04-016	05-04-018	08-6689	28/1As
CITO	Metal tin	China	22-02-016	22-02-016	Ao-1112	01-0216A
RITA	Metal tin	China	02-03-016	02-03-018	A1-8782	3200/01121

2.4. Preparation of media

2.4.1. Preparation of Peptone Water

Exactly 0.1% of peptone water was prepared by dissolving 1 g of peptone powder into 1000 mL of distilled water, dispensed into dilution bottles then sterilized at 121°C for 15 minutes and cooled.

2.4.2. Preparation of MacConkey Broth Medium

Thirty-Five grams (35 g) of MacConkey Broth powder was added into 1 liter of distilled water, dispensed into reaction tubes fitted with fermentation tubes (Durham tubes), then sterilized at 121°C for 15 minutes and cooled to 45°C.

2.5. Methods

2.5.1. Proximate analysis

The method described by AOAC (2012) was used in the determination of moisture, ash, lipids, protein and carbohydrate content.

2.5.2. Physicochemical analysis

The pH and titratable acidity determinations were done using the method described by Onwuka (2010).

The pH was determined with a table top universal pH meter which was calibrated using buffer 4 and 7. About 25 mL of the Tomato sample was placed in a clean beaker. The pH electrode was dipped into the solution and the pH value was recorded when the displayed value was stable. The titratable acidity was determined by diluting 10 g of each tomato sample in distilled water, after which 10 mL aliquot was transferred into a conical flask using a pipette. One (I) mL of Phenolphthalein indicator was added. The mixture was titrated against 0.1 N NaOH until a pink coloration that signifies an end point was obtained. The titration was repeated two more times and the average was recorded. The value for titratable acidity was calculated from the formula below:

$$\% \text{ Acidity} = \frac{\text{Titer value x } 0.007009}{\text{Volume of the sample}}$$

Note: 0.007009 is a factor for citric Acid

The viscosity content was determined by the method described by Eke-Ejiofor (2015). The viscosity of the tomato paste sample was measured after separation by centrifugation. Each sample was centrifuged at 3000 rpm for 15 minutes at 4˚C. The resulting supernatants were then transferred to an Oswald viscosity apparatus (#100 and # 200 hundred series) for viscosity analysis. The resultant precipitates (i.e., solids) were weighed, and the precipitate weight ratio (PPT) was calculated for each sample. Average values from triplicate measurements were reported.

The method described by Quartey *et al.* (2012) was used in the determination of total solids. This was determined by the gravimetric method. A measured weight of sample (5 g) was disposed into a previously weighed moisture can and was evaporated to dryness over a Geller-cup steam bath. The dry sample in the moisture can was then dried in the oven at 105°C until a constant weight was obtained. In each case, dried sample was cooled and calculated using the formula:

$$\% \text{ Total solid} = \frac{(W_2 - W_1) \text{ x } 100}{W_2 - W_1}$$

Where:

W_1= weight of the can only

W_2= weight of the can + sample before drying

W_3 = weight of the can + sample after drying

2.5.3 Lycopene and vitamin C analysis

The lycopene content was evaluated using the technique described by Ravelo-Perez *et al.* (2000) while the method reported by Postma *et al.* (2000) was used for the determination of vitamin C content.

2.5.4. Microbial analysis

Presumption Test of Coliform Group (MPN)

The method described by Eczema (2007) was used. Twenty-five (25) mL each of tomato paste samples and 0.1% peptone water were aseptically transferred into a sterile blender jar and blended for 2 minutes. Decimal dilution of 1:10, 1:100 and 1:1000 was prepared by adding 11 mL of the previous dilution to 99 mL of the sterile diluents. Three replicate tubes of MacConkey broth per dilution were prepared with 1 mL of the previously prepared 1:10, 1:100 and 1:1000 dilutions. The tubes were incubated for 24 and 48 hours respectively at 35.00 ± 0.50 °C. The tubes were observed for gas production either in the inverted vial or by effervescence produced when the tubes were gently shaken after 24 hours. Negative tubes were re-incubated for an additional 24 hours. All tubes showing gas within 48 hours were recorded. The result was reported as the presumptive Most Probable Number (MPN) of the coliform bacteria per gram of the sample.

2.6. Statistical analysis

The statistical package of social sciences (SPSS) software version 21.0 was used. The results were evaluated using analysis of variance (ANOVA) and were presented as the mean value ± SD (standard deviation of mean) for the samples. Differences among the means were assessed using the Duncan's Multiple Range Test to determine which mean values were significantly different at $p<0.05$.

3. Results and Discussions

3.1. Proximate composition

The results of proximate composition, presented in Table 3 revealed that, aside from fat content, there was no significant difference in the moisture, ash, protein and carbohydrate content of the different tomato brands that were evaluated. This implied that the different tomato fruits region of cultivation, and processing methods had minimal variation on these proximate properties of the selected tomato paste brands. The moisture content values (89.27 - 91.11%) were high compared to the values (69.00 - 84.85%) reported by Eke-Ejiofor (2015) and those reported by Abdullahi *et al.* (2016) (71.80 - 72.40%). High moisture content of the samples indicated low total solid content. Also, since moisture content is an index of food stability (Offor, 2015), it could be presumed that the samples would have lower shelf stability once the packaged is opened or ruptured. The ash content of the samples is quite low (0.82 to 1.06%). Ash content translates to the mineral content of foods (Ndife *et al.*, 2014), thus, the mineral contents of the selected tomato paste samples might be low. The protein contents of the samples ranged from 1.64 to 3.28%. These values are low which could be attributed to the impact of denaturation from heating operations.

Table 3: Proximate composition of tomato paste samples (%)

Sample	Moisture	Ash	Protein	Fat	Carbohydrate
LAMAMA	$89.38^{a}\pm0.24$	$0.95^{a}\pm0.01$	$2.24^{a}\pm0.07$	$0.91^{b}\pm0.03$	$6.02^{a}\pm0.52$
AMARIA	$89.56^{a}\pm0.61$	$1.06^{a}\pm0.01$	$2.19^{a}\pm0.00$	$1.09^{a}\pm0.06$	$6.10^{a}\pm0.52$
CITO	$89.27^{a}\pm0.39$	$0.82^{a}\pm0.02$	$2.74^{a}\pm0.77$	$1.00^{b}\pm0.01$	$6.17^{a}\pm0.37$
RITA	$90.09^{a}\pm0.60$	$1.02^{a}\pm0.03$	$1.64^{a}\pm0.77$	$0.99^{b}\pm0.03$	$6.32^{a}\pm1.37$
SARAH	$89.74^{a}\pm0.99$	$0.82^{a}\pm0.61$	$2.19^{a}\pm0.00$	$1.00^{b}\pm0.00$	$8.27^{a}\pm0.99$
SONIA	$90.55^{a}\pm0.44$	$0.94^{a}\pm0.05$	$3.28^{a}\pm0.00$	$0.81^{b}\pm0.00$	$4.42^{a}\pm1.04$
TASTY	$90.35^{a}\pm0.44$	$0.89^{a}\pm0.01$	$2.74^{a}\pm0.77$	$1.08^{a}\pm0.01$	$4.94^{a}\pm1.25$
LUNA	$91.11^{a}\pm1.57$	$0.72^{b}\pm0.01$	$2.19^{a}\pm0.00$	$0.99^{b}\pm0.16$	$4.99^{a}\pm1.53$

The data are mean value ± standard deviation (SD) of triplicate samples. Figures with different superscripts in the column are significantly different ($p<0.05$)

Although, protein content does not affect the commercial quality of tomato pastes but affects the overall expression of refractive index expressed as brix (Boumendjel & Perraya, 2008). AMARIA (1.09 %) and TASTY (1.08 %) had higher fat content compared to other samples. However, the fat content of the samples is generally low, which would be beneficial during storage. The carbohydrate content (4.42 - 8.27 %) is lower than the values reported by Onyeaghala *et al.* (2016), Eke-Ejiofor (2015) & Abdullahi *et al.* (2016). The low carbohydrate content is an indication of low starch content and minimal sugar level, which in-turn signified minimal or absence of adulteration (Lu *et al.*, 2014).

3.2. Physicochemical properties

The results of physicochemical properties are presented in Table 4. The pH content ranged from 3.75 to 4.35 with SONIA having the highest pH content while TASTY had the lowest value. These values are in agreement with the values (3.99 - 4.38) reported by Eke-Ejiofor (2015). The pH is a parameter indicating hygienic quality of tomato paste. Its decline is interpreted as an improvement in conservation since they are classified as canned food with pH below 4.5. More so, the pH values obtained in this study did not exceed the maximum pH (4.5) as recommended by Codex Alimentarius Commission (CAC) for tomato paste (CAC, 2011). Similarly, the acidity of the tomato pastes (0.36 - 0.49%) did not exceed the maximum acidity (7%) recommended by CAC. The viscosity (210 - 270 mP.s) of the tomato paste are considerably low and are lower than the values reported by Eke-Ejiofor (2015) (510.40 - 1074.35 Pa.s). Viscosity is an important technological factor which is influenced by the content of protein, pectins, polysaccharides and substances insoluble in alcohol (Gallais *et al.*, 1992). Sobowale *et al.* (2011) also reported that the viscosity of tomato products depends on fiber, protein, fat and total solids,

Table 4: Physicochemical properties of tomato paste samples

Samples	pH	Titratable acidity (%)	Viscosity (mP.s)	Total solid (%)
SONIA	$4.35^{a} \pm 0.01$	$0.46^{c} \pm 0.01$	$270.20^{a} \pm 0.03$	$9.45^{a} \pm 1.10$
SARAH	$3.94^{bc} \pm 0.01$	$0.40^{b} \pm 0.01$	$210.70^{b} \pm 0.74$	$12.26^{a} \pm 0.99$
LAMAMA	$3.73^{c} \pm 0.01$	$0.49^{a} \pm 0.01$	$270.03^{a} \pm 0.58$	$10.62^{a} \pm 0.24$
LUNA	$4.05^{b} \pm 0.01$	$0.37^{b} \pm 0.03$	$220.03^{g} \pm 0.20$	$8.89^{a} \pm 1.58$
TASTY	$3.75^{c} \pm 0.03$	$0.36^{d} \pm 0.00$	$240.42^{f} \pm 0.01$	$9.65^{a} \pm 0.44$
AMARIA	$3.93^{bc} \pm 0.01$	$0.41^{b} \pm 0.01$	$211.47^{b} \pm 0.91$	$10.44^{a} \pm 0.64$
CITO	$4.05^{b} \pm 0.01$	$0.47^{a} \pm 0.01$	$235.49^{c} \pm 6.82$	$10.73^{a} \pm 0.39$
RITA	$3.88^{c} \pm 0.03$	$0.37^{b} \pm 0.01$	$250.17^{d} \pm 0.53$	$9.98^{a} \pm 0.60$

The data are mean value ± standard deviation (SD) of triplicate samples. Figures with different superscripts in the column are significantly different ($p<0.05$)

while Hawbecker (1995) reported that viscosity is the combined effect of liquid soluble material, insoluble in suspension that contribute to the overall consistency of tomato paste. Thus, the low viscosity of the samples implied that the consistency and texture of the samples might be low. This could be attributed to the high moisture content (89.27 - 91.11%) present in the samples. The total solid of the samples ranged from 8.89 to 12.26%, which is below the standard level of 20 - 22% required by CAC (2011). These values are also lower than the values (15.15 - 30.99%) reported by Eke-Ejiofor (2015) but higher than the values reported by Nunoo *et al.* (2014) and Oko-Ibom & Asiegbu, (2007) with values ranging between 8.00 - 8.40%. The reduced level of total solids and high moisture content in the tomato pastes signified the possible presence of increased vitamin C content since water soluble vitamins increased with the presence of moisture and depreciates with increasing dehydration of the samples. Therefore, the processing steps of the selected brands may need adjustments in order to increase the concentration of total solids.

3.3. Lycopene and vitamin C composition

The results of lycopene and vitamin C composition are presented in Table 5. Vitamin C and lycopene are two important quality parameters used in assessing tomato paste. Similar to other food products, vitamin C in tomato acts as antioxidant, preventing the oxidation of some fatty acid component and plays some important vital role in the body metabolism. The vitamin C contents (19.36 - 23.58 mg/100 g) are high with AMARIA having the highest vitamin C content (23.58 mg/100 g). These values are higher than the values (5.71 - 10.00 mg/100 g) reported by Abdullahi *et al.* (2016). The level of vitamin C which increases with a decrease in total solids and vice versa in tomato is known to vary with Weather (Gharezi *et al*., 2012). This can be observed in the present study such that the level of vitamin C for all the studied samples is double the amount of their total solid contents. The results implied that the tomato paste samples sold in Kano contain appreciable amount of vitamin C. Lycopene has been found to be beneficial in neutralizing harmful radicals, which are implicated in cancer, heart disease, macular degeneration and other age-related illnesses (Agarwal & Rao, 2000), thus, lycopene is a strong quality index in fresh as well as processed tomato products. William *et al.* (2015) reported that processed tomato products such as pasteurized tomato juice, soup, sauce, and ketchup contain higher concentrations of bioavailable lycopene compared to the amount present in fresh tomato fruit. Also, Nguyen & Schwartz (1998) reported that the availability of lycopene from tomato products is increased when these foods are processed at high temperature or packaged with oil. They also reported that mechanical treatment (homogenization) and heating enhance the release of lycopene from the tomato matrix and may explain the improved bioavailability seen with consumption of processed tomato products (cooked tomato, tomato paste). This increase is as a result of the conversion of the unavailable trans-lycopene to the bioavailable *cis*-lycopene from the combined effect mechanical disruption and heat treatment. The lycopene content obtained in this study ranged from 20.36 to 27.93 mg/kg. These values are lower than the values (104.78 - 923.45 mg/kg) obtained by Eke-Ejiofor (2015), which implied that the studied samples in the present study possess lower quality with respect to lycopene content. More so, the variation in the lycopene content of the samples indicated different levels of processing deployed by companies of the studied samples.

3.4. Microbial composition

The microbial composition, specifically the total coliform count of the studied tomato pastes is presented in Table 6.

Table 5: Lycopene and vitamin C composition of tomato paste samples

Samples	Ascorbic acid (mg/100 g)	Lycopene (mg/kg)
LAMAMA	$20.77^{b} \pm 0.50$	$27.93^{a} \pm 0.06$
AMARIA	$23.58^{a} \pm 0.50$	$24.51^{c} \pm 0.06$
CITO	$21.47^{b} \pm 0.50$	$21.97^{de} \pm 0.01$
RITA	$22.53^{b} \pm 0.00$	$24.19^{c} \pm 0.27$
SARAH	$19.36^{b} \pm 0.50$	$26.15^{b} \pm 0.04$
SONIA	$22.88^{a} \pm 0.50$	$24.21^{c} \pm 0.03$
TASTY	$22.18^{a} \pm 0.50$	$20.36^{e} \pm 0.01$
LUNA	$20.06^{b} \pm 0.50$	$22.37^{d} \pm 0.00$

The data are mean value ± standard deviation (SD) of triplicate samples. Figures with different superscripts in the column are significantly different ($p<0.05$)

Table 6: Coliform bacterial count in the tomato pastes (cfu/g)

Samples	Dilution	Plate Count			Mean	CAC maximum limit
		Plate 1	Plate 2	Plate 3		
LAMAMA	10^2	26	28	25	$26.33^{b} \pm 1.53$	10 cfu/g
AMARIA	10^2	37	40	42	$39.67^{a} \pm 2.52$	10 cfu/g
CITO	10^2	29	27	30	$28.67^{b} \pm 0.88$	10 cfu/g
RITA	10^2	19	21	17	$19.00^{c} \pm 2.00$	10 cfu/g
SARAH	10^2	18	23	17	$19.33^{c} \pm 3.22$	10 cfu/g
SONIA	10^2	37	33	45	$38.33^{a} \pm 6.11$	10 cfu/g
TASTY	10^2	14	16	15	$15.00^{d} \pm 1.00$	10 cfu/g
LUNA	10^2	28	29	31	$29.33^{b} \pm 1.58$	10 cfu/g

The data are mean value ± standard deviation (SD) of triplicate samples. Figures with different superscripts in the column are significantly different ($p<0.05$)

The obtained values ranged from 15.00 to 39.67 cfu/g. The results showed that AMARIA and SONIA had the highest microbial load of 39.67 cfu/g and 38.33 cfu/g respectively while TASTY (15.00 cfu/g) had the lowest microbial load followed by RITA (19.00 cfu/g). However, the microbial load of the studied samples exceeded the maximum limit (10 cfu/g maximum) stipulated by Codex Alimentarius (CAC, 2011), which implied poor implementation of good manufacturing practices (GMP) and consequently poor microbial quality of the samples.

4. Conclusion

Comparative evaluation of the qualities of selected tomato pastes brands sold in Yankaba market, Kano was evaluated in the present study. The moisture contents of the studied tomato pastes are high with corresponding reduced concentration of total solids. Mores so, the tomato pastes are poor sources of mineral, protein and fat. The carbohydrate evaluation indicated that the samples had minimal or absence of adulteration. The pH and acidity of the tomato pastes were within the recommended limit of Codex Alimentarius Commission (CAC) while the viscosity of the samples was below the recommended limit. The microbial quality of the studied samples is poor and exceeded the maximum microbial load for tomato pastes as stipulated by CAC. However, the tomato pastes are rich in vitamin C and appreciable concentration of lycopene. Importantly, they are free from adulteration.

Conflict of interest

The authors declare that there are not conflicts of interest.

Ethics

This Study does not involve Human or Animal Testing.

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